Sustainable Production and Consumption 27 (2021) 1857–1868

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Research article

The promotion of innovative service business models through public procurement. An analysis of Energy Service Companies in Spain

Maria Concepción Peñate-Valentín[a], María del Carmen Sánchez-Carreira[b,c,*], Ángeles Pereira[b,c]

[b] Department of Applied Economics, Universidade de Santiago de Compostela, Spain
[b] ICEDE Research Group, Universidade de Santiago de Compostela
[c] CRETUS, Universidade de Santiago de Compostela

ARTICLE INFO

Article history:
Received 6 November 2020
Revised 31 March 2021
Accepted 25 April 2021
Available online 28 April 2021

Editor: Prof. Ming-Lang Tseng

Keywords:
Public procurement
Circular economy
Innovation
Business models
Energy service companies

ABSTRACT

Energy Service Companies are one of the most promising sustainable business models that may support the transition towards a more sustainable energy system and mitigate climate change. The existence of multiple barriers in the Energy sercives industry market suggest that public procurement is a useful tool to promote these innovative business models, reducing some of the extant barriers. This paper contributes empirically to analyse the role of public procurement to mitigate barriers and promote sustainable models through a multiple case study of seven Spanish regional and municipal projects centred on Energy Service Companies. The paper is based on a qualitative methodology, which combines the analysis of the projects public tenders and eight in-depth interviews with public and business managers of the energy efficiency projects. The Spanish market is highly conditioned by the large size of awarded companies and the predominance of the construction sector, while the participation of small and medium-sized enterprises is limited. The main insights gained through this research point out to the importance of Energy Services Companies to achieve environmental and economic goals. Finally, based on the analysis of barriers a set of recommendations to promote the uptake of Energy Services Companies by using public procurement are offered. These recommendations are collected in a guide that differentiates five steps, from the needs identification to the evaluation phase. In addition, solutions are proposed in accordance with the barriers identified and the type of company. In conclusion, the adequate analysis of barriers and the definition of ambitious and clear goals by the public sector support the effective use of public procurement of innovation to promote a more sustainable energy industry.

1. Introduction

Tackling climate change has become one of the major challenges for European society in the last years. This implies the adoption of numerous measures to mitigate CO_2 emissions associated with human activities. Buildings are the largest source of CO_2 emissions and their total energy consumption has been increasing in recent decades. More than 40% of the energy consumption in Europe is due to heating and lighting of its buildings (Pérez-Lombard et al., 2008; IEA, 2018). Through several directives, the European Commission agreed on a series of energy efficiency targets consisting of a 20% increase in energy efficiency by 2020 and at least 32.5% by 2030 (Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency). In addition to the use of renewable energy sources, there is a strong emphasis on the need to improve energy efficiency. The aim is to achieve a reduction in energy consumption, reduce impacts on climate change, as well as to reduce the economic bill and the European Union dependence on non-renewable energy sources.

The EU energy strategy includes many different measures to achieve these objectives, contributing to the EU leadership in energy efficiency. Particularly, the promotion of the energy services market, and especially encouraging the development of innovative and sustainable business models is one key milestone of this strategy. The adoption of sustainable business models by companies, based on offering product-service solutions rather

* Corresponding author.
E-mail address: carmela.sanchez@usc.es (M.d.C. Sánchez-Carreira).

https://doi.org/10.1016/j.spc.2021.04.028

Nomenclature of acronyms

CE	Circular Economy
EPC	Energy Performance Contract
ESCO	Energy Services Company
EU	European Union
ISCED	International Standard Classification of Education
PPI	Public procurement of innovation
PSS	Product-service systems
SME	Small and medium-sized enterprise

than selling products, has been recognized as a useful way towards the achievement of environmental objectives (Mont, 2002; Tukker, 2015; Witjes & Lozano, 2016). Services may contribute to dematerialization and to get resource and energy savings (Gadrey, 2010; Stahel, 2010; Djellal & Gallouj, 2016). In particular, result-oriented product-service systems (PSS) is the most innovative way of providing services to satisfy the customer needs, while reducing important environmental impacts (Tukker, 2004, 2015). The concept of innovative service-based business models has also been applied to other domains, such as electric vehicle charging stations (Wu & Chang, 2013) or the food and beverage industry (Lee et al,. 2014), showing its suitability for more efficient outcomes.

Most of recent literature about PSS focuses on business-to-business and business-to-consumers relationships and their contribution to a Circular Economy (CE) (Bocken, Short, Rana & Evans, 2014; Yang et al., 2018; Vence & Pereira, 2019). Nevertheless, the performance economy has also been linked to services provided to the public sector. Selling performance to governments usually consists of long terms contracts where the private sector manages operations and infrastructures, and provides integral support to optimise systems performance, usually reserved for the public sector. The partnerships are led by the government, which tries to address certain challenges, such as hazard reduction, risk transfer, capacity building, national competitiveness and improved governance (Stahel, 2010).

A promising type of innovative PSS are Energy Efficiency Service Companies. Besides the generation of important energy savings, it is highlighted the ability of Energy Service Companies (ESCOs) to drive sustainable innovation (COWI, 2008; Stahel, 2010). In recent years, there has been an increase in those services provided by private companies to the public sector. An ESCO is “a company that is engaged in developing, installing and financing comprehensive, performance-based projects, typically 5–10 years in duration, centred around improving the energy efficiency or load reduction of facilities owned or operated by customers” (Vine, 2005, 691). The innovative business model of ESCOs represents a catalyst for system-wide sustainability transitions (Bolton & Hannon, 2016). Indeed, there is empirical evidence that ESCOs help reduce energy consumption. On average, ESCO projects deliver energy savings of about 25% (IEA, 2018). It has been also proven that they help to mitigate CO_2 emissions; therefore, they contribute to reducing climate change (Fang, Miller, & Yeh, 2012; Fang & Miller, 2012).

The market for ESCOs in the EU has grown over the last few decades, although there are significant differences among countries. Furthermore, the markets differ by levels of maturity, types of contracts, presence of multinational and/or local companies, and are very determined by the context and political ambition of each country. In the case of Spain, the ESCO market has grown moderately in recent years. The market has been especially promoted in the public sector since Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 (Bertoldi & Boza-Kiss, 2017). Thus, there is potential to expand the market. However, significant barriers remain and hinder their diffusion. These barriers affect not only businesses, but also the public sector.

Usually, the shift to energy efficient street lighting presents two relevant barriers: street lighting is a major cost factor, and municipalities have limited budgets (Polzin, von Flotow, & Nolden, 2015). ESCOs represent an opportunity to overcome these barriers through energy service contracts. In recent years, a few countries have developed Energy Performance Contracts (EPCs) as a tool for improving energy efficiency in public buildings. EPCs involve two benefits for the public sector: a technical risks reduction, as a consequence of transferring the risks to the energy specialized private supplier; and costs savings, helping to manage public funds more efficiently (Roshchanka & Evans, 2016). For the private sector, EPCs with the public sector are an opportunity to broaden the market and to gain a relevant client. In this sense, Polzin et al. (2015) state that services involving third-party contractors (such as the public sector) can reduce certain obstacles and, at the same time, stimulate the diffusion of energy efficiency technologies.

Moreover, public procurement can be a useful tool for local governments to achieve social, innovation and environmental aims (Lember, Kalvet, & Kattel, 2011; Cohen & Amorós, 2014; Alhola, Ryding, Salmenperä & Busch, 2019). It also has several benefits for companies, such as opening new markets, generating knowledge and technologies useful to further develop new products and services, and fostering behavioural change in relation to innovation by companies. Thus, private companies may take advantage of the use of public procurement with environmental and/or innovation goals to shift to circular business models and to offer new green services that allow them to get competitive advantages while fulfilling a public requirement.

This paper seeks to enrich the existing literature on barriers of ESCO models from a public procurement perspective. To this end, the aim is to increase knowledge regarding the barriers and limitations of using the public procurement tool for these services. In so doing, the paper also aims to identify the opportunity of this tool to promote the ESCO market in Spain and to characterise companies.

To tackle the objective, the paper analyses several cases of ESCOs in Spain in order to identify good practices aimed at the successful implementation of energy efficiency projects, and to make recommendations that allow, through public procurement, to contribute to the expansion of sustainable business models with broad benefits for society.

The paper is structured as follows. In section two the conceptual framework is built, from the review of barriers to sustainable business models, with special attention to ESCOs. In addition, the key aspects of public procurement as a tool to promote the contracting of innovative services and the obstacles it faces are identified. In section three the methodology is explained, and in section four the results of the cases analysed are explained and discussed. The paper closes with a brief conclusion.

2. Literature review

2.1. Barriers to performance-oriented business models

The hybridization of products and services has been the focus of scholars from different disciplines along the last 30 years (Bryson, 2010) from managerial and marketing studies (Vandermerwe & Rada, 1988; Oliva & Kallenberg, 2003) to engineering and environmental sciences (Mont, 2002; Mont & Tukker, 2006; Tukker, 2015). Mont (2002 p. 239) suggests that a PSS is "a system of products, services, networks and supporting infrastructure that is designed to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models".

The increasing interest in this type of business model comes from its ability to contribute to the development of a functional or dematerialized economy, reduce the environmental impact of economic activity and move towards more sustainable models of doing business (Mont, 2002; Gaiardelli, Resta, Martinez, Pinto, & Albores, 2014; Stahel & Clift, 2016). Product-based, Use-Oriented and Performance-Based entail different types of product-service offering, with differential environmental impacts (Tukker, 2004; Gaiardelli et al., 2014). Especially Performance-Based PSS are in focus due to their potential contribution to resource efficiency and the Circular Economy (Bocken et al., 2014; Tukker, 2015; Vence & Pereira, 2019).

Energy service companies represent an example of product-service system business model based on selling performance. The Energy Services Directive (2006/32/EC) states that an ESCO delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, with the payment based, at least partially, on the achievement of energy efficiency improvements and on the meeting of other agreed performance criteria (IEA, 2018). However, other energy service provider companies, regularly also called ESCOs, do not bring the same energy savings neither are they based on offering performance (Boza-Kiss, Bertoldi, & Economidou, 2017).

ESCOs offering EPCs can drive innovation for sustainability (Stahel, 2010). Those types of services may contribute to lower emissions of the built environment and to realize the EU climate and energy policy objectives. A study at the EU level states that EPCs have been growing in the energy market between 2014 and 2016, though there are important differences across member states. Those types of contracts have achieved certain market penetration in public and institutional sector, including government facilities, schools, hospitals and street lighting (Boza-Kiss et al., 2017). A report from the International Energy Agency shows that the ESCO market in the EU grew up to USD 3 billion in 2017. This figure is reduced, compared with the mature US market, which was USD 7.6 billion, also very far away from the boom in China, where it reached nearly USD 17 billion in 2017.

Public policies have a relevant role in the creation and acceleration of the ESCO market (IEA, 2018). However, the still low presence of ESCOs and especially of EPCs in the market is due to the existence of numerous barriers, starting at the profitability of the incumbent business model, which benefits from scale economies, learning effects, adaptive expectations and network economies. The existing infrastructure at the household level (energy metering systems) and a regulatory framework that favours contracts with conventional energy companies are significant barriers to the adoption of ESCOs (Hannon, Foxon, & Gale, 2011). Alongside the barriers imposed by the incumbent model, due to the lock-in and path dependence phenomena that characterise technological change, ESCOs find other obstacles, which are related to the novelty of this sustainable business model.

The literature offers different perspectives on the analysis of these barriers, and we have classified them in Table 1. Some studies focus on the obstacles faced by companies wishing to implement business models based on ESCOs and EPCs. In this sense, legal and political barriers are those factors that, due to the existing regulation or lack thereof, hinder the implementation of these business models, e.g. unstable legislation and contradictory regulation (Bertoldi & Boza-Kiss, 2017). As institutional barriers several authors mainly refer to transaction costs and to procedures which, from the demand side, discourage this type of model (Bobbino, Galván, & González-Eguino, 2013; Lee, Lam, & Lee, 2015; Bertoldi & Boza-Kiss, 2017). A number of financial barriers are also found by companies to support the financing of their business models both by private and public sectors (Bertoldi & Boza-Kiss, 2017; Hannon, Foxon & Gale, 2015; Lee et al., 2015).

Closely related to institutional and financial barriers are information barriers, which make it difficult to convince customers, financial institutions and end users of the benefits of ESCOs (Bobbino et al., 2013; Bertoldi & Boza-Kiss, 2017). Finally, there are studies focusing on the customer point of view, and they highlight a number of barriers also of an informational nature, as well as related to rigidity of contracts (Hannon et al., 2015; Lee et al., 2015).

Moreover, Bolton & Hannon (2016) suggest that a synergistic relationship between a business model, investor perceptions of risk and a political framework is crucial to develop a successful energy project. In this sense, political actors play a crucial role and EPC projects need to be promoted from the government. Measures could include the modification of government procurement practices to facilitate EPCs and governments backing up a portion of ESCOs' guarantee to lending banks. In addition, ESCOs bring reinforcing and mutual benefits for private companies and the public sector. Polzin et al. (2016) state that services involving third-party contractors (such as the public sector) can reduce certain obstacles and, at the same time, stimulate the diffusion of energy efficiency technologies. EPCs represent an opportunity to overcome public street lighting barriers, such as the imbalance between the service cost and the reduced budgets of municipalities (Polzin et al., 2016). For the private sector, it is an opportunity to broaden the market and to gain a client with reliable resources. For the public sector, it involves two dimensions: the technical risks reduction, as a consequence of transferring the risks to the energy specialized private supplier; and the decline of costs, helping to manage public funds more efficiently (Roshchanka & Evans, 2016).

Existing literature reports various barriers in different geographical contexts at the supranational level (Bertoldi & Boza-Kiss, 2017), in developing countries (Painuly, Park, Lee, & Noh, 2003) and in single countries and municipalities (Bolton & Hannon, 2016; Bobbino et al., 2013), by using different methodologies. The current paper provides an insight into the Spanish market based on case studies, which allow for more detailed information on the projects. In addition, previous literature recommends an active role of the government in the procurement of efficient services. A study in the context of German municipalities suggests promoting EPCs through the creation of standard contracts (Polzin et al., 2016). Also in the Russian context, it is recommended public investment in research on EPCs and to set guaranteed savings contracts (Roshchanka & Evans, 2016), while another research in the UK focused on the system thinking approaches towards promoting wider system-level transitions (Bolton & Hannon, 2016). However, these studies do not analyse the potential of public procurement as a tool to promote ESCOs and do not offer a guide to set public procurement of energy efficient services. This paper attempts to fill this gap by analysing public procurement processes in energy efficiency projects, identifying best practices aimed at reducing barriers, both on the part of companies and the public sector.

2.2. Public procurement for promoting sustainable business models

The literature on innovation policies has not traditionally paid enough attention to the demand-side. The EU shows a growing interest on the demand-side, due to the perception of relative failures in the prevalent supply-side policies (Zelenbabic, 2015; Guerzoni & Raiteri, 2015). Nowadays, the European Union is addressing both side policies, as well as its coordination (Edler & Georghiou, 2007; Guerzoni & Raiteiri, 2015; Uyarra, 2016). (Sánchez-Carreira, Peñate-Valentín and Varela-Vázquez, 2019) also underline the relevance of the coordination of both perspectives in innovation policies.

Public procurement can be defined as the acquisition of goods and services by the public sector (Sánchez-Carreira, 2020). The

Table 1
Types and examples of ESCOs barriers.

Type of barrier	Examples of barriers	References
Lock-in incumbent model	Profitability of the incumbent business model	Hannon et al. (2011)
	Scale economies	
	Learning economies	
	Adaptive expectations	
	Network economies	
	Existing infrastructure household level	
	Regulatory framework	
	Hostile response from incumbent energy companies	Painuly et al. (2003)
	Lack of facilitators	Bertoldi & Boza-Kiss (2017)
Legal and political barriers	Unstable legislation	Bertoldi & Boza-Kiss (2017)
	Lack of official ESCO definition	
	Contradictory regulation	
	Technical: lack of standard and enforced M&V protocols, and accountability of ESCO	Bobbino et al. (2013)
	Market-related: lack of law harmonisation across regions, which limits ESCOs market	
Institutional barriers	High transaction costs	Bertoldi & Boza-Kiss (2017)
	Transaction costs of project financing	Lee et al. (2015)
	Administrative: public procurement process and administrative burdens	Bobbino et al. (2013)
	Lack of standardised energy service contracts	Painuly et al. (2003)
Informational barriers	Lack of measurement tools	Bertoldi & Boza-Kiss (2017)
	Market obstacles (lack of trust)	
	Informative: limited awareness of citizens, high perceived technical and financial risk	Bobbino et al. (2013)
Financial barriers	Difficulties for accounting of EPC projects	Bertoldi & Boza-Kiss (2017)
	Limited private finance	
	Instability of national financial grants	
	Lack of capital investment to cover the high upfront costs	Hannon et al. (2015)
	Need to build up the financial institutions's confidence	Lee et al. (2015)
	Financial: no suitable financing schemes	Bobbino et al. (2013)
	Aversion to long payback periods	
Customer barriers	Procurement-related barriers	Bertoldi & Boza-Kiss (2017)
	Lack of flexibility of long-term contracts	Hannon et al. (2015)
	Disruption to customer activities	
	Need to access confidential data	
	Perceptions about the actual level of energy efficiency	
	Existence of internal technical expertise	
	Inability to sanction energy service contracts	
	Lack of familiarity with the whole life cycle of an EPC project	Lee et al. (2015)
	Lack of flexibility for ESCOs retrofit proposals	
	Aversion to long payback periods	Bobbino et al. (2013)

Source: Own elaboration

public sector is a key consumer; thus, PP amounts to 2,1 billion euros in EU in 2017, which stands for around 14% of the EU GDP (European Commission, 2019), with considerable differences among countries and sectors. Public procurement is more outstanding in public services, in particular, in health, which accounts for 30.1% of the total public procurement in the OECD (OECD, 2019).

Besides its direct purchase power and the resulting indirect effects in the economy, PP may be used as policy tool to achieve additional goals, such as economic, environmental and social issues. Thus, it can drive innovation, sustainability, regional and local development, or equity and inclusiveness (McCrudden, 2004; OECD, 2019; Sánchez-Carreira, 2020).

The increasing literature about public procurement is mainly focused on innovation goals. However, the interest in the use of public procurement for environment goals is emerging, in particular at the municipal level (Cohen & Amorós, 2014; Ghisetti, 2017; Peñate-Valentín et al., 2018). In addition, public procurement may foster Circular Economy (Alhola et al., 2019). Thus, 28 OECD countries have a green public procurement strategy or policy in 2017 (OECD, 2019). Many EU countries have developed specific national action plans on GPP since 2005. In addition, environmental protection means 3% of total public procurement in the OECD (OECD, 2019).

Different kinds of public procurement can be identified depending on the classification criteria (Sánchez-Carreira, 2020). Considering the purpose of this paper, three main types of PP related with sustainability are highlighted. Firstly, sustainable public procurement is the broad term, referring to the three dimensions involved in sustainability: environmental, economic and social aims. Secondly, green public procurement as a specific kind of SPP focuses on environmental aims, attempting to decrease the environmental impact of products and services (McCrudden, 2004; Hoo, Dickinson and Chan, 2010). Finally, circular public procurement focuses on reaching a circular economy. In this sense, its main goals are reducing the use of resources and turning waste in resources through reusing, repairing or remanufacturing (Alhola et al., 2019; Sánchez-Carreira, 2020). These three kinds of PP do not necessarily involve the emergence of innovations, since it is not their main purpose. However, they represent an opportunity for the development of new products, processes and technologies (Alhola et al., 2019; Sánchez-Carreira, 2020). In this sense, they are linked with public procurement of innovation, which fosters innovation to meet the public needs. Thus, green public procurement of innovations is used to promote the development of innovations that meet environmental criteria. In fact, the growth of green and clean technologies in the last decade is closely linked to the driving role of the public sector.

The public sector is a pioneer in many activities, setting the pace for innovation and technological change (Gregersen, 2010). Thus, public procurement can drive the development of new services, goods, and markets (Van Meerveld et al., 2015; Ghisetti, 2017; Alhola et al., 2019). Public procurement of innovative products and services can be a signal for private users, supporting the diffusion of innovations in a sounder way than private demand incentives (Gavras et al., 2010). In this sense, public procurement of innovation (PPI) offers an opportunity for companies to innovate in services, being a particularly relevant tool to contribute to the development of more sustainable business models

Table 2
Types of public procurement barriers.

Type	Barrier
Development of Public Procurement	Inappropriate criteria and/or excessive weight of cost related criteria
	Combination of opposite objectives aimed at satisfying several stakeholders
	Management difficulties due to the existence of different strategic objectives in PPI
	Different rationalities that are necessary to understand and to manage
	Excessive rigidity of the specifications
	Selecting the most appropriate tendering process
Public Sector Constraints	Lack of organizational culture
	Risk aversion in the public sector
	Regulation and institutional framework
	Resource constraints from the public sector
Private Sector Constraints	Lack of technological development
	Asymmetric information
Public and Private Association	Lack of understanding between the public sector and the private sector
	Lack of trust between private and public sector

Source: Own elaboration based on Peñate-Valentín et al. (2018)

(Witjes & Lozano, 2016;Peñate-Valentín et al., 2018; Alhola et al., 2019). PPI opens up opportunities for technological development in sectors that lack the minimum market. Thus, public sector provides a 'lead market' for new technologies through demand pull (Lember et al., 2011).

The criteria used for the bids in any PPI project are critical to achieve the expected outcomes. In this sense, when public sector pursues environmental goals through PPI, sustainability criteria become crucial. Three types of environmental commitment can be established in the award criteria, from highest to lowest level of rigidity (Grandia et al., 2014): ecological criteria are essential and mandatory; ecological criteria are mandatory but non-exclusive for awarding the project; and ecological criteria are just recommended but non decisive.

The experience of several cities has proven that ecological criteria can lead to better results if the ultimate goal is a technological transformation in the medium and long term. Another aspect associated with criteria, which could benefit successful PPI sustainable projects, is to formulate the requirements in functional terms, which means describing the function instead of the characteristic of the product or service (Edquist & Zabala-Iturriagagoitia, 2020). This kind of PP gives room for flexibility and opportunities to innovate in the private sector.

PPI can foster innovation in services, playing a driving role for companies to adopt PSS business models (Cohen & Amorós, 2014; Alhola et al., 2019;Peñate-Valentín et al., 2018). Private companies may take advantage of PPI to shift to PSS and sustainable business models and to offer new green services that allow them to get competitive advantages while fulfilling a public requirement. At the same time, the public sector may use PPI to foster the development of more sustainable societies.

Public procurement processes face general barriers that may hinder the development of innovative and/or green solutions. In this regard, there are barriers affecting the preparation phase, such as type of criteria and the excessive weight of costs, as well as the proper definition of objectives. Another set of barriers refer to the main constraints for the public sector, such as the existence of risk aversion or the lack of organizational culture. In addition, the private sector suffers barriers from the lack of technological development or the emergence of asymmetric information. Lastly, there are certain barriers involving both the public and the private sector, such as the absence of understanding and/or trust between the agents. Table 2 summarizes these groups of barriers.

The aforementioned studies do not focus their research on the potential and barriers of public procurement to promote energy services addressing the characteristics of the companies. In this regard, this study attempts to fill this perceived gap and offer a categorization of specific barriers per type of company, as well as a framework to overcome them. Moreover, PP focused on contracting PSS offered by innovative companies may support the reduction of several barriers usually identified by public procurers, such as low experience, lack of flexibility, uncertainty, and duration.

2.3. Methods

PPI is still an underused tool in Spain, although the number of PPI projects has increased in recent years, in particular, projects related to sustainability, favouring ESCOs. This paper studies the experience of seven cases of new business models fostered by PPI, which were implemented in different regions of Spain.

This paper is based on the multiple case study methodology to address in a comprehensive and multidimensional way the characteristics of ESCOs and public procurement processes aimed at contracting energy efficiency services in Spain. The case study is an appropriate methodology to analyse a contemporary phenomenon in its real environment (Yin, 1984; Eisenhardt, 1989, 1991), and has been used previously in research on the topic (Bolton & Hannon, 2016; Roshchanka & Evans, 2016). A relevant advantage of the multiple case study methodology is that it allows the replication and expansion among individual cases, as well as it underlines the complementary aspects (Eisenhardt, 1991). The case studies can be used to accomplish different aims: provide description, test a theory or build theory (Eisenhardt, 1989; Corley & Gioa, 2011). This research has a descriptive purpose, as it seeks to identify the key elements that influence the implementation of ESCOs in the public sector. However, it also implies the development of theory (Glaser & Strauss, 1967; Gioa, Corley, & Hamilton, 2013; Taylor, Bogdan & DeVault, 2016) regarding the barriers affecting these experiences and the means to overcome them.

The case study methodology carried out in this research has been replicated in the seven selected cases. The unit of analysis is the ESCO project and the analysis seeks the identification of their main characteristics and barriers, paying special attention to the size and type of companies.

The cases were selected from an own database which collects 114 PPI projects from the different Spanish regions, as well as national cases. These cases were identified in the Official Journals of the regions analysed. They were selected because they fulfilled the following criteria: they implied the participation of a company that switched from selling products to the provision of services (fully or partially); ecological criteria were critical for the selection of an offer; and innovations (radical or incremental) were developed.

The research was based on the joint use of various sources of evidence: tender specifications and in-depth interviews with agents involved in contracting. Thus, the research was conducted in two phases. The first phase consisted of the descriptive analysis

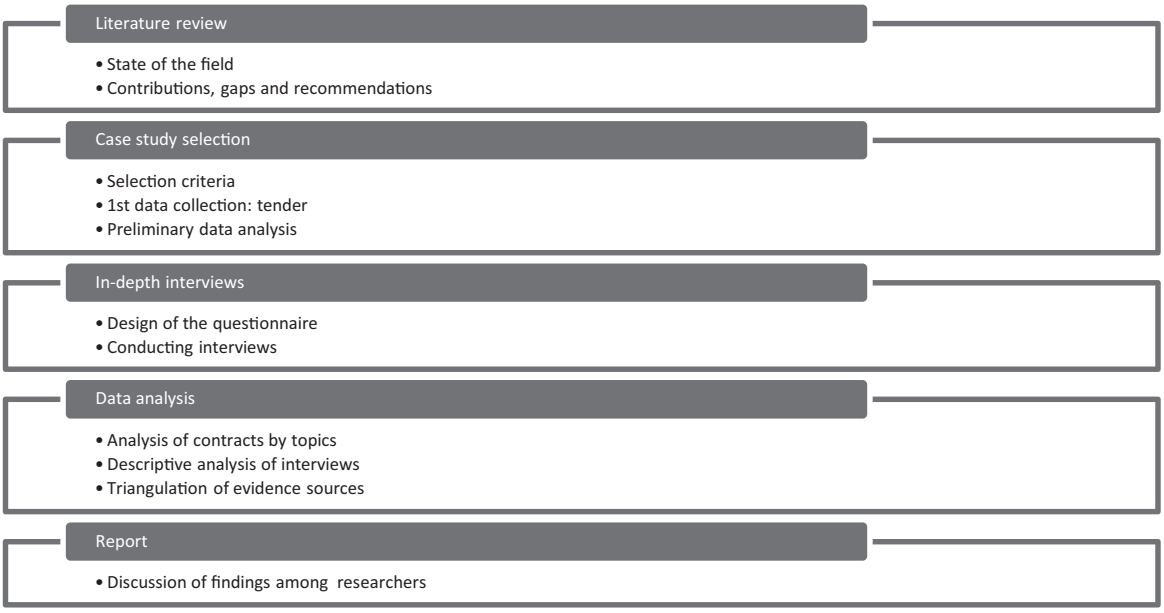


Fig. 1. Case study research steps.
Source: Own elaboration based on Yin (1984), Eisenhardt (1989, 1991).

of the aforementioned cases. During the second phase, this analysis was complemented with interviews with key agents to identify the barriers. These interviews were conducted between the years 2018 and 2020. A semi-structured questionnaire was designed, in order to identify some crucial aspects, such as successful factors, barriers and lessons for the future. This basic questionnaire is included as supplementary information in the Section 1 of the Supplementary Information.

Therefore, in addition to the qualitative analysis of the obtained data, eight interviews were conducted among key actors from the public and the private sector. The data from the interviews were captured by taking notes. The interviews were conducted by the research team, with different roles. Thus, while one researcher handling the interview questions, the others observe, took notes and remarks (Eisenhardt, 1989). The qualitative information from the interviews was analysed using several steps. The first step consisted of gathering information from the interviews and turned it into categorized parts. Then, the connections between these categories were identified and aggregated into broader categorizations or group of topics, such as barriers or success factors. Finally, fundamental categories were selected, analysed and linked with the remaining information. The analysis of the categorized information was descriptive and interpretative. Fig. 1 summarizes the research flow used for this study.

The interviewees were chosen according to the following criteria: they had participated or are currently involved in public procurement processes; their company switched from selling products to the provision of services (fully or partially) and developed innovations in order to satisfy the public demand; or they belong to public organisations that established ecological criteria. Experience in both the public and private sector was identified in one of the interviewees. Four of the interviewees are public procurement officers. From the public sector, the interviewees worked in the procuring units and, in some cases, were also the final users. Two agents focus their work on large procurement processes, while one of them has participated both in smaller and larger procurement processes. Moreover, it should be underlined that one of these actors has the experience of participating in public procurement processes from both sides: from the private sector, in a large international enterprise; and from the public sector, preparing the offers for the public tenders as well as being responsible of training public personnel and managing the services provided by the enterprise. Concerning the private companies, the four interviewees belonged to large companies, as well as SMEs. Their position was related to the contracting activities of these companies. Two of the interviewees come from large size companies related to construction and/or environmental services. These companies are based in Spain but offer their services worldwide. One of these companies usually cooperates with smaller ones, sometimes directly cooperating with them or as part of a subcontract. The third interviewee works in a small size company from the ICT sector. The fourth enterprise is a medium sized one, which develops its activity in the ICT managerial sector. Because this is a case study, the aim is to illustrate how the barriers are perceived from the perspective of the different agents, rather than to achieve representativeness. The conducted interviews lasted around one hour, being extended up to one hour and a half in some cases. The educational background of these informants is above bachelor level or equivalent, according to the International Standard Classification of Education (ISCED). Even one interview has education at doctoral level and other two at master level. Concerning their experience, all the interviewees present at least 5 years of experience. Two of them exceed 20 years, while only one does not reach 10 years. Table 3 summarizes the main characteristics of these informants. These insights, in conjunction with the data gathered from official sources, were necessary in order to seek successful factors and barriers. Successful experiences are relevant for promoting innovation in services through PPI (Stern et al., 2011). From this point of view, public policy could play a role in promoting these companies as a way to foster eco-innovative services with benefits for the society as a whole.

3. Results and discussion

3.1. Energy Service Companies cases in Spain

The energy efficiency projects that are analysed in different Spanish regions and cities present some common features. All of the projects are led by a combination of environmental and economic objectives. The environmental savings lead the way to eco-

Table 3
Main characteristics of the interviewees.

Informant	Nature of the organization	Role in the organization	Length of the interview	Years of experience	Educational background
Interviewee 1	Public	Public procurement officer	85 minutes	Between 20-25	Doctor
Interviewee 2	Public	Public procurement officer	75 minutes	Between 15-20	Master
Interviewee 3	Public	Public procurement officer	65 minutes	Between 10-15	Bachelor
Interviewee 4	Public	Public procurement officer/ Contracting and training unit	97 minutes	Between 10-15	Bachelor
Interviewee 5	Private	Procurement consultant	50 minutes	Between 15-20	Bachelor
Interviewee 6	Private	Contracting unit	58 minutes	Between 5-10	Bachelor
Interviewee 7	Private	Contracting and training unit	80 minutes	Between 10-15	Bachelor
Interviewee 8	Private	Procurement consultant and contracting unit	78 minutes	Between 20-25	Master

Source: Own elaboration

Table 4
Main characteristics of the Spanish PPI and ESCOs cases analysed.

Region/City	Duration	Procurement objectives	Objectives fulfilled	Environmental savings
Galicia Hospital Complex	8 years	Maintenance of facilities Energy supply	Installation of a cogeneration plant An innovative modulating system Maintenance service and energy management Replacement of the existing lighting	50% in lighting 25% in air conditioning 3,900 tonnes of CO_2
Bilbao Bilbao Fine Arts Museum	4 years	Energy management Special features: comfort conditions, maintenance of moisture conditions and lighting to preserve the contents	Energy management, with the special features requested	23% in electricity 18% of the overall consumption
Canary Islands Regional government	15 years	Reduction of energy consumption in official buildings	Energy management of buildings Maintenance Renewal of the public facilities	3.2 million kilowatts a year
Canary Islands Municipality of Moya	18 years	Energy efficiency of the street lighting and official buildings	Replacement of old lights to install new technology Energy management of buildings and street lighting	33,700 kilowatt/hours per year
Castellon	12 years	Energy management of public lighting and municipal buildings	Installation of innovative lights Management of municipal buildings	66,3% of energy consumption 280 tonnes of CO_2 per year
Castellon The City Council of Nules	10 years	Development of an information and energy management system	Innovative services Energy efficient printing, scanning and photocopy equipment	18,400 euros/year Energy consumption
Castellon	12 years	Rent of energy efficient printing, scanning and photocopy equipment	Reduction of energy consumption	Energy and cost reduction Savings of more than 3,500 euros per year Nearly ten tons of CO_2 have not been released to the atmosphere

Source: Own elaboration

nomic savings for public procurers, due to the reduction of energy consumption. The contracts set medium-long terms and are in most of the cases flexible with regards to technical standards, thus, they offer room for innovation to companies in order to provide an adequate solution.

The Spanish ESCOs market status is small. According to Boza-Kiss et al. (2017), even though almost 1,000 companies were inscribed as energy service providers in 2015, only a small segment works as an ESCO to all purposes. The established sectors are primarily public lighting in buildings, hospitals, schools, etc.

The legal changes are particularly important for ESCOs in Spain, as it has been a pushing force for this market. In this regard, some opportunities may arise for further development, if there is governmental support.

The seven cases are described in the Section 2 of the Supplementary Information and an analysis of the main characteristics is conducted next. The conducted interviews were aimed at fulfilling the particular goals of this research. Table 4 presents the potential results of these projects regarding energy savings and consumption reduction.

In summary, the Spanish ESCOs analysed attempt to develop innovative solutions for energy efficiency. They also intent to adopt new systems and technologies for efficient energy management in buildings and street lighting. All the ESCOs offer services aimed at optimizing consumption, reducing energy costs of installations and buildings, and minimizing CO_2 emissions into the atmosphere. These companies perform energy audits and monitoring, as well as measure the consumption of energy and resources. They set energy saving targets to be accomplished not only by the implementation of several improvements, but also by offering ongoing maintenance. In this context, PPI projects have been launched with the objective of decreasing the costs for the public sector in the medium and long term, and have acted as incentives to promote sustainable business models focused on reducing energy consumption and toxic emissions.

This finding is important because it makes visible the benefits for the customer (public sector) and society in general, in terms of consumption efficiency, lower energy costs and improved environmental performance. Thus, it is possible to reduce uncertainty, one of the elements of these projects that generates barriers such

Table 5
Main characteristics of ESCOs analysed in Spain.

Location	Operating regions/countries	Size	Turnover (year)	Awarded contracts (cases analysed)	Main activity	Services	Other characteristics
Madrid	Spain, Portugal and United Kingdom	Large	Over 30 million euros	5	Construction	Wide range of services: cleaning, security, management, eco-management, etc.	Belongs to a relevant Spanish construction group operating in international markets
Madrid	National level	Large	Over 30 million euros	2	Construction	Management and control services in several areas, such as environment and energy	Oldest ESCO analyzed (almost 40 years old); it started in the construction sector
Valencia	National level	Medium	NA	2	Construction	Sustainable construction and energy management	
Castellon	National level	Small	Less than 3 million euros	1	Construction	Specialized construction and management of buildings	
La Rioja	National level	Small	Over 10 million euros	1	Services	It offers both energy related products and services	
Barcelona	National level	Small	Less than 600,000 euros	1	Services	Energy services: audit, management and control of energy consumption	Only one specialized exclusively in energy services

Source: Own elaboration

as distrust on the part of the customer or financial obstacles, as referred by Bobbino et al. (2013) and Bertoldi & Boza-Kiss (2017).

The analysis of the cases presented in this study allows identifying certain characteristics of the ESCOs operating in Spain. Six companies have been identified through the analysed cases, and their main characteristics are presented, classified from the most awarded company to the least one. The different companies show a set of heterogeneous characteristics, with one company being predominant in most of the cases. Table 5 presents the main characteristics of these Spanish ESCOs.

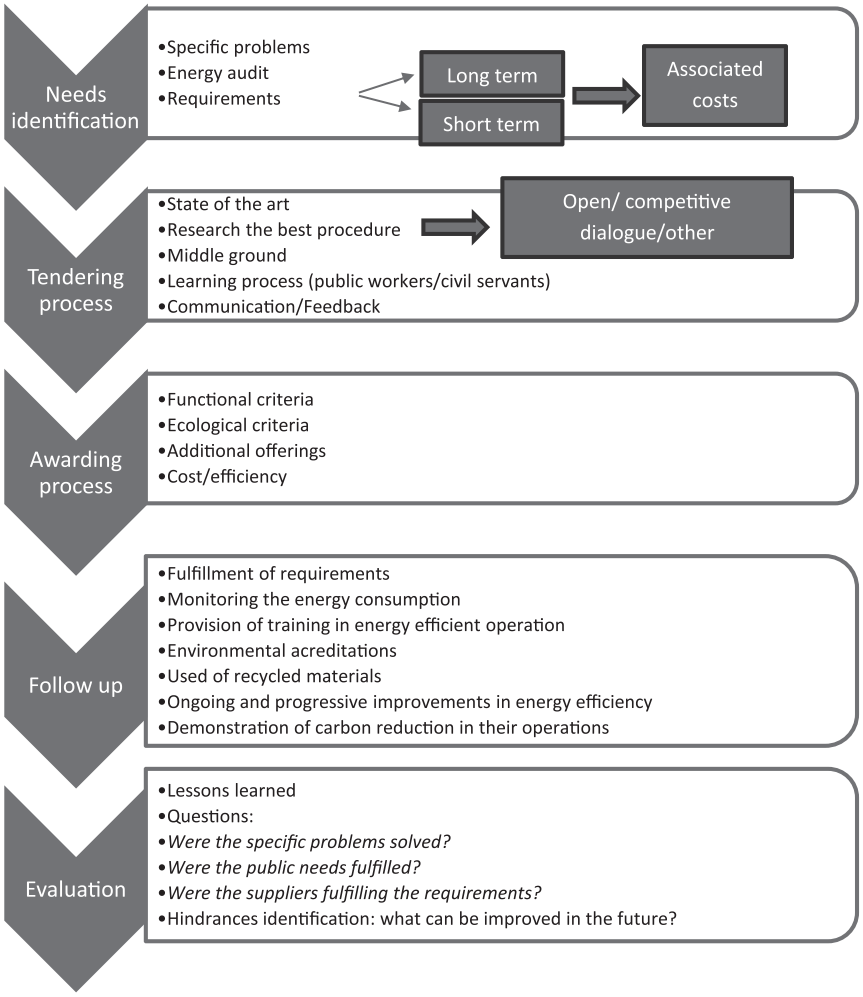
The most awarded companies in the analysed cases for this study share common characteristics: they are large companies, with high revenues, and offer multiple services. They come from or are linked to construction companies or groups, which have numerous international contracts (both private and public). Most of the small companies are also related to construction and they have included energy related services in recent years (less than ten years). Only one of the smallest companies offers energy audits and energy management services, as its main activity. Therefore, multiservice large companies with experience in the construction and/or energy sectors are the most awarded, even in regions where there are local companies offering similar services (although smaller and less experienced). In this sense, although some relatively small companies are awarded, it seems that the adoption of PSS through PPI is mostly handled by large multiservice companies, with experience in the field. Hence, the analysis of these seven cases shows that PPI could represent a better opportunity for larger companies, while most of smaller companies may struggle to win public contracts, when the size of the tender is large and involves a long period of time. This finding agrees with the results gathered by Uyarra et al. (2014), where they identify that certain barriers are more relevant for small firms. Furthermore, the fact that almost all of these companies started their activity offering different services and products and have added services related to energy and emissions management and control, proves the increasing market interest in this type of service. In this sense, public procurement plays a key role, contributing with its procuring capacity to this expansion. Small and medium size (SMEs) companies face several challenges concerning public procurement, such as the lack of resources and capabilities. In this way, SMEs can benefit from the collaboration with other companies or the participation in partnerships, due to the access to external recourses, the building of capacities and competences, and the achievement of learning and experience (Saastamoinen, Reijonen, & Tammi, 2018; Sánchez-Carreira et al., 2019).

3.2. Analysis of barriers

The analysis of these Spanish experiences, along with the conducted interviews, allow pointing out certain critical questions for procurers and suppliers. Addressing these topics may become crucial to innovate and satisfy the public demand, while developing a successful sustainable business model. At the same time, procurers and suppliers may find here a guideline to overcome significant barriers, which is the result of the previous analysis. Fig. 2 summarizes the main steps and guidelines for public procurers in this process. These steps were the result of the analysis of cases, as well as the remarks collected during the interviews.

The first step refers to the needs identification, where the public demand observes specific problems and the associated requirements to solve them. In this step, the procurer must identify between long and short-term issues, as well as the costs involving each time frame. This step may depend upon an energy audit to support the analysis and decisions taken. The energy dependency on the region determines the needs and limitations to consider in a tender. Therefore, procurers must study said energy dependency concerning the region and/or buildings prior to the tendering process, as it was also stated by Peñate-Valentín et al. (2018). This step may require conducting an energy audit, as it was mentioned in the cases analysed and the interviews.

The second step is the tendering process, which will be the result of the needs identification step. The tendering process is also highlighted as crucial by Uyarra et al. (2014), Edler et al. (2015) and Edquist & Zabala-Iturriagagoitia (2020). Knowing the state of art is a key aspect during this phase to establish whether the needed solutions are feasible or not. In addition, one major aspect to consider is the coordination of the demand with the appropriate offer. Establishing a middle ground for both procurers and suppliers has been pointed out as a crucial issue for both parties, during the interviews. It is also a barrier pointed out in the literature, especially from the customers view (Bobbino, 2013; Hannon et al., 2015). In this sense, practices such as the competitive dialogue may open a



Source: Own elaboration

Fig. 2. Main steps and guidelines for public procurers.
Source: Own elaboration.

way to connect public needs with the state of the art and convey a suitable innovative service. In any circumstance, fluid and clear communication becomes essential for this procurement to be successful, as Uyarra et al. (2014) also underline. In this sense, procurers must research and identify the most suitable procedure for each scenario.

The awarding process is related to the objectives and criteria set in the previous step. In this regard, functional and ecological criteria must be taken into consideration, since they are crucial to achieve environmental and innovation goals. Companies may include additional offerings that go beyond the demands of the procurer; and these offerings may add value to a specific offer. On top of this, procurers must evaluate the link between cost and efficiency of each offer, in order to determine which proposal is the most suitable one, according to their needs. This step may support the reduction of informational and customer barriers (Bobbino et al., 2013; Bertoldi & Boza-Kiss, 2017).

After these steps, there is a follow up phase, where procurers examine and monitor the fulfilment of the established requirements. This step involves scrutinizing if the providers are achieving the reduction of energy consumption, using recycled materials, improving energy efficiency, diminishing the use of carbon in their operations, or even if they provide any kind of training in energy efficient operations.

Lastly, procures must face an evaluation step which will gather all the information from the lessons learned and hindrances observed during the process. In this step, some questions may arise, such as if the specific problems were solved and the needs satisfied, or if suppliers successfully fulfilled their commitments. In sum, this step allows identifying what needs to be improved in the future. This step is aimed at increasing flexibility and ability to setting retrofit proposal, which are obstacles mentioned in the ESCOs literature (Hannon et al., 2015; Lee et al., 2015).

The length of the contracts is another relevant point. The companies may need to invest a substantial part of their budgets on the development of new services. If the contract length is too short, this may discourage this private investment. This was a crucial point according to the interviewees from the private sector and it aligns with the findings addressed by Hannon et al. (2015). In addition, the high costs associated with the development of innovations may hinder the adoption of eco-innovative services. Sometimes this barrier may be overcome by dividing the tender in smaller lots to encourage the participation of smaller companies or the cooperation between companies with different sizes. However, the nature of the public needs could impede this practice and certain tenders could not be divided into lots.

Another relevant issue is the specifications related to the tender. In this regard, procurers should consider including manda-

tory (required by the tender in order to enter the process) ecological criteria whenever possible. This inclusion has been proven crucial in the cases analysed, and it has also been pointed out as a successful factor during the interviews, as it was concluded by Grandia et al. (2014). It would also mitigate important institutional, legal and political barriers, such as lack of definition and standards of ESCOs (Painuly et al., 2003 Bobbino et al., 2013; Bertoldi & Boza-Kiss, 2017). In addition, the use of functional criteria in the tender has led to overcome the lack of knowledge of the existing technology in the case of the procurer. Hence, the importance of functional public procurement has also spurred creativity and solutions adaptability in the private sector. Edquist & Zabala-Iturriagagoitia (2020) also bring up this finding.

For the private sector, several hindrances can be addressed. These hindrances may differ depending on the size and/or expertise of the companies. The conducted interviews have shown differences regarding their frequency of appearance. Sometimes the companies have the capacity to compete but ignore how to participate or even enter the public tender. In this scenario, companies can use the support of consultancy, internal and/or external. Understanding public procedures is the first step to avoid an unsuccessful proposal. It is helpful to build trust and transparency and mitigating information barriers.

If companies lack the necessary experience to enter the bidding, as could be the case for SMEs, they can associate with experienced ones and make a joint offer. In this sense, SMEs show difficulties to participate on their own. One possible solution may come from the partnership with other companies (same size and/or different sizes), which can help to build a study and competitive offer. In addition, these companies may benefit from public support. This barrier appears to be rarely relevant for large companies, according to some of the interviewees.

The lack of experience of the sector and its needs can be overcome by cooperating with the public sector (Uyarra et al., 2014; Edler et al., 2015). A dialogue with the procurer may contribute to shape the project in concordance with the observed problems and the state of the art. In this regard, companies must research the fields where there is a lack of understanding. Associating with expert partners is another possible recommendation to avoid this barrier.

Financial barriers commonly identified in the literature on ESCOs (Hannon et al., 2015, Bertoldi & Boza-Kiss, 2017) also emerged in the interviews. The lack of funding is an issue usually faced by SMEs. This particular barrier will be more relevant if the size of the project is substantial. Partnerships, again, can help to surpass this step. However, public funding can also be crucial, since several programs support private innovation (for instance, supply side innovation policies). Some forms of private funding are appropriate too, in particular, at the first stages of the process.

The presence of step backs during the tendering process strikes as being less frequent than other barriers, but not less important. In this scenario, companies can explore the inclusion of partners and experts that may locate the problem and help solving it. The support of internal or external consultancy may also be recommended.

Most of these step-backs can be solved through an appropriate dialogue and communication with the procurer. However, if there is a lack of communication and understanding between the procurers and the suppliers, this might be troublesome. Therefore, some measures should be taken into consideration, such as the use of mediators or negotiators. In addition, the aid of bureaucracy experts can be helpful to avoid misunderstandings. In this sense, some procedures, such as competitive dialogue might contribute to a better understanding of the parts, lowering institutional barriers (Bobbino et al., 2013).

Table 6 summarizes the barriers identified in the study of these cases and the interviews carried out, as well as how frequent they were perceived. It should be noted that most of the identified barriers agree with the results of Uyarra et al. (2014) and Edler et al. (2015) focused on supplier perspective in PPI.

4. Conclusions

This paper analyses the role of public procurement in stimulating the development of sustainable business models focused on energy efficient services. It examines data from seven cases of ESCOs that developed innovations for the public demand in the country, and interviews eight actors from both the private and the public sector. This research contributes empirically to identify economic and environmental benefits of Energy Service Companies, as well as to showcase how public procurement processes may be developed to promote these services and reduce extant barriers.

4.1. Theoretical implications

Based on existing theory, this paper assumed the deterring effects of different factors towards the implementation of sustainable business models, as well as the dynamizing role of public demand in promoting innovation. The results allow to confirm the existence of barriers previously identified in the literature and to shed new evidence on the field. The companies face different barriers to participate in public tenders, such as the lack of experience, specific knowledge of the process, knowledge on the ESCO market and EPCs, as well as resources and funding constraints. Other crucial issue concerns the proper identification and transmission of needs from the public sector. These barriers are more critical for SMEs.

4.2. Practical implications

The proper identification of the barriers found in projects running in Spain allowed to suggest proper solutions to address and mitigate those obstacles, including specific recommendations for SMEs. Therefore, this research provides a guide for the agents participating in ESCOs projects via PPI, which constitutes a novel result. This guide constitutes a useful tool to practitioners and policymakers to use PPI properly for environmental objectives. In this sense, public procurement can trigger Circular Economy, facilitating the adoption of sustainable service-based models. The projects developed in the different Spanish regions and cities show that public procurement may support the development of new services, particularly related to energy efficiency. Firstly, through tendering processes that set performance objectives rather than specific and rigid products/services characteristics, public sector favours the development of several types of innovation. Secondly, the different procedures, such as the competitive dialogue, are key to provide an adequate environment for innovation. At the same time, through service performance contracts, companies find incentives to develop or adopt other technological innovations (new products and services).

In addition, the promotion of ESCOs through PPI for services contributes to achieve economic and environmental goals. By setting performance objectives, the government achieves important energy cost savings, which is highly relevant in times of budgetary constraints. In order to maintain their economic competitiveness, the companies that get these projects need to find and implement eco-efficient solutions. The length of the contracts and the financial resources of governments act as incentives for companies to innovate.

Table 6
Barriers and proposed solutions per type of company.

Barriers	Small/Medium companies Addressed as frequent	Possible solutions	Large companies Addressed as frequent	Possible solutions
Lack of experience/specific knowledge about the process	Often	Consultancy services Public support	Rarely	Consultancy services Internal advisors
Capacity to participate in its own	Very often	Partnership with other companies (same size and/or different sizes) Public support	Rarely	Partnership with other companies (same size and/or different sizes)
Lack of knowledge of the project/sector/needs	Often	Cooperate with the tender Dialogue with the procurer Research the fields Associate with experts partners	Rarely	Cooperate with the tender Dialogue with the public sector Research the fields
Lack of funding	Very often	Partnerships Public funding (EU, national, regional…) Private funding (business angels…)	Rarely	Partnerships Public funding (EU, national, regional…)
Step backs/problems	Rarely	Explore including partners and/or experts External consultancy Dialogue with the procurer	Rarely	Explore including partners and/or experts External/internal consultancy Dialogue with the procurer
Lack of communication with the public sector	Often[a]	Mediators/ Negotiators Competitive dialogue (when possible) or similar procedure Bureaucracy connoisseurs	Often[a]	Mediators/ Negotiators Competitive dialogue (when possible) or similar procedure Bureaucracy connoisseurs

Source: Own elaboration
[a] It usually depends on the tendering process.

Through PPI, companies may have certain guarantee for a market, within a specific time frame and sufficient information; they find incentives to invest in new product-service developments; they reduce pricing risks; they have a clear signal for combining economic and environmental value in the proposal. In some cases, there is an interaction among stakeholders that may help to reduce risks and uncertainties for both companies and hosts. In addition, the implementation of energy efficiency services sets an example for others; thus, it creates an environment that favours the learning of other companies, regarding both organizational and technological capabilities.

Overall, these cases show successful experiences from companies that developed energy related services, proving the potential of ESCOs. In this sense, we observed that the procuring capacity of the public sector endows the diversification of companies that started in a different sector. Thus, PPI can play a key role to foster innovative and sustainable services.

4.3. Limitations and future research lines

This research presents some limitations, which should be mentioned. First, the need for an extended period of time to evaluate the long-term effects of these experiences. Second, retrieving data from the cases entailed certain difficulties due to the complex identification of PPI cases. Third, the results also show some unintended effects of the projects, and open future lines of investigation. In this regard, PPI could be promoting new service models in large companies, in particular, developing eco-related services, while being less useful for small ones. It would deserve additional research to understand how SMEs may take advantage of financial resources and long-term contracts to do their service innovation journey. Another research line will focus on the systemic effects of using PPI to promote sustainable transitions, as well as the implications for employment and regional development of servitized companies.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to thank the valuable collaboration of the interviewees. The research leading to these results has received funding from the European Community's (Horizon 2020 grant agreement No. 730378) the Spanish Innovation Agency (grant agreement ECO2017-87142-C2-1-R). The authors belong to the Galician Competitive Research Group GRC ED431C 2018/23 and to the CRETUS Strategic Partnership (ED431E 2018/01). All these programmes are co-funded by ERDF (EU).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.spc.2021.04.028.

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