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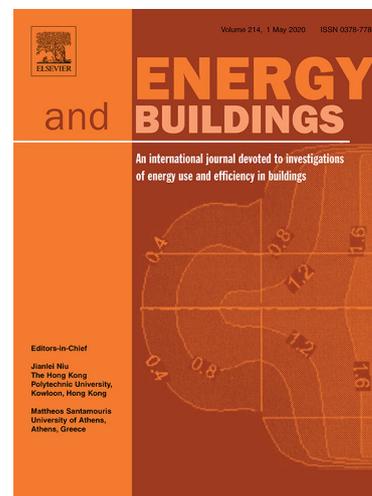
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The role of one-stop shops in energy renovation - A comparative analysis of OSSs cases in Europe

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Abstract

With energy transition setting the ground for innovation and new ways of conducting business, one-stop shops (OSSs) have recently gained momentum in the renovation market. By transforming a complex set of multiple-actor decisions into a single entry and customer-centric service, OSSs have the potential of establishing a bridge between the fragmented demand and supply sides of the traditional renovation value chain. To assess the viability of the OSSs model as a vehicle of accelerating decarbonisation efforts in the European building stock, this paper collects and analyses 63 case studies of OSSs across Europe. The study offers insights into the dynamics of their business model, key benefits and ways forward, by explicitly exploring OSSs' role in incentivising homeowners to decide to renovate. Our findings show that OSSs can be instrumental in addressing the multitude of barriers that prevent homeowners to renovate. With around 100,000 OSSs projects per year, their activity is expected to substantially contribute to the European renovation targets to rise, subject to favourable policy framework, availability of affordable financing solutions and experience sharing within and across countries. With some OSSs already supporting vulnerable households to renovate, OSSs might be well-placed in the future to contribute to tackle energy poverty by assisting in accessing financing and engaging property owners to renovate.

Keywords:

Energy Renovation; Energy Efficiency; Residential Sector; One-Stop-Shops; Renovation Barriers; EU Energy Policy

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1 Introduction

The EU has called for carbon neutrality by 2050 in its Communication on the Long Term 2050 climate action strategy³, where energy efficiency was identified as a major contributor to achieve the decarbonisation efforts. A large portion of the reduction in energy consumption is expected to be achieved in the building sector. In particular, 40% of the total EU final consumption is associated with the building sector, and the residential sector accounts for 25% (Tsemekidi Tzeiranaki et al., 2019).

As part of the European Green Deal (European Commission, 2019) launched in December 2019, the Commission has proposed to raise the 2030 greenhouse gas emission reduction target to at least 55% compared to 1990 levels. The building sector is an essential component of Europe's clean energy transition and is therefore expected to be a major contributor towards the increased target ambition. Most of the existing building stock was built prior the adoption of energy performance standards in Europe (Economidou et al., 2011). Considering the need to accelerate energy renovations in buildings, the European Commission launched a new specific strategy to promote renovation of buildings in 2020: "A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives" (European Commission, 2020a). With current renovation rates ranging from 0.4 to 1.2% per year, this would mean that a renovation rate of at least 2% must be attained. This initiative builds on several building-related measures already agreed under the Clean Energy for all European package, such as the requirement for Member States to publish long-term building renovation strategy under the updated Energy Performance of Buildings Directive (EU) 2018/844, and the national energy and climate plans under the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate. As part of the Renovation Wave package, the European Commission has also strengthened its commitment to tackle energy poverty with the publication of its Recommendation on Energy Poverty (European Commission, 2020b), in which renovation is acknowledged as a key strategy to address energy poverty. In addition, the EU Structural and Investment Funds, such as the European Regional Development Fund (ERDF), European Social Fund (ESF) and Cohesion Fund (CF), have also extensively promoted energy efficiency projects (Štreimikienė, 2016).

Despite the plethora of supporting measures, the current level of energy renovations in EU is still far from the optimal one (Rosenow, Kern, & Rogge, 2017). One reason behind such a partial inefficacy is related to the way measures encouraging renovation assume homeowners to decide when faced with the option to renovate. Homeowners are typically depicted as being motivated to renovate to save energy and money, but they are often refrained from doing so due to hurdles such as capital constraints and behavioural failures (Gillingham, Newell, & Palmer, 2009). However, the decision to renovate is far more complex than this. Renovation decisions are not only influenced by financial and informational barriers, but also by factors that affect decision-making as well as by the conditions of everyday domestic life (Wilson et al., 2015). Whilst new financial models are tested in the European market, a successful energy transition in the building sector depends also on factors beyond financing (Bertoldi et al. 2021).

Therefore, new innovative approaches must be explored to promote energy efficiency renovation decisions. Among the most prominent recent approaches aimed at supporting renovation decisions, the market-based model of one-stop shops (OSSs) has been identified. OSSs offer integrated renovation solutions for small scale renovation projects, guiding the homeowner through the entire

³ Access at https://ec.europa.eu/clima/policies/strategies/2050_en

renovation journey and securing the right financial solutions. While all energy efficiency projects could be good candidates, OSSs are particularly well equipped in addressing the market fragmentation barrier on both demand and supply sides, overcoming some of the sociotechnical barriers surrounding the decision to renovate in a holistic way (Mahapatra et al., 2013, 2011). Yet, there are only a few studies specifically investigating the OSS approach (Brown, 2018; De Nigris, 2019; Mahapatra et al., 2013; Pandelieva-Dimova, 2017; Pardalis, Mahapatra, Bravo, & Mainali, 2019; Pardalis, Mahapatra, Mainali, & Bravo, 2021; Pardalis, Mainali, & Mahapatra, 2019), in part because it has only recently started to emerge in Europe (Boza-Kiss & Bertoldi, 2018).

In the “Smart Financing for Smart Buildings initiative” published in Annex 1 to the Clean Energy Package, the European Commission encourages Member States to develop dedicated local or regional OSSs as a means of promoting more locally developed project pipelines and strong and trustworthy partnerships with local actors such as SMEs, financial institutions, and energy agencies. The setup of these OSSs is supported at the EU level by an exchange of good practices through Manag'Energy (a European initiative supporting regional and local energy agencies to become leaders in the energy transition), the EU Horizon 2020 research and innovation funds, the EU Project Development Assistance facilities (e.g. the European Local Energy Assistance programme) and the European Structural and Investment Funds.

Recognising the role of OSSs in promoting integrated energy renovation services, the Directive 2018/844/EU, amending the Directive 2010/31/EU on the energy performance of buildings (EPBD), called for Member States to facilitate access to appropriate mechanisms for accessible and transparent advisory tools such as OSSs. These are promoted considering the need for sophisticated energy advisory services that can guide consumers throughout the whole renovation journey from the provision of information, technical assistance and structuring to financial support, which can blend public and private sources, and monitoring of energy savings. The amending EPBD is the first EU legislative act calling for specific OSS-focused actions, with previous directives such as the Energy Efficiency Directive (Directive 2012/27/EU) promoting general advisory services through more traditional mechanisms. In the assessment of the long-term renovation strategies submitted in 2017, it was found that only France and Belgium reported the existence of the OSSs model in their renovation markets, confirming the initial market stages (Castellazzi et al., 2019).

Yet, to be considered as a valid approach to be widely promoted by policymakers at national, regional, and local levels, a systematic identification of the role of OSSs in facilitating energy renovation is required. Given that some major efforts only emerged in the recent years and mostly targeting the residential sector, research on their role is currently limited to a few countries or projects. To fill this gap in the literature, this paper aims to answer the following question: which is the role of OSSs in energy renovations in the European residential sector? To accomplish this aim, we collect and qualitatively analyse a dataset on current OSSs case studies across Europe. By conducting a qualitative comparative analysis, the study identifies the role of the OSSs approach in facilitating renovation decisions. Finally, it derives avenues for future improvements, as well as policy recommendations to provide stronger support on the development of OSSs in the future.

The structure of this paper is as follows. Section 2 describes the renovation decision process and summarises the present barriers faced by homeowners when taking renovation decisions. Current renovation approaches are presented in Section 3 together with the basics behind the OSSs concept and a discussion of the state-of-art. The methodology used to collect data is given in Section 4. Based on the collected case studies, the current status of the European market of home renovation through integrated OSSs services is discussed in Section 5. The systematic review of case studies includes both best practice examples and businesses that failed, with a view of gaining a deeper

understanding of what OSSs should ideally represent. Section 6 discusses the role of OSSs in Europe together with policy recommendations to overcome remaining issues. Conclusions are drawn in Section 7.

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2 Renovation decision process

A puzzle of central relevance to energy policy is why there are still untapped opportunities to reduce energy costs through increased energy efficiency, in particular through renovation adoption (Rosenow et al., 2017). Despite energy efficiency investments are associated to long-run cost savings, empirical evidence reports on a gap between the optimal level of adoption and the one that is actually undertaken by households (Hirst & Brown, 1990; Jaffe & Stavins, 1994). Such an *energy-efficiency gap* has been and is still at the centre of a long-lasting scientific debate, which led scientists to investigate the factors underlying the decision to invest in energy efficiency (reviewed by, e.g., (James, 2012; Lopes, Antunes, & Martins, 2012; Lutzenhiser, 1993; Streimikiene & Balezentis, 2020; Wilson & Dowlatabadi, 2007), and more particularly in renovations (reviewed by Wilson et al., 2015).

The factors that have been so far considered in energy policy are those identified by economics and behavioural sciences (Foulds & Robison, 2018; Loewenstein & Chater, 2017). These perspectives assume the decision to invest in energy efficiency as an optimal investment decision that individuals often fail to perform, due to some barriers (Bertoldi, 2020), and the policy goal is to detect and remove these barriers (Gillingham et al., 2009). Policies removing these barriers generally rely on interventions that are justified on economic grounds, such as mandates or bans, financial incentives and non-regulatory ones (such as mandatory disclosure of information), as well as on behavioural grounds, such as nudges and boosts (Loewenstein & Chater, 2017).

However, the economic and behavioural perspective is only one of the available perspectives to approach the decision to renovate (März, 2018). Other perspectives have been advanced to advocate a more situated approach than the one looking only at economic and behavioural barriers (Lutzenhiser, 1993). Renovation decisions are not only influenced by financial, informational and decision-making barriers, but also by personal (such as age) and contextual factors related to everyday life (Abreu, de Oliveira, & Lopes, 2020; DellaValle, Bisello, & Balest, 2018; Palm & Reindl, 2018).

By focusing on the structure that constrains or enables people's actions, the sociological perspective has been identified as key to consider the routine and the practices shared with relevant peers in the household surrounding the decision to renovate (Wilson et al., 2015). Such a perspective also enables to better account for the context-specific features of a target group, such as the households' meanings and needs surrounding the technological output (Labanca & Bertoldi, 2018) and trusted community members who can act as facilitators to promote the uptake of energy audits (Scott, McCarthy, Ford, Stephenson, & Gorrie, 2016).

Taking stock of previous studies, we summarize the main factors preventing the decision to renovate in Table 1.

Table 1: Overview of renovation decision barriers in the residential sector

	Barrier	Description of the barrier	Relevance to		
			young singles or couples	families	elderly
Economic	Upfront costs	<ul style="list-style-type: none"> High investment costs (Schleich et al. 2021) Delayed benefits (Schleich et al, 2016) 	Usually small or no equity	Many other costs, but more future-oriented	Short-term planning
	Need for loan	<ul style="list-style-type: none"> Creditability questions with financiers Loan aversion (Schleich et al. 2021) 	Low creditability	Aversion to loans	Low creditability Aversion to loans
	Split incentives/disagreement between owners	<ul style="list-style-type: none"> Landlords might underinvest under the fear of not being able to recoup the costs of investments in the rent (Melvin 2018; Bird and Hernández, 2012) Owners in multifamily buildings or household members might find it hard to reach an agreement and decide to invest (Ambrose, 2015; Economidou, 2017; Matschoss et al., 2013). 	Typical tenants	Country-specific	Country specific
Informational	Information asymmetries/contractor risk	<ul style="list-style-type: none"> Unknown quality of work Lack of trust (De Wilde, 2019) Low contractor credibility (Wilson et al. 2015) Low contractor energy efficiency training (Mahapatra et al. 2013) 	Knowledge gap, difficult to select good contractors	Knowledge gap, difficult to select good contractors	Knowledge gap, difficult to select good contractors
	Outcome uncertainty	<ul style="list-style-type: none"> Unknown co-benefits (i.e. comfort, health) 	Usually renting, no own home	Owned homes, big potential	Small homes, limited potential
	Incorrect beliefs	<ul style="list-style-type: none"> Incorrect beliefs over future benefits of an energy efficiency renovation (Allcott and Greenstone, 2012) Misperception of energy use (Allcott, 2011) 	Lack of knowledge	Lack of knowledge	Lack of knowledge
Decision-making	Limited attention	<ul style="list-style-type: none"> Imperfect information-processing capacities (people base their choices on the elements that capture their attention more) (Allcott and Taubinsky, 2015) 	Usually renting, no own home	Focus on comfort and practicality	Focus on comfort and health
	Social invisibility	<ul style="list-style-type: none"> Weak social signalling/comparison (Bartiaux et al. 2016) 	Other frequent practices among peers	Lack of examples	Low value given to EE renovation
	Cognitive burden	<ul style="list-style-type: none"> High costs for information search (Wilson et al. 2015) 	Difficulty in contracting the right contractors	Difficulty in contracting the right contractors	Lack of experience, difficult to select good contractors
	Loss aversion	<ul style="list-style-type: none"> Anticipated disturbance, stress, inconvenience/ Anticipated loss of options with irreversible investments (Heutel, 2019) 	Usually rented and short-term housing, so benefits from renovation are perceived as too uncertain	Fear of need for further change (due to family structure change), so benefits from renovation are perceived as too uncertain	Fear of home-of-life loss

	Status bias/sunk fallacy	quo cost	<ul style="list-style-type: none">Psychological commitment to status quo and costly investments made in the past (Schubert and Stadelmann 2015; Blasch and Daminato 2020)	Short-term stays induce preference for status quo	Commitment to previous investments	Commitment to previous investments, fear of change
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3 Approaches supporting renovation decisions

Renovations are complex projects requiring the involvement of several service providers with project management, technical, engineering, administrative and legal expertise. Many homeowners often take the role of a project manager, relying on professional input for certain tasks and taking charge of others (Risholt & Berker, 2013). If a homeowner lacks sufficient awareness or technical knowledge, this may result in a missed opportunity, thus deferring the implementation of energy efficiency measures to a much later stage in the lifecycle of the building. In other cases, a poorly conducted piecemeal or staged renovation without proper expert guidance may yield suboptimal results (e.g. oversized heating system).

Energy service providers, defined by the Energy Efficiency Directive as natural or legal persons delivering energy services or other energy efficiency improvement measures in a final customer's facility or premises, are an important player in the renovation market. There have been several EU policy initiatives to stimulate the energy services market and enhance the role of energy service providers, including energy service companies (ESCOs) (Economidou et al., 2020; Boza-Kiss, Bertoldi, & Toleikyte, 2019). Within the broad range of ESCO services, energy performance contracts represent an example of the ESCO main activities and the most elaborated business models on energy efficiency, in which the energy cost savings delivered by the ESCO are used to repay the project costs, based on either the guaranteed or shared energy savings model (Bertoldi, Rezessy, & Vine, 2006; Sorrell, 2007). While the worldwide ESCO market has grown over the last decades, its growth in Europe has been slow—in part due to the financial crisis of 2008 (Boza-Kiss et al., 2019), as well as to various legal, political, financial and other barriers (Bertoldi & Boza-Kiss, 2017)—with notable differences among EU countries (Boza-Kiss, Bertoldi, & Economidou, 2017; Boza-Kiss et al., 2019; Boza-Kiss, Zangheri, Bertoldi, & Economidou, 2017). Even if the ESCO concept has been tested in large residential buildings (Augustins, Jaunzems, Rochas, & Kamenders, 2018), it is generally believed that this type of business is more appropriate in the public, commercial and industrial sectors due to the size of the ESCO project being a prerequisite for the project success (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011). However, Boza-Kiss et al. (2019) have found that ESCO projects are increasingly used in traditionally ignored sectors, such as households and SMEs. Examples include the LABEEF programme for multifamily building renovations in Latvia and LEMON project in Italy for social housing renovations (Bertoldi et al. 2021).

Other energy service providers include traditional energy consultants, who may walk the homeowner through various steps of the renovation journey, such as energy audits or feasibility studies. Energy consultants often work independently, and, unlike OSSs, they do not guarantee the quality of the overall project nor assist in financial arrangements. Other service providers include market facilitators who may help arrange financing for the operation, thus also playing a key role in the process. They act as mediators for large projects between ESCOs and public authorities and their level of involvement in the renovation project itself can vary (Bullier & Milin, 2013). Unlike OSSs, they do not take responsibility of the project. Examples include the Belgian super ESCOs and ESCO associations (such as Belesco, or the recently dissolved Fedesco) with a long history in facilitating ESCO projects, French municipalities acting as key actors to facilitate different models, including OSSs (e.g. Picardie Pass, France) (Refabert, 2019), and the Swedish municipality of Växjö, which plans not to offer an OSS service itself, but facilitate its operations.

Beyond efforts to enhance the role of ESCOs and other actors in the renovation market, many governments choose to scale up energy efficiency investments through the provision of dedicated financial incentives. This may involve the participation of various energy service providers or, more commonly, target homeowners as the main beneficiary of the incentives. Economidou, Todeschi, &

Bertoldi (2019) examined the role of public and private schemes in supporting energy renovations and found many traditional schemes in the form of grants, subsidised loans and tax incentives in most EU countries as well as new business models.

Despite the rich portfolio, available measures encouraging renovations are not fully exploited by homeowners (Gosnell & Bazilian, 2021). One of the reasons lies in the fact that the classical renovation process is still predominantly seen as “atomized model” (Brown, 2018), wherein the homeowner needs to make all major decisions, from taking contact with the suppliers and partners, to investing time and money and taking risk, and can be supported only through more available incentives and information. Therefore, a renovation project will be more likely to be successful if the customer is supported through affordable private financial products or public incentives, together with technical support and information necessary to navigate through the complex renovation process. However, as described in section 2, such a complexity prevents homeowners from deciding to start and continue the renovation journey.

In contrast to the “atomized model” implicitly assumed by established supporting measures, in the “one-stop shops model” the customer is no longer the main responsible of the stages of the renovation journey. Rather, OSSs represent and manage the major steps of the renovation journey. At the same time, the customer directly interacts with the OSSs, which provides all the relevant information, contact points and management support (Mahapatra et al., 2013). The OSSs approach is an example of the “integrated solutions” (Cré et al., 2012, p. 2; Lazarevic, Kivimaa, Lukkarinen, & Kangas, 2019) that first emerged in the 1990s in the IT sector (Brady, Davies, & Gann, 2005), since it enables to transform and integrate fragmented offers in the renovation and construction market into higher-value offers. The OSSs have also been referred as “competence house” (Mahapatra et al., 2013) providing and making accessible highly technical information to homeowners.

The OSSs can be considered more than an intermediary (Kivimaa & Martiskainen, 2018), as it translates a fragmented supply side, e.g. designers, suppliers, installers, financiers into an integrated solution offered to homeowners, who are supported throughout the renovation journey. More particularly, the services offered by OSSs can range from information provision and awareness raising, technical assistance, structuring and provision of financial support, to the monitoring of savings (Mahapatra et al., 2013). Therefore, the OSSs approach embeds an enormous potential to help homeowners overcome the major barriers preventing them to invest in renovation.

Such a potential has also been explicitly recognized by the European Commission, which showed an interest to support the OSSs concept through the “Smart financing for smart buildings” initiative and through the “new” Energy Performance of Buildings Directive (EPBD) as part of the Directive 2018/844/EU (Boza-Kiss & Bertoldi, 2018). In the directive it is explicitly mentioned that “Member States are required to facilitate access to appropriate mechanisms for accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments” (European Union, 2018).

Despite their potential, OSSs are only recently appearing in Europe. This is true not only for the OSSs targeting the residential sector, but especially those targeting the public sector, for which only a few examples cases in Piedmont, Bulgaria and Netherlands have been operating so far. As a result, the scientific understanding of the role of OSSs in facilitating renovation decisions is still at its infancy. In particular, a search for the term ‘one-stop-shop’ and ‘renovation’ as either a title, abstract or keyword in scientific studies generated only a bit more than 10 document results in Scopus and Web of Science. In the following paragraph, we briefly review these studies.

Mlecnik et al. (2012) and Mahapatra et al., (2013) are among the first studies highlighting the potential for OSSs to promote renovation in the single-house sector. In offering a comparative overview of the OSSs examples present in the Nordic countries, the authors noted the need of supporting measures to promote market formation. Bertoldi et al. (2021) studied new and emerging practices in the residential sector including energy efficient mortgages, crowdfunding, and on-bill finance models, and highlighted the potential of OSSs to remove barriers such as upfront costs, split incentives, and cost of finance, which most conventional solutions have failed to successfully tackle. Looking specifically at business model archetypes to promote renovation in the residential sector, Brown (2018) identifies OSSs as holistic approach to facilitate residential retrofit, to be combined with other types of renovation. Finally, in proposing strategies to enhance renovation market of detached houses, Mainali, Mahapatra, & Pardalis (2021) identify OSSs as a promising approach to make energy renovation accessible also to homeowners with financial limitations. A few OSSs case studies also appear in the literature. Bjørneboe et al. (2017) report on a case study adopting the OSSs concept to promote homeowner's decision to renovate, finding that a one-single contact person is not enough to motivate homeowners to engage in extensive renovation. De Nigris (2019) reports on a project development assistance service (PDS), following the OSSs approach, implemented in the Piedmont region, as an effective way to promote a successful implementation of the energy performance contracts in public buildings (EnPC). Adopting the organization adoption innovation framework, Pardalis, Mainali, et al. (2019) analysed construction SMEs owners' interest in the OSSs concept, using interviews. They found that construction owners are reluctant to employ OSSs, because of the perceived complexity and underlying risks and uncertainties.

Conversely, Pardalis, Mainali, et al. (2019) focused on homeowners' interest in the OSSs concept by conducting a survey on Kronberg (Sweden) residents. The authors found a general low interest in the OSSs offering package solutions to encourage renovation decisions in detached houses, highlighting the need to adjust the OSSs concept to the local context, as the market for detached houses is very context-specific. Pardalis, Mahapatra, et al. (2019), Mahapatra et al. (2019) and Pardalis et al. (2021) investigated the same household types, conducting an online survey. In addition to exploring the causal relationships among variables underlying the decision to renovate with a structural equation modelling approach, the authors found that only a specific segment of the population showed an interest in the OSSs, namely the middle-aged and with higher income and education, suggesting the need for customizing renovation package solution based on socio-demographics. Pardalis et al. (2020) proposed a more holistic OSSs concept for renovation in detached houses, which encompasses, in addition to the economic dimensions, also the environmental and social ones. This concept is proposed as an effective approach to help potential customers appreciate how OSSs create economic, environmental and social value. Pardalis et al. (2020b) present OSSs as innovative business models that can enable micro and small-sized enterprises to offer comprehensive renovation packages that better meet the renovation needs of detached house stock in Sweden. Finally, Capogrosso et al. (2021) report on a H2020 project aimed at facilitating the deep renovation of residential buildings in the Mediterranean area, following the OSSs approach.

Overall, previous studies proposed OSSs as an innovative business model enabling to facilitate renovation decisions, however these focused only on specific projects or selected geographical areas, leaving a gap in understanding overall OSSs' role in Europe.

In the next sections, we fill this gap by identifying the role of OSSs in helping homeowners overcome the major barriers preventing them to invest in renovation in Europe. To do so, we analyse the current OSSs present in Europe.

4 Methodology and data

The collection of data on OSSs case studies in Europe was carried out in two phases. A scoping study was conducted in 2017 to set-up the first collection of OSSs case studies. The case studies were collected through literature and document search, resulting in the comparative description of 23 OSSs based on document analysis and interviews with OSSs' representatives (Boza-Kiss & Bertoldi, 2018). The following data were collected about the OSSs: Title/name; auspices; host organisation; location of the OSSs; expertise at the OSSs; geographical coverage of the service; timeframe; current status; operational details; main aims; key points in the value chain; content of the service; channels; customer relations; key selling point; partnerships (esp. local financing community); target clients; target measures; social responsibility; costs of services (business case); results (realized or planned); costs of the OSSs; costs that are financed from public budget; further information and contact details. Based on the data, a first assessment of the place of OSSs in the value chain was assessed.

To further our knowledge of European OSSs, a workshop titled "One-Stop Shops in the EU: status current and future role in building renovation" was organised in Brussels in March 2019 by the European Commission Joint Research Centre (JRC)⁴. The workshop enabled to get further insights about the implementation and operation of OSSs, their success stories and failures. The representatives were asked to share their experiences and their market knowledge via answering pre-defined research questions in their presentations or at discussions. The above 23 identified OSSs and other experts were solicited to identify further organisations with similar business models. Based on these, as part of the second phase of the OSSs market study, carried out in summer 2019, further OSSs case studies were identified. The data collection was conducted with an email-based survey focusing on costs and policies, in collaboration with INNOVATE⁵, based on previous research projects, such as the Eracobuild⁶ and Refurb⁷. Document analysis and clarification interviews (by phone and email) were then used to validate the collected data, and collate the market and business information that was already collected. The final OSSs registry resulted with about **63 OSS examples**, located in 22 European countries⁸. 57 were found to be operating or planned to be launched soon across the EU and Norway, while 6 OSSs had been closed. Around 2/3 of the MS have at least one OSS on the national renovation market. Countries in Western Europe display a higher presence of OSSs, in particular in France, Netherlands, the UK, Belgium, Spain and Denmark (see Figure 1).

⁴ The agenda and the presentations can be found at <https://e3p.jrc.ec.europa.eu/events/one-stop-shops-eu-current-and-future-role-building-renovation>

⁵ More information can be found at <http://www.financingbuildingrenovation.eu/>

⁶ More information at <http://www.one-stop-shop.org/node/21>

⁷ More information at <http://www.go-refurb.eu/>

⁸ When we analyze European OSSs, we mean OSS in the EU Member States, the UK, Switzerland and Norway.

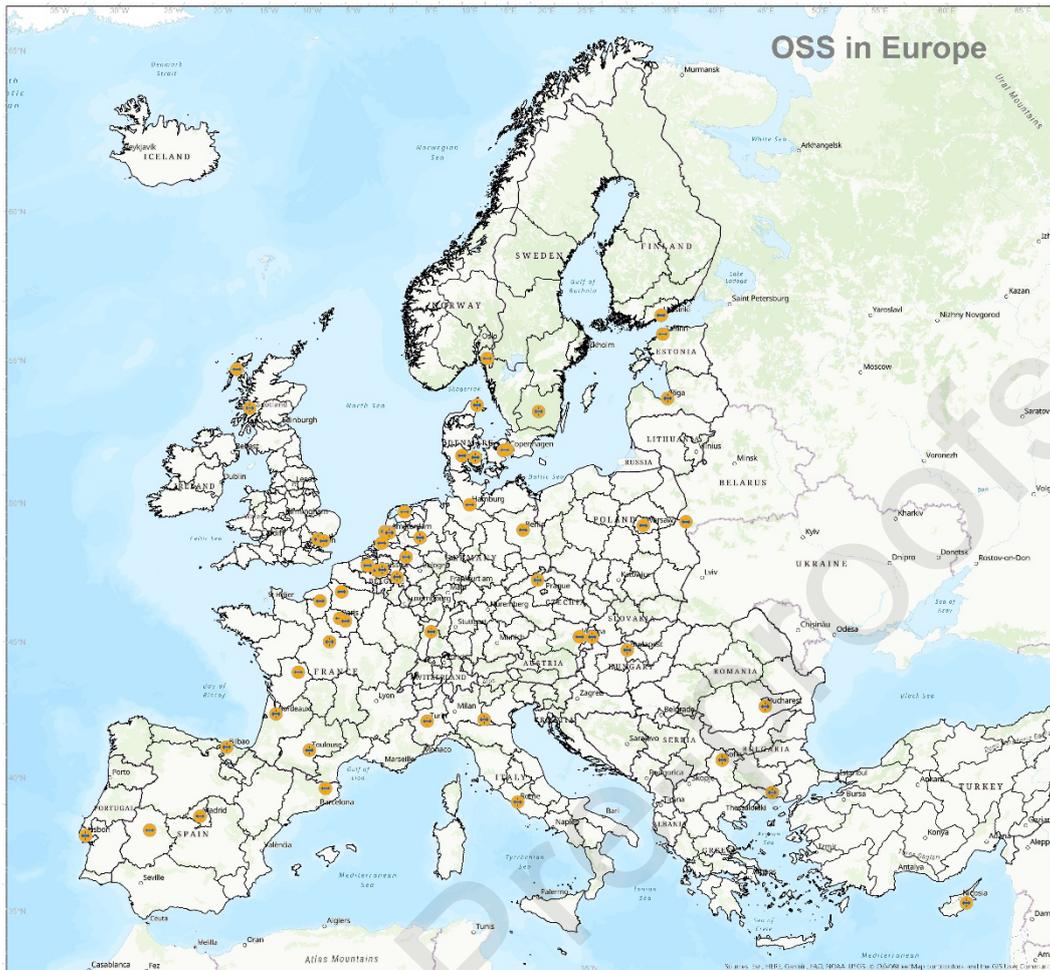


Fig. 1: OSSs identified across Europe up to 2020 (Source: own data)

Since 2014, OSSs have started diffusing more rapidly in Europe (information of the launch date of was available only for 34 of the identified OSSs – see Figure 2).

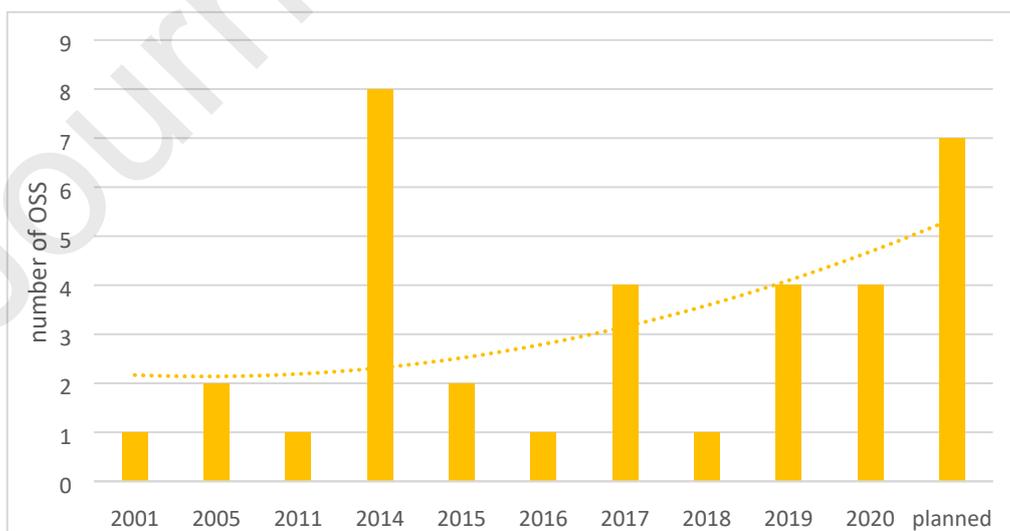


Fig. 2: Year of launch where known (N=34). Source: own data.

The most diffused level at which OSSs operate is the national one (24), followed by regional (19). Only a few case studies operate at a more local level (city -13 or city and regional – 6; see Fig 3). The majority of OSSs was initiated by (local) administration or as a pilot in a Horizon 2020 project (i.e. from EU research budget) (see Fig. 4).

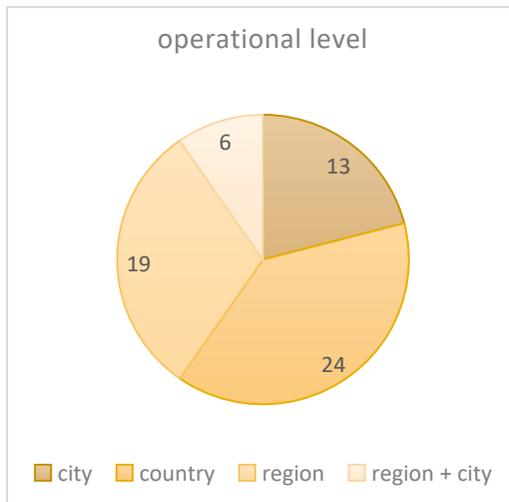


Fig. 3: Level of governance covered (N=62).
Source: own data.

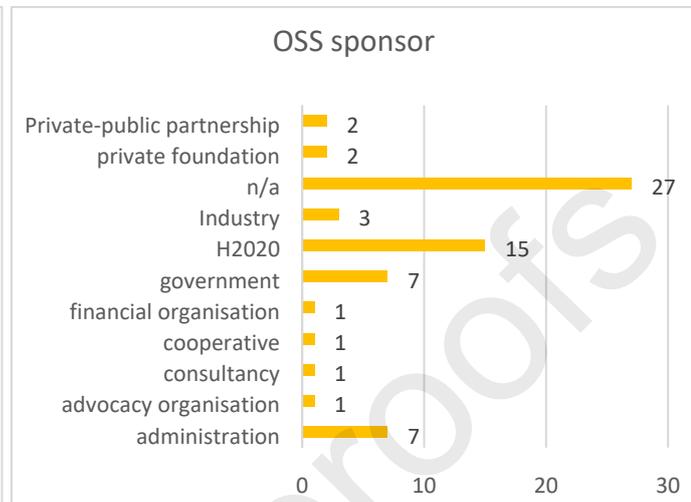


Fig 4: OSS sponsor (N=40).
Source: own data.

In the following section, the descriptive case study methodology (Harrison, Birks, Franklin, & Mills, 2017) and Qualitative Comparative Analysis (QCA) (Schneider & Wagemann, 2012) were used to further analyse the data collected. Descriptive case study research aims to accurately and systematically describe a population, situation or phenomenon: in our case a market element. We assessed the 23 case studies in depth, and used a selected set of indicators for the whole case study set of more than 60 OSSs. Qualitative Comparative Analysis (QCA) is a tool based on [set theory](#) to identify and explain causal relationships between given phenomena and events. QCA results can be used to inform data analysis, and was used for the policy assessment in this study. The methods was developed by Charles Ragin (Ragin, 1987) to overcome the issues related to data sets that are too small for linear regression analysis but large for cross-case analysis.

5 Results

In this section, results are analysed by comparing how OSSs looking first at pricing strategies, types, and clients, and second at how they differ or are similar in the service provision throughout the phases of the renovation journey (see Fig 5).

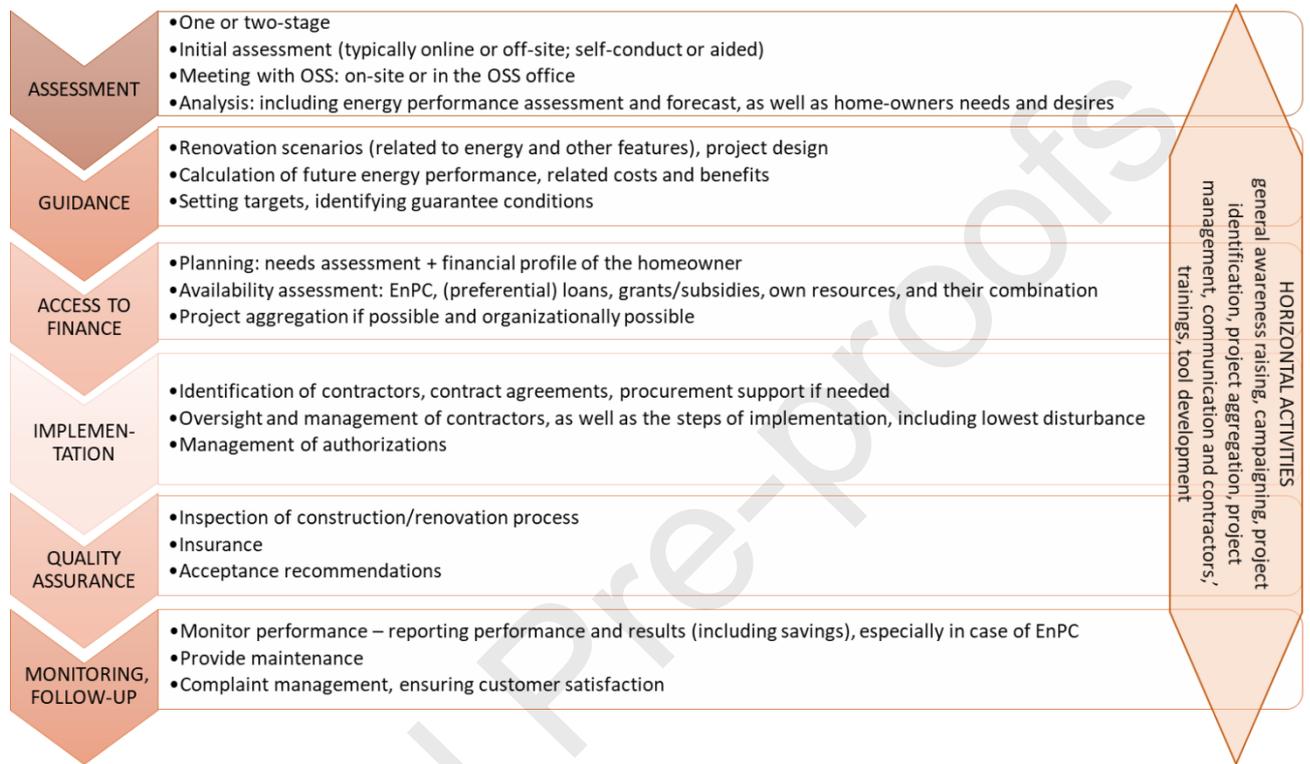


Figure 5. The full-service value chain for homeowners

Source: own graphic based on various sources

5.1 Price of the service

The OSSs offer includes more than a simple renovation project, and it is reasonable to expect that the service is associated with a price. Of the 63 reviewed OSSs, we could collect information related to pricing only from 23 OSSs. Four main business models have been identified (see Fig. 6):

1. There are providers that offer **their services for free**, wherein the homeowners do not have to pay for the information and/or the organisational provision by the OSSs. In total 6 out of 23 OSSs have reported to follow this model.
 - There are OSSs that are operated by a municipality **as a municipal service**. For example, HomeGrade in Brussels, RenoWatt in Wallonia (in case of private customers), Allenergy in the UK work with this model, and contribute to a wider community target, e.g. carbon-reduction target.
 - The service offered by BetterHome (Denmark) is also free because 4 industry partners established the OSSs to provide **community service to potential customers**, who then often purchase their products.
 - Two of the 23 providers indicated that currently they offer their services **for free**, either because they are testing the service, or have other revenue source to offer the service.

However, after the trial period, these consider running the OSSs services with a price. For example, the OSSs in Extremadura (Spain) is being set up and is currently financed under the EU projects INNOVATE and HouseEnvest⁹, but future business model alternatives are being explored during this phase. Another example is the Piemonte OSSs (in Italy) under the Project Development Assistance (PDA) scheme.

2. The OSSs set a **fee for the specific service**, which typically includes general and tailored advice, feasibility study, selecting contractors, technical assistance during the project, and monitoring the technical implementation and savings. While these value offers may not all be included, the price can be matched with the content. In these cases, the implementation costs are separated from the OSSs service costs, and it depends on the content of the renovation and the contractors chosen.
 - Prices can be set as a **fix price**, and range across large varieties depending on the country (and thus the customers' financial possibilities), and the cost structure of the OSSs. Examples range from e.g. 4.000-2.500 EUR per transaction, to ca. 600 EUR per customer, down to 4 EUR per apartment in case of multi-apartment buildings.
 - Several OSSs **link their prices to the overall project volume**. For example, the Center for Sustainability (the Netherlands) works with a small fix fee and 10% of the renovation costs. Reimarkt (the Netherlands) also asks around 10% of the full project cost.
 - Several of the OSSs **offer various plans**, depending on the requirements of the customer. For example, ARTEE in France offers a basic service of energy consumption assessments for a fix price (close to 500 EUR), which can be complemented by packages of varying commitment, from full support including third-party financing, contractor analysis, monitoring, eco-gestures training, etc. (for close to 2000 EUR per project), to light support with less content and for about half or less price. Oktave (France) has a very similar plan, and other French models include traits of this model, too.
3. There are OSSs that **bundle their offer to another service** and consider the OSS service as free, while paying for other services. For example, Opengela and HolaDomus (both in Spain) will not charge the homeowners, but the contractor will pay a fee per project for basic services. However, the homeowner has the option to hire these OSSs for additional services (typically, for 'project management'), and will bear the associated costs.
4. Finally, two of the interviewed OSSs reported to have not decided yet their pricing strategy but are in the planning phase.

⁹ H2020 project, available at: <https://renuevatucasa.eu/>

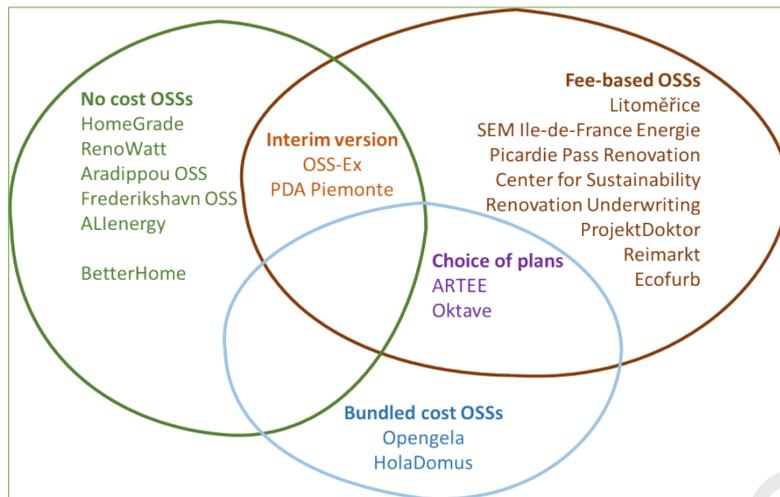


Figure 6. The three main business models identified in our survey.

Source: OSS survey

5.2 OSSs types

When considering the main functionality and main owner, 56 OSS could be identified (for 7 OSS there was no information). In more specific terms, the OSSs in our sample have the form of:

- a producer or its subsidiary (e.g. BetterHome (DK), CleanTech (DK), or Reimarkt (NL)),
- an energy agency (TIG in the UK),
- a project manager (ProjektDoktor in Hungary),
- a new venture partially owned by a local government or its specialised body (Ile-de-France Energies (FR)),
- a department of a local or regional government (e.g. HomeGrade (BE))
- a central procurement agency (Rhodoshop (BG)),
- a cooperative (Retrofit Works (UK)),
- a specialized store (WoonWijzerWinkel Rotterdam (NL)).

These OSSs types have been clustered in six main key types (see Table 2).

Table 2. OSSs types

Government-driven (local or regional) OSSs	Industry driven OSSs	ESCO based OSSs	Facilitator OSSs	Cooperative type OSSs	Store OSSs
Their programmes are mostly driven by climate and/or energy considerations, sometimes by social targets.	Manufacturers or installers that aim to extend their businesses or improve customer care.	Building on their complex offerings, they extend and reclassify their value-added solution-parts.	Consultants that develop their original customer-related businesses, e.g. by extending the types of services, in order to reach more customers	Aims mostly at the societal benefits, not necessarily focused only at energy savings/cost savings	A large store or a warehouse, where the shoppers can get acquainted with the technologies and products, and have a personal contact option to ask for tailored advice and further assistance at the spot.
e.g. Ile-de-France Energies (FR), SPEE Picardie (FR), RenoBooster (AT), HomeGrade (BE)	e.g. Reimarkt (NL), CleanTech (DK), ProjektLavenergi (DK), BetterHome (DK)	e.g. Ile-de-France Energies (FR), HolaDomus (ES), EBRD credit lines (SK)	e.g. CLEAR (BE; ES, PT; IT, NE), Tighean Innse Gall (UK)	Haarlemse Huizenaanpak (NL), Retrofit Works (UK)	e.g. Center for Sustainability (NL) and WoonWijzerWinkel Rotterdam (NL)

5.3 OSS clients

The customers are typically owners of residential buildings, typically built before 2000 or even 1990. Almost 80% of the OSSs for which information is available (20 out of 26), target single domestic buildings. Six of these OSSs are solely targeting single houses. Seventeen of 25 OSSs renovate multi-apartment buildings, and therefore, their customers are the homeowner associations or their representatives. Three OSSs in the sample work specifically with property managers and condominium managers and succeed in renovation works in multi-apartment buildings.

Some exceptions specifically target public buildings (e.g. RenoWatt in Belgium, Project Development Assistance for Local Authorities in Piemonte in Italy). It is more common that the OSSs that have a focus on residential clients can also work with mixed-used buildings, and as a spin-off also public buildings (e.g. HomeGrade in Belgium).

Finally, 8 OSSs have been identified as specifically addressing vulnerable categories, among which five working with social housing. More specifically, the OSSs support vulnerable categories in the form of:

- inclusive financing scheme, intermediary (Reimarkt (NL), Center for Sustainability (NL), RetrofitWorks (UK) , RenoBooster (AT))
- support and advice to save on energy bills (BetterHome (DK), Opengela (ES), HomeGrade, (BE))
- promotion of energy culture, trust and universal accessibility (Opengela (ES))
- energy poverty awareness (HomeGrade (BE), Espace-Info-Energie (FR))

5.4 Building Performance Assessment

This is the first step where OSSs starts directly supporting homeowners in their renovation journey. On the one hand, the OSSs have the resources and knowledge to evaluate the current energy performance of the homeowner's property. On the other one, the client has valuable information, which can provide either by directly interacting with the energy experts or via an online tool.

Results from the survey suggest that the assessment stage is often carried out in two phases. First, following a self-assessment implemented through a web-based tool or paper-based questionnaire, the client fills in the information and data about the status of the building and the energy related consumption. This phase is followed by a tailored assessment, typically through a face-to-face meeting with a specialized company (advisor) partnered with the OSSs or with the in-house expert of the OSSs. As an example, in the ZEROhome program (DK), an independent consultant (called "Charlie") provides advice and boosts trust. Within the Dampoort Gent (BE), advice is provided by public partners, which are perceived to be neutral, thus reducing homeowners' fear to be manipulated by more informed technical actors.

The place of the meeting can be either the OSSs office or the targeted building/apartment. The role of the OSSs and the client in this stage is summarized in Table 3.

Table 3. Role of OSSs and client in the assessment phase based on two exemplary OSS variations

	OSSs	Client	Examples
Alternative 1	Operates local office with energy experts	Visits office, collects data	Reimarkt (6 offices around the Netherlands)
Alternative 2	Operates an online tool to aid self-assessment	Fills-in data, prepares for next assessment stage	Espace-Info Energie (FR), RenoBooster Hub Vienna (AT)

5.5 Guidance

In this stage, the advisor (independent or in-house OSSs) evaluates the data on the current energy performance status, compares a set of interventions, and identifies possible points of action.

Survey results show that OSSs can work:

- with a selected list of limited types interventions (for example the OSS-Ex of Extremadura in Spain will offer four very distinct intervention options: Window renovation, improvement of the building envelope, improvement of the HVAC system, and integration of Renewable Energy Facilities in the building);
- with tailored packages (such as the three packages of BetterHome (DK) and Reimarkt (originally in the Netherlands) that include a different set of renovation measures. In another variation, “the Step-by-Step renovation” consists in the replacement of different building components (such as windows, plasterwork, roof covering, boiler etc.) closer to the end of their lifetime, thus encourages the building owners/tenants to implement only fewer but more economical measures at one time, and upgrade the works later in a next step);
- with other refurbishment aims (such as Reimarkt or Refurb (BE) packages, that integrate improvements of amenities with and energy saving measures),
- on a case-by-case basis (WoonWijzerWinkel Parkstad (NL)).

The process leading from the desire to renovate to an accepted plan is highly dependent on the type of housing: simpler and more tailored for single households and involving a range of decision steps in case of condominiums. Therefore, while taking into account the technical and financial feasibility, funding options, materials, available contractors, and realistic savings targets, the energy renovation plan might also account for the specific needs (condominium, individual). The role of the OSSs and the client in this stage is summarized in Table 3.

Table 4. Role of OSSs and client in the guidance phase based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	Individual renovation plan	Collaborates with OSSs on selecting from alternatives	Most of the OSSs in this research, e.g. Frederikshavn (DK), Aradippou (GR), Litoměřice (SK), etc.
Alternative 2	Renovation plan for condominiums	Establishes (if not yet existing) a representative body to manage the project; collaborates with OSSs on selecting from alternatives	Very few OSSs are focused on condominiums, e.g. Ile-de-France Energies (FR), Facilitateur Bâtiment (FR)

5.6 Access to finance

Survey results show that the OSSs may either directly participate in the financing of the project, or – more often – act as an intermediary. OSSs explore the funding sources that are already available and shares these with the client. However, in many cases, when the existing schemes are not suitable,

.e.g. because local banks offer only short-term loans, loans with high-interest, or the clients have low creditability, OSSs can facilitate the setting up of new sources.

In particular, OSSs can assist the client to identify the best mixture of financing from available schemes (market-based financial products and public support, such as subsidies, tax credits and loans). As part of the project preparation, OSSs can also assist the homeowner to prepare all of the required paperwork. OSSs can also identify the availability of loans that are offered by partner banks (potentially supported by a public guarantee fund), or via revolving funds established by regional or national authorities to support energy renovation of buildings.

OSSs also help vulnerable homeowners, as they cannot cope with unforeseen expenses and for whom it is impossible to pay for a potential intervention (such as the case of OSS-EX for the Extremadura's households in Spain).

The role of the OSSs and the client in this stage is summarized in Table 3.

Table 5. Role of OSSs and client in the financing phase based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	Direct financing	Evaluate own financial capacities and the need for further financial resources. Diligent repayment.	Oktave (FR), which acts as third-party
Alternative 2	Mediating access to financing	Provide data to assess financial capacities and the creditability. Diligent repayment.	Bridging loans for Oktave (FR) clients – these are provided by local banks to overcome liquidity until the subsidy kicks in.

5.7 Implementation of the renovation works

OSSs simplify the renovation process by taking over the overall management and organisation of the renovation. The OSSs identify and contract the contractors, organise timing and material supplies. OSSs usually have a list of contractors that they work with, which is the basis of a standard level of services. However, a few OSSs have capacities to carry out the implementation themselves (like the case of RetrofitWorks in the UK). At the same time, some OSSs do not actually hold all the contracts in their hands, but rather mediate between the contractors and the clients, in which case the client still needs to navigate with a bunch of contractors. In this case, OSSs can still assist in the selection, the quality assurance and client representation.

The role of the OSSs and the client in this stage is summarized in Table 3. 6.

Table 6. Role of OSSs and client in the implementation phase based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	In-house implementation (full management)	Contract the single entity OSSs	EnergieSprong (NL, UK, FR, etc.)
Alternative 2	Contractor mediation	Based on the recommendations of the OSS, contract the contractors.	BetterHome (DK)

5.8 Quality assurance

In order to ensure a successful and timely completion of the renovation projects, OSSs need to guarantee that the contractors for the actual works are qualified, reliable and available. Results show that OSSs often establish a list of reliable contractors to work with. Trainings are a popular way to set up a standard level of quality of the overall renovation, integration of parts of the process, develop specific knowledge on new energy efficient technologies and building methods, build a high level customer treatment, and establish uniform branding. OSSs can provide the training themselves,

or cooperate with training centres and construction associations to train contractors and installers. The trainings may be a way to achieve deep retrofitting. In addition, training programmes are also offered to banks and financial institutions to increase their awareness of the market potentials from energy renovation and specifically from the OSSs-recommended projects. Besides improving skills through trainings, some OSSs use an online assistance tool to aid contractors at the renovation site and in dealing with the clients and their data. Furthermore, often OSSs also establish quality control procedures for the construction, and coordinates suppliers and contractors and oversees the whole renovation process. To this end, there is a process of meetings, site supervision, and evaluation of performance. Some OSSs, like Renowatt (BE), also exploits as a form of energy savings guarantee.

The role of the OSSs and the client in this stage is summarized in Table 3.

Table 7. Role of OSSs and clients in the quality assurance stage based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	Training and/or online tool provision	No involvement	About half of the OSSs has this service, but Allenergy's Affordable Warmth Service in the UK and BetterHome (DK) specifically focus on this.
Alternative 2	Certification	No involvement	EnerPHit certification

5.9 Monitoring and follow-up

After completion of the renovation, some OSSs continue to stay engaged with the client, and monitor the results for up to several years. Monitoring can be implemented through follow-up energy audits, reports on energy bills and satisfaction surveys. The role of the OSSs and the client in this stage is summarized in Table 8.

Table 8. Role of OSSs and client in the monitoring phase based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	Performance contract	Share the cost savings under the EnPC contract	Oktave (FR)
Alternative 2	Monitoring for client satisfaction	Cooperate with OSSs on monitoring on the site	HolaDomus (ES)

5.10 Horizontal activities

Some OSSs promote community energy culture by raising awareness and disseminating information. Usually, such campaigns focus on both the cost and CO₂ savings that can be achieved through the building renovation, with the aim to raise interest in energy efficient renovations. In particular, homeowners can learn about the specific value of interventions, in terms of improved indoor environment, layout, functionality and comfort.

There are exemplary case studies that are particularly active in raising awareness and energy culture. Reimarkt (NL) travels around the country to showcase general knowledge and specific solutions in industry fairs, pop-up stores and joining other events. ZeroHome (DK) promotes interest in energy efficiency by motivating people to saving both energy and money. Buurtkracht (NL) provides homeowners insights on their energy consumption through the smart meters. As information dissemination requires resources, OSSs employ different instruments, such as a blog (Reimarkt, NL), news linked to projects (e.g. EnergieSprong in various countries, e.g. the Netherlands, the UK, Germany, France), downloadable documents or brochures (HomeGrade in Brussels, SIRE in Madrid). Many OSSs also provide information on previous projects, and a few give detailed data on the technologies and options available (e.g. the product site of Reimarkt, the main focus of CLEAR

project operational in a number of countries, or the offline version of WoonWijzerWinkel Parkstad, NL, which is a large store that tops up the sales with personalised consultations).

Besides these direct services, OSSs also offer collaboration to or help other market players. In particular, OSSs can facilitate the implementation of locally-developed project pipelines as well as trustworthy partnerships with local actors (e.g. SMEs, financial institutions, energy agencies). As an example, ProjectZERO (BE) promotes trust and community energy culture by engaging citizens and local ambassadors. They also often develop partnerships with (local) banks. The role of the OSSs and the client in the horizontal activities is summarized in Table 9.

Table 9. Role of OSSs and client in horizontal activities based on two exemplary OSSs variations

	OSSs	Client	Examples
Alternative 1	Offline campaign – e.g. "store of measures" in a warehouse, pop-up stores; pop-up stores, industry fairs; energy events	Visit the warehouse, visit the event and meet the advisors	WoonWijzerWinkel Parkstad (NL)
Alternative 2	Online information about general benefits of energy renovation and/or demonstration cases	Visit the website	Reimarkt (NL), EnergiSprong (DE), CLEAR (BE, IT, NL, ES, PT), SIRE (ES)

6 Discussion and review of policy solutions

Our comparative case analysis suggests that OSSs can bring valuable resources and an array of unique skills in the renovation market that can help overcome several long-standing barriers in energy efficiency (Table 10).

Firstly, OSSs can support homeowners in addressing information-related challenges. By participating in local events and fairs and by establishing direct interaction with homeowners, OSSs can play a pivotal role in nurturing trust among homeowners who may otherwise disregard information due to information asymmetries. They can support homeowners with misplaced beliefs on energy use or perceived uncertainties on energy savings through the provision of dedicated calculator tools, dissemination of exemplary projects and use of innovative awareness raising activities. OSSs can also reduce perceived contractor risks by establishing certification procedures.

On decision-making, the ability to reduce the complexity of the renovation journey and its associated cognitive burden is one of the strongest points offered by OSSs. In addition to lower transaction costs associated with better access to information (e.g. on suitable contractors or financing options), they can also reduce the cognitive burden by simplifying the different phases of the renovation journey and guiding homeowners through the journey step by step. OSSs can help homeowners embrace the often-invisible nature of energy efficiency and direct their focus on the attributes or priorities that are most relevant to them, such as improved thermal comfort, budgetary constraints or tight timeframes. To tackle issues related to loss aversion, the OSS advisory services can be tailored to the specific needs and concerns of the homeowner including the provision of guarantees on the quality of the work, which would address uncertainties about renovation benefits. Exploiting the EnPC as a form of energy savings-guarantee, and managing relationships with contractors are also helpful in developing trust and stability. OSSs that work with EnPC will offer guarantees and risk-sharing modules to customers, yet all OSSs could improve their contractual liabilities with [technical or financial guarantees](#). This can be particularly important in cases where homeowners have already invested in previous home improvement projects. By providing personalized advice and offering predefined packages that are tied to previous projects as a follow-up, OSSs can help overcome the natural tendency to opt for the status-quo and shift social perceptions.

OSSs can also help homeowners overcome many financial barriers. In particular, they can reduce loan aversion by assisting in key bank-related decisions and can improve credibility by setting up partnerships with local banks and by providing guarantees. Property owners might often forego investing because of split incentives. OSSs can act as mediators and bridge differences between tenants and owners through an appropriate model that would align the costs and benefits of both parties. Finally, OSSs can promote homeowners' financial capacity by supporting access to available financial options, including the most vulnerable categories.

These two latter points, also considering the ongoing activities that some OSSs have with vulnerable groups, suggest that OSSs can play a crucial role in the future to contribute to tackle energy poverty. Notably, the energy poor do not have the financial capacities to invest in energy efficiency. In addition, they do not have a voice in the decision to renovate, as they generally rent the dwelling in which they live. OSSs might help bridge this financial and power gap, by assisting vulnerable households in engaging their property owners to renovate. They might also assist the energy poor in loan or acquisition from local banks or public authorities (DellaValle, 2019), and provide funding via ESCO through savings on energy bills, although this latter option is less common in Europe. On a broader perspective, by boosting their budgeting capacities, OSSs also have the potential to help the

energy poor become actors of change and protagonists of the green transition (DellaValle & Sareen, 2020).

To overcome financial barriers, however, certain conditions that are beyond the OSSs' control must hold. The OSSs' support in exploring available funding options is subject to the condition that there is availability of financing at the national and regional contexts. Banks might consider loans for energy renovation attached to the property itself rather than the homeowner and can use the physical asset or the future energy savings as guarantee. The OSSs can take a further step by creating pools of projects and facilitating financing by gaining access to guarantee funds on energy efficiency projects. Finally, split incentives will be only partially solved, unless they are complemented by stronger regulatory interventions (Bird & Hernández, 2012; Castellazzi, Bertoldi, & Economidou, 2017; Economidou, 2017).

Although the OSSs model is not traditionally compatible with the concept of deep renovations as OSSs are often geared towards soft investments, a few OSSs have been found to promote deeper renovations. OSSs can be further encouraged to move towards deeper renovations by compensating financial losses and risks, raising awareness among homeowners on the benefits of deep renovations, and awarding the environmental and climate benefits for the society. The perspective of multiple benefits could also be adopted (Zambotti, Pezzutto, & Bisello, 2018), focusing on increased thermal comfort, higher property value, etc.

Table 10. Barriers to energy renovation of residential buildings and the possible solution provided by OSSs.

Barrier		Description of the barrier	Possible OSSs solution	Typically not addressed by OSSs
Economic	Upfront costs	<ul style="list-style-type: none"> High investment costs Delayed benefits 	<ul style="list-style-type: none"> ✓ Support in accessing financial alternatives; ✓ Grants and other financing solutions are leveraged; ✓ EnPC solution in certain OSSs systems; ✓ Dedicated support for financially vulnerable categories 	<ul style="list-style-type: none"> ✓ Renovation cost is still high ✓ Grants availability depend on the context
	Need for loan	<ul style="list-style-type: none"> Creditability Loan aversion 	<ul style="list-style-type: none"> ✓ Technical assessment to support the bank decision, guarantee provision; ✓ Information/awareness raising among banks, including partnership; ✓ Pilots about on-bill loans (e.g. EuroPACE); ✓ In-house loans (e.g. by Posit'IF). 	<ul style="list-style-type: none"> ✓ The loan used for the renovation can be linked to the homeowner as a personal bank product
	Split incentives	<ul style="list-style-type: none"> Landlords might underinvest under the fear of not being able to recoup the costs of investments in the rent 	<ul style="list-style-type: none"> ✓ Raising awareness and providing information ✓ Mediating between owners and tenants 	<ul style="list-style-type: none"> ✓ Regulatory solutions (minimum performance levels, revision in rent acts)

Information	Information asymmetries/ contractor risk	<ul style="list-style-type: none"> • Unknown quality of work • Lack of trust • Low contractor credibility 	<ul style="list-style-type: none"> ✓ Participation to public events, local fairs. ✓ personalized advice and assessment ✓ Trust relationship ✓ Responsibility for contractors performance, customer care; ✓ Training and supporting contractors; ✓ Certification; ✓ Maintaining an interdependent network of market stakeholders; 	
	Incorrect beliefs	<ul style="list-style-type: none"> • Incorrect beliefs over future benefits of an energy efficiency renovation • Misperception of energy use 	<ul style="list-style-type: none"> ✓ Online tools for self-analysis of energy performance, which can visualize the energy consumption and compare to peers and literature values. ✓ Raising awareness and providing information 	
	Outcome uncertainty	<ul style="list-style-type: none"> • Unknown co-benefits 	<ul style="list-style-type: none"> ✓ Experience based offers and knowledge collected at the OSSs (demonstrating these via exemplary projects); ✓ Risk transfer to OSSs (as ESCOs), guarantees. 	
Decision-making	Limited attention	<ul style="list-style-type: none"> • Imperfect information-processing capacities 	<ul style="list-style-type: none"> ✓ Simplified process making salient only relevant attributes (Non-financial benefits like comfort are emphasized with energy performance improvement) ✓ Appropriate timing, e.g. at the time of home transfers ✓ OSSs showcase the value of energy renovation ✓ Some OSSs demonstrate finished projects on their website; 	
	Social invisibility	<ul style="list-style-type: none"> • Weak social signalling/comparison 	<ul style="list-style-type: none"> ✓ Many OSSs disseminate their solution via peer-information; ✓ OSSs that are cooperatives, or owned by the local community promote a local energy culture. ✓ OSSs can provide a descriptive norm (making salient that a certain percentage of peers have already embraced and finished their renovation journey) 	
	Cognitive burden	<ul style="list-style-type: none"> • High transaction cost of searching for information • Complexity 	<ul style="list-style-type: none"> ✓ Transaction costs are reduced ✓ Knowledge and skills offered as part of the service; ✓ Selection and organisation of contractors by OSSs; ✓ Assistance in financing plan and application. ✓ Simplification: Single contractor (the OSSs), which mediates between all contractors and the client 	
	Loss aversion	<ul style="list-style-type: none"> • Anticipated disturbance, stress, inconvenience, resources, efforts to carry out the renovation • Anticipated loss of options with irreversible investments 	<ul style="list-style-type: none"> ✓ OSSs provide customer care; ✓ OSSs provide advisory services and disseminate information on renovation benefits making salient how the process will avoid expected losses 	

	Status quo bias/ sunk cost fallacy	<ul style="list-style-type: none"> Psychological commitment to status quo and costly investments made in the past 	<ul style="list-style-type: none"> ✓ Tailored package and personalized advice; ✓ Predefined packages (energy efficiency renovation linked with necessary home improvements or that are tied to shallow renovations as a follow-up) 	
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Based on the collected information, the current level of activity of the European OSSs market is estimated at just over 100 000 projects per year. Despite the presence of OSSs in 22 Member States, our findings confirm that their diffusion in Europe is still at preliminary stages despite the promotion of the OSSs model by a number of policies and initiatives at international, national, regional and local levels. The surveyed OSSs provided useful insights on what policies and measures, as well as framework conditions have been helpful, or on the other hand, hinder their operations and successes (Table 11).

In interviews and discussions with experts, a number of supportive policy actions emerged as compatible measures with the OSSs model. Currently, the development of OSSs models is promoted at the EU level by the “Smart Financing for Smart Buildings” initiative¹⁰, the updated Energy Performance of Buildings Directive 2018/844/EU and the Renovation Wave initiative. At national level, a strong policy framework on energy efficiency (Bertoldi et al., 2021), has created favourable conditions for the OSSs model to flourish. Beyond this, OSSs-specific funding, awareness raising, training, organisational set-up and experience sharing activities are supported by several EU research and innovation projects. The European Investment Bank (EIB) and other EU or supranational pipelines, including ELENA —a joint EIB and European Commission facility providing technical assistance for energy efficiency and renewable energy investments in buildings and innovative urban transport— are also crucial in creating new business opportunities.

Despite the positive aforementioned conditions, experts have stressed the need of further policy action. . In particular, national targets, stringent energy performance requirements and standards, dedicated awareness-raising campaigns and specialised financial incentives are some of the key policy measures that strengthen the foundation for OSSs. Offering blended loans and guarantees from public and private sources through OSSs may increase trust in renovation and ensure certain quality requirements are met. Finally, the promotion of energy-efficiency obligation schemes can also be linked to OSS renovations.

At regional level, an energy efficiency policy framework favouring the ESCO market and EnPC model or explicitly supporting home renovations, can reduce the financial barriers for renovation investments and create a demand for OSSs. In addition, a regional policy enforcing “public-private partnership” for home retrofitting efforts can help promote the diffusion of OSSs.

Finally, at a local level, municipalities can directly set up and operate municipal-based OSSs (Tingey et al. 2021). Climate or energy targets, such as renovation minima, can provide a working framework boosting local governments’ interest to set-up OSSs as well as homeowners’ awareness of the service. Municipalities can also directly support OSSs through local grants or tax reliefs, and information sharing and promotion connecting with relevant stakeholders (such as homeowners association or academia). This is especially crucial to reduce or eliminate the fee asked by OSSs for

¹⁰ Accelerating clean energy in buildings. Annex to the Clean Energy For All Europeans. Brussels, 30.11.2016. COM(2016) 860 final.

the service provided, which would be an additional cost to add to the overall renovation project. Another possibility for municipalities is the use of property assessed clean energy (PACE) financing, an innovative on-tax scheme that links the financing to the property and ensures a secure repayment mechanism through the collection of property taxes. In Europe, this financial model is so far piloted in the Spanish city of Olot (Styczyńska & Zubel, 2019).

For such policies to be effective, however, some conditions need to hold. According to feedback from experts, compulsory renovation programmes, mandatory renovations for all public buildings or other renovation rate linked obligations and pledges can provide a basis for more commitment. The call to at least double renovation rates in the next 10 years across Europe as stipulated in the EU's Renovation Wave Strategy, together with the central government renovation requirement under Energy Efficiency Directive and the requirement to set up milestones in the national long-term building renovation strategies under the updated Energy Performance of Buildings Directive are all encouraging policy developments.

At the national and regional levels, energy policy stability and durability are essential to reduce uncertainty faced by homeowners. A sound legal and financial framework can facilitate the uptake of loans for renovation not as a personal bank product, to be guaranteed ideally by future energy savings. Financial availability and dedicated renovation policies are needed for the set-up of dedicated renovation grants or subsidized loans. This also applies for the local level, which also requires coordination with national initiatives. Local commitment to renovation is also a key factor for the set-up of local OSSs. Technical assistance for OSSs linked with grants could also help create a better synergy, while transparency in energy consumption data can raise more awareness. Finally, international sharing of experiences can contribute to dissemination of best practices.

Table 11. Identified policies, measures and framework conditions that enable or hinder OSSs project implementation at EU, national, regional and local levels based on the experiences of the surveyed OSSs. Source: questionnaire and interviews

	Level	Supportive policies	Hindering barriers
	EU	<ul style="list-style-type: none"> • Horizon2020 projects for research and innovation • EIB funds, ELENA, PDA • Climate and energy targets 	<ul style="list-style-type: none"> • Lack of pledges on renovation rate. • Eurostat rules on EnPC accounting
	National	<ul style="list-style-type: none"> • Energy efficiency policy framework • National commitments and targets • National subsidies, tax reliefs • EEOs 	<ul style="list-style-type: none"> • Lack of energy regulation for individual houses. • Costly grants and thus quickly drying out funds. • Loans are personally-linked instead of building-based.
	Regional	<ul style="list-style-type: none"> • Regional energy efficiency policy framework • Removing barriers to ESCO/EnPC 	<ul style="list-style-type: none"> • Costly grants and thus quickly drying out funds. • Lack of renovation policies.

	Local	<ul style="list-style-type: none"> • Supporting the OSSs solution through information sharing and promotion • Establishing the OSSs as part of the municipal services • Climate or energy targets • Renovation rate targets • Local grants or tax reliefs • Supporting the OSSs in exploiting behavioural insights through exchange with academia 	<ul style="list-style-type: none"> • Costly grants and thus quickly drying out funds. • Lack of coordination of national promotion campaign and locally available suppliers. • Lack of motivated government to lead by example in energy renovations.
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7 Conclusions

OSSs can be instrumental in accelerating energy efficiency upgrades in the building sector and helping homeowners overcome various organisational hurdles, management difficulties and financial challenges associated with renovation projects. They can be especially supportive to those who are interested in upgrading the energy efficiency of their homes but face several obstacles preventing them from taking any action. OSSs also embed a potential to attract the interest of homeowners and tenants who are not yet willing to or plan to implement energy renovations, by raising public awareness on energy efficiency benefits.

The key role of OSSs in Europe is their ability to offer integrated solutions, guiding the homeowner through the entire renovation journey and securing the right financial solutions. While all energy efficiency projects could be good candidates, OSSs are particularly well equipped in addressing the market fragmentation barrier on both demand and supply sides by offering holistic, whole-value-chain renovation solutions in residential buildings and in particular single-family houses.

The benefits of OSSs go beyond fostering building renovations. Being locally embedded, OSSs can also promote a positive community culture by promoting projects benefiting the whole neighbourhood, helping current building occupants improve their living conditions, and contributing to tackle energy poverty. Overall, we found that OSSs can be a promising approach to bring together homeowners and actors from the construction supply side and, therefore, to increase demand in energy renovations because:

- They are locally embedded, know the local market, the local clients and the local conditions;
- They establish a trust-based relationship with the clients;
- They can accelerate building refurbishments by simplifying the renovation decision process, informing, motivating, and providing support from the start to the end;
- They can boost the interest of not yet committed energy users/asset owners to implement an energy saving measures or other sustainable projects through awareness raising;
- They can facilitate access to financing and occasionally offer better rates;
- They can follow-up on finished projects;
- They can improve the average renovation depth in terms of energy performance through the holistic approach;
- They can reach out to vulnerable populations and contribute to tackle energy poverty.

Despite the huge potential to promote renovation decisions, there are still many barriers that OSSs cannot tackle alone, notably the financial ones. Only a banking and institutional framework that recognises the economic, societal and other benefits associated to energy efficiency improvements might help secure the financial capacity required not only by homeowners to cover the renovation costs, but also by OSSs to set-up their business. Favourable financial conditions together with an appropriate policy environment, experience sharing, transfer of models within countries and across countries are also prerequisites for scaling up the OSSs market. Through appropriate policy interventions, it can also be possible to develop a stronger relationship between deep renovations and the OSSs model. These interventions may include compulsory renovation programmes and more targeted incentives or access to soft loan facilities, but importantly they must be based on a long-term ambitious vision by jurisdictions with clear energy transition targets.

While this research added to an emerging literature on the novel approach of OSSs by qualitatively identifying the potential and limitations to promote renovate decisions, it is only a first attempt aimed at identifying OSSs' role in facilitating energy renovations in the European residential sector. Future research should aim to collect data on consumer experience with OSSs and actual uptakes of renovations following the OSSs service, as well as to investigate the economic effects of OSSs on the overall cost of renovation, for instance whether economies of scale compensate the OSSs fees. This research would enable to complement the qualitatively insights derived from this study.

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References

- Abreu, M. I., de Oliveira, R. A., & Lopes, J. (2020). Younger vs. Older homeowners in building energy-related renovations: Learning from the Portuguese case. *Energy Reports*, 6, 159–164. <https://doi.org/10.1016/j.egy.2019.08.036>
- Allcott, Hunt, and Dmitry Taubinsky. "Evaluating behaviorally motivated policy: Experimental evidence from the lightbulb market." *American Economic Review* 105.8 (2015): 2501-38. <https://doi.org/10.1257/aer.20131564>
- Allcott, Hunt, and Michael Greenstone. "Is there an energy efficiency gap?." *Journal of Economic Perspectives* 26.1 (2012): 3-28. <https://doi.org/10.1257/jep.26.1.3>
- Allcott, Hunt. "Consumers' perceptions and misperceptions of energy costs." *American Economic Review* 101.3 (2011): 98-104. <https://doi.org/10.1257/aer.101.3.98>
- Ambrose, Aimee R. "Improving energy efficiency in private rented housing: Why don't landlords act?." *Indoor and Built Environment* 24.7 (2015): 913-924. <https://doi.org/10.1177/1420326x15598821>
- Augustins, E., Jaunzems, D., Rochas, C., & Kamenders, A. (2018). Managing energy efficiency of buildings: Analysis of ESCO experience in Latvia. *Energy Procedia*, 147, 614–623. <https://doi.org/10.1016/j.egypro.2018.07.079>
- Bartiaux, Françoise, et al. "Social diffusion of energy-related practices and representations: Patterns and policies in Portugal and Belgium." *Energy Policy* 88 (2016): 413-421. <https://doi.org/10.1016/j.enpol.2015.10.046>
- Bertoldi, P. (2020). Overview of the European Union policies to promote more sustainable behaviours in energy end-users. In *Energy and Behaviour*. Edited by Marta Lopes, Carlos Henggeler Antunes and Kathryn B. Janda (pp. 451–477). Elsevier. <https://doi.org/10.1016/B978-0-12-818567-4.00018-1>
- Bertoldi, P., & Boza-Kiss, B. (2017). Analysis of barriers and drivers for the development of the ESCO markets in Europe. *Energy Policy*, 107, 345–355. <https://doi.org/10.1016/j.enpol.2017.04.023>
- Bertoldi, P., Economidou, M., Palermo, V., Boza-Kiss, B., & Todeschi, V. (2021). How to finance energy renovation of residential buildings: Review of current and emerging financing instruments in the EU. *Wiley Interdisciplinary Reviews: Energy and Environment*, e384. <https://doi.org/10.1002/wene.384>
- Bertoldi, P., Rezessy, S., & Vine, E. (2006). Energy service companies in European countries: Current status and a strategy to foster their development. *Energy Policy*, 34(14), 1818–1832.
- Bird, S., & Hernández, D. (2012). Policy options for the split incentive: Increasing energy efficiency for low-income renters. *Energy Policy*, 48, 506–514. <https://doi.org/10.1016/j.enpol.2005.01.010>
- Bjørneboe, M. G., Svendsen, S., & Heller, A. (2017). Using a one-stop-shop concept to guide decisions when single-family houses are renovated. *Journal of Architectural Engineering*, 23(2), 05017001. [https://doi.org/10.1061/\(ASCE\)AE.1943-5568.0000238](https://doi.org/10.1061/(ASCE)AE.1943-5568.0000238)
- Blasch, Julia, and Claudio Daminato. "Behavioral anomalies and energy-related individual choices: the role of status-quo bias." *The Energy Journal* 41.6 (2020). <https://doi.org/10.5547/01956574.41.6.jbla>

- Boza-Kiss, B., & Bertoldi, P. (2018). One-stop-shops for energy renovations of buildings. European Commission, Ispra, 2018, JRC113301.
- Boza-Kiss, B., Bertoldi, P., & Economidou, M. (2017). Energy Service Companies in the EU—Status review and recommendations for further market development with a focus on Energy Performance Contracting. EUR 28716 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71476-4 (print), 978-92-79-71475-7 (online), doi:10.2760/919473 (print), 10.2760/12258 (online), JRC106624
- Boza-Kiss, B., Bertoldi, P., & Toileikyte Agne, M. (2019). Energy Service Market in the EU. , EUR 29979 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-13092-5, doi:10.2760/45761, JRC118815.
- Boza-Kiss, B., Zangheri, P., Bertoldi, P., & Economidou, M. (2017). *Practices and opportunities for Energy Performance Contracting in the public sector in EU Member States*. EUR 28602 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-68832-4, doi:10.2760/49317, JRC106625
- Brady, T., Davies, A., & Gann, D. M. (2005). Creating value by delivering integrated solutions. *International Journal of Project Management*, 23(5), 360–365, doi: [10.1016/j.ijproman.2005.01.001](https://doi.org/10.1016/j.ijproman.2005.01.001)
- Brown, D. (2018). Business models for residential retrofit in the UK: a critical assessment of five key archetypes. *Energy Efficiency*, 11(6), 1497–1517. <https://doi.org/10.1007/s12053-018-9629-5>
- Bullier, A., & Milin, C. (2013). Alternative financing schemes for energy efficiency in buildings. *ECEEE Summer Study Proceedings, Stockholm, Sweden*. ECEEE. <https://doi.org/10.2172/952869>
- Castellazzi, L., Zangheri, P., Paci, D., Economidou, M., Labanca, N., Ribeiro Serrenho, T., Zancanella, P. and Broc, J., (2019) Assessment of second long-term renovation strategies under the Energy Efficiency Directive, EUR 29605 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-98726-7, doi:10.2760/141406, JRC114200
- Castellazzi, Luca, Bertoldi, P., & Economidou, M. (2017). Overcoming the split incentive barrier in the building sector. EUR 28058 EN, Publication Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-58837-2, doi:10.2790/912494, JRC101251
- Capogrosso, Roberta, et al. (2021) "Deep Energy Retrofit of Residential Buildings in the Mediterranean Area: The MedZEB Approach." In *Smart and Sustainable Planning for Cities and Regions*, Edited by Adriano Bisello and Daniele Vettorato, pp. 29-45. https://doi.org/10.1007/978-3-030-57764-3_3
- Cré, J., Mlecnik, E., Kondratenko, I., Degraeve, P., Van der Have, J.-A., Vrijders, J., ... others. (2012). Developing an integrated offer for Sustainable Renovations. *Retrofit 2012 Conference, Manchester, UK*. <http://resolver.tudelft.nl/uuid:27bc933c-4c95-4013-8126-c1485c58a4b1>
- De Nigris, S. (2019). The Energy Performance Contracts to enhance the energy efficiency in public sector. The case of Piemonte Region. *E3S Web of Conferences*, 119, 00022. EDP Sciences. <https://doi.org/10.1051/e3sconf/201911900022>
- De Wilde, Mandy. "The sustainable housing question: On the role of interpersonal, impersonal and professional trust in low-carbon retrofit decisions by homeowners." *Energy Research & Social Science* 51 (2019): 138-147. <https://doi.org/10.1016/j.erss.2019.01.004>

DellaValle, N. (2019). People's decisions matter: Understanding and addressing energy poverty with behavioral economics. *Energy and Buildings*, 204, 109515.

<https://doi.org/10.1016/j.enbuild.2019.109515>

DellaValle, N., Bisello, A., & Balest, J. (2018). In search of behavioural and social levers for effective social housing retrofit programs. *Energy and Buildings*, 172, 517–524.

<https://doi.org/10.1016/j.enbuild.2018.05.002>

DellaValle, N., & Sareen, S. (2020). Nudging and boosting for equity? Towards a behavioural economics of energy justice. *Energy Research & Social Science*, 68, 101589.

<https://doi.org/10.1016/j.erss.2020.101589>

Economidou, M, Todeschi, V., Bertoldi, P., Agostino, D., Zangheri, P., & Castellazzi, L. (2020). Review of 50 years of EU energy efficiency policies for buildings. *Energy and Buildings*, 110322.

<https://doi.org/10.1016/j.enbuild.2020.110322>

Economidou, Marina. (2017). Energy efficiency upgrades in multi-owner residential buildings: Review of governance and legal issues in 7 EU Member States. *Publications Office of the European Union: Luxembourg*. EUR 29094 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-79347-9, doi:10.2760/966263, JRC110289.

Economidou, Marina, Atanasiu, B., Despret, C., Maio, J., Nolte, I., Rapf, O., ... Strong, D. (2011). *Europe's buildings under the microscope. A country-by-country review of the energy performance of buildings*. Netherlands. ISBN 978-94-91143-01-4. Available at http://dl.dropbox.com/u/4399528/BPIE/LR_%20CbC_study.pdf or from http://www.bpie.eu/eu_buildings_under_microscope.html

Economidou, Marina, Todeschi, V., & Bertoldi, P. (2019). Accelerating energy renovation investments in buildings. EUR 29890 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-12195-4, doi:10.2760/086805, JRC117816.

European Commission (2020a) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives COM/2020/662 final

European Commission (2020b) Commission Recommendation (EU) 2020/1563 of 14 October 2020 on energy poverty. C/2020/9600

European Commission (2019) COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS The European Green Deal COM/2019/640 final

European Union (2018) Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance) PE/4/2018/REV/1

- Foulds, C., & Robison, R. (2018). *Advancing energy policy: Lessons on the integration of social sciences and humanities*. Springer Nature. ISBN 978-3-319-99097-2
- Gillingham, K., Newell, R. G., & Palmer, K. (2009). Energy efficiency economics and policy. *Annu. Rev. Resour. Econ.*, 1(1), 597–620. <https://doi.org/10.1146/annurev.resource.102308.124234>
- Gosnell, G. K., & Bazilian, M. D. (2021). Changing behaviour is the key to solving the climate challenge. *Nature Human Behaviour*, 1–1. <https://doi.org/10.1038/s41562-020-01047-8>
- Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case study research: Foundations and methodological orientations. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 18. <https://doi.org/10.17169/fqs-18.1.2655>
- Heutel, Garth. "Prospect theory and energy efficiency." *Journal of Environmental Economics and Management* 96 (2019): 236-254. <https://doi.org/10.1016/j.jeem.2019.06.005>
- Hirst, E., & Brown, M. (1990). Closing the efficiency gap: Barriers to the efficient use of energy. *Resources, Conservation and Recycling*, 3(4), 267–281. [https://doi.org/10.1016/0921-3449\(90\)90023-w](https://doi.org/10.1016/0921-3449(90)90023-w)
- Jaffe, A. B., & Stavins, R. N. (1994). The energy-efficiency gap What does it mean? *Energy Policy*, 22(10), 804–810. [https://doi.org/10.1016/0301-4215\(94\)90138-4](https://doi.org/10.1016/0301-4215(94)90138-4)
- James, P. (2012). Overcoming barriers to low carbon dwellings: The need for innovative models of finance and service-provision. *Environmental Development*, 2, 6–17. <https://doi.org/10.1016/j.envdev.2012.02.002>
- Kivimaa, P., & Martiskainen, M. (2018). Innovation, low energy buildings and intermediaries in Europe: Systematic case study review. *Energy Efficiency*, 11(1), 31–51. <https://doi.org/10.1007/s12053-017-9547-y>
- Labanca, N., & Bertoldi, P. (2018). Beyond energy efficiency and individual behaviours: Policy insights from social practice theories. *Energy Policy*, 115, 494–502. <https://doi.org/10.1016/j.enpol.2018.01.027>
- Lazarevic, D., Kivimaa, P., Lukkarinen, J., & Kangas, H.-L. (2019). Understanding integrated-solution innovations in sustainability transitions: Reconfigurative building-energy services in Finland. *Energy Research & Social Science*, 56, 101209. <https://doi.org/10.1016/j.erss.2019.05.019>
- Loewenstein, G., & Chater, N. (2017). Putting nudges in perspective. *Behavioural Public Policy*, 1(1), 26–53. <https://doi.org/10.1017/bpp.2016.7>
- Lopes, M., Antunes, C., & Martins, N. (2012). Energy behaviours as promoters of energy efficiency: A 21st century review. *Renewable and Sustainable Energy Reviews*, 16(6), 4095–4104. <https://doi.org/10.1016/j.rser.2012.03.034>
- Lutzenhiser, L. (1993). Social and behavioral aspects of energy use. *Annual Review of Energy and the Environment*, 18(1), 247–289. <https://doi.org/10.1146/annurev.eg.18.110193.001335>
- Mahapatra, Krushna, Brijesh Mainali, and Georgios Pardalis. "Homeowners' attitude towards one-stop-shop business concept for energy renovation of detached houses in Kronoberg, Sweden." *Energy Procedia* 158 (2019): 3702-3708. <https://doi.org/10.1016/j.egypro.2019.01.888>

- Mahapatra, K., Gustavsson, L., Haavik, T., Aabrekk, S., Svendsen, S., Vanhoutteghem, L., ... Alajuusela, M. (2013). Business models for full service energy renovation of single-family houses in Nordic countries. *Applied Energy*, 112, 1558–1565. <https://doi.org/10.1016/j.apenergy.2013.01.010>
- Mahapatra, K., Gustavsson, L., Haavik, T., Aabrekk, S., Tommerup, H. M., Svendsen, S., ... Alajuusela, M. (2011). *Possible financing schemes for one-stop-shop service for sustainable renovation of singlefamily houses*. Nordic Innovation Centre, 2011. 25 p. (Nordic Call on Sustainable Renovation NICE; No. 08191 SR)
- Mainali, B., Mahapatra, K., & Pardalis, G. (2021). Strategies for deep renovation market of detached houses. *Renewable and Sustainable Energy Reviews*, 138, 110659. <https://doi.org/10.1016/j.rser.2020.110659>
- Marino, A., Bertoldi, P., Rezessy, S., & Boza-Kiss, B. (2011). A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. *Energy Policy*, 39(10), 6190–6198. <https://doi.org/10.1016/j.enpol.2011.07.019>
- März, S. (2018). Beyond economics—Understanding the decision-making of German small private landlords in terms of energy efficiency investment. *Energy Efficiency*, 11(7), 1721–1743. <https://doi.org/10.1007/s12053-017-9567-7>
- Matschoss, Kaisa, et al. "Energy renovations of EU multifamily buildings: do current policies target the real problems." *Proceedings of the ECEEE*. 2013. https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2013/5b-cutting-the-energy-use-of-buildings-policy-and-programmes/energy-renovations-of-eu-multifamily-buildings-do-current-policies-target-the-real-problems/2013/5B-235-13_Matschoss.pdf/
- Melvin, Jesse. "The split incentives energy efficiency problem: Evidence of underinvestment by landlords." *Energy Policy* 115 (2018): 342-352. <https://doi.org/10.1016/j.enpol.2017.11.069>
- Mlecnik, Erwin, et al. "Collaboration opportunities in advanced housing renovation." *Energy Procedia* 30 (2012): 1380-1389. <https://doi.org/10.1016/j.egypro.2012.11.152>
- Palm, J., & Reindl, K. (2018). Understanding barriers to energy-efficiency renovations of multifamily dwellings. *Energy Efficiency*, 11(1), 53–65. <https://doi.org/10.1007/s12053-017-9549-9>
- Pandelieva-Dimova, I. (2017). CREATION OF ONE-STOP-SHOP TO BOOST INVESTMENT IN ENERGY EFFICIENCY AS A RESULT OF H2020 CITYNVEST ACTIVITIES IN THE RHODOPE REGION, BULGARIA. *International Multidisciplinary Scientific GeoConference: SGEM*, 17, 261–266. <https://doi.org/10.5593/sgem2017/54/s23.034>
- Pardalis, G., Mahapatra, K., Bravo, G., & Mainali, B. (2019). Swedish house owners' intentions towards renovations: Is there a market for one-stop-shop? *Buildings*, 9(7), 164. <https://doi.org/10.3390/buildings9070164>
- Pardalis, G., Mahapatra, K., & Mainali, B. (2020). A triple-layered one-stop-shop business model canvas for sustainable house renovations. *IOP Conference Series: Earth and Environmental Science*, 588, 022060. IOP Publishing. <https://doi.org/10.1088/1755-1315/588/2/022060>
- Pardalis, Georgios, Krushna Mahapatra, and Brijesh Mainali. "Swedish construction MSEs: simply renovators or renovation service innovators?." *Building Research & Information* 48.1 (2020b): 67-83. <https://doi.org/10.1080/09613218.2019.1662713>
- Pardalis, G., Mahapatra, K., Mainali, B., & Bravo, G. (2021). Future Energy-Related House

- Renovations in Sweden: One-Stop-Shop as a Shortcut to the Decision-Making Journey. In *Emerging Research in Sustainable Energy and Buildings for a Low-Carbon Future*, Edited by Howlett, Robert J. and Littlewood, John R. and Jain, Lakhmi C. (pp. 37–52). Springer. https://doi.org/10.1007/978-981-15-8775-7_4
- Pardalis, G., Mainali, B., & Mahapatra, K. (2019). One-stop-shop as an innovation, and construction SMEs: A Swedish perspective. *Energy Procedia*, 158, 2737–2743. <https://doi.org/10.1016/j.egypro.2019.02.031>
- Refabert, F. (2019). Webinar - *Financing Home Renovation in Europe*. *Sustainable Energy Investment Forums*, https://ec.europa.eu/energy/topics/energy-efficiency/financing-energy-efficiency/sustainable-energy-investment-forums/webinar-financing-home-renovation-europe_en
- Risholt, B., & Berker, T. (2013). Success for energy efficient renovation of dwellings— Learning from private homeowners. *Energy Policy*, 61, 1022–1030. <https://doi.org/10.1016/j.enpol.2013.06.011>
- Rosenow, J., Kern, F., & Rogge, K. (2017). The need for comprehensive and well targeted instrument mixes to stimulate energy transitions: The case of energy efficiency policy. *Energy Research & Social Science*, 33, 95–104. <https://doi.org/10.1016/j.erss.2017.09.013>
- Schleich, Joachim, Corinne Faure, and Thomas Meissner. "Adoption of retrofit measures among homeowners in EU countries: The effects of access to capital and debt aversion." *Energy Policy* 149 (2021): 112025. <https://doi.org/10.1016/j.enpol.2020.112025>
- Schleich, Joachim, et al. "Making the implicit explicit: A look inside the implicit discount rate." *Energy Policy* 97 (2016): 321-331. <https://doi.org/10.1016/j.enpol.2016.07.044>
- Schneider, C. Q., & Wagemann, C. (2012). *Set-theoretic methods for the social sciences: A guide to qualitative comparative analysis*. Cambridge University Press. ISBN: 978-1-107-01352-0
- Schubert, Renate, and Marcel Stadelmann. "Energy-using durables—why consumers refrain from economically optimal choices." *Frontiers in Energy Research* 3 (2015): 7. <https://doi.org/10.3389/fenrg.2015.00007>
- Scott, M. G., McCarthy, A., Ford, R., Stephenson, J., & Gorrie, S. (2016). Evaluating the impact of energy interventions: Home audits vs. Community events. *Energy Efficiency*, 9(6), 1221–1240. <https://doi.org/10.1007/s12053-015-9420-9>
- Sorrell, S. (2007). The economics of energy service contracts. *Energy Policy*, 35(1), 507–521. <https://doi.org/10.1016/j.enpol.2005.12.009>
- Štreimikienė, D. (2016). Review of financial support from EU Structural Funds to sustainable energy in Baltic States. *Renewable and Sustainable Energy Reviews*, 58, 1027–1038. <https://doi.org/10.1016/j.rser.2015.12.306>
- Streimikiene, D., & Balezentis, T. (2020). Willingness to Pay for Renovation of Multi-Flat Buildings and to Share the Costs of Renovation. *Energies*, 13(11), 2721. <https://doi.org/10.3390/en13112721>
- Styczyńska, I., & Zubel, K. (2019). *EU28 legal and fiscal readiness for the adoption of an on-tax financing mechanism-EuroPACE*. **SSRN Electronic Journal**. <https://doi.org/10.2139/ssrn.3437202>
- Tingey, M., Webb, J., & van der Horst, D. (2021). Housing retrofit: six types of local authority energy service models. *Buildings and Cities*, 2(1), 518–532. DOI: <http://doi.org/10.5334/bc.104>

Tsemekidi Tzeiranaki, S., Bertoldi, P., Diluiso, F., Castellazzi, L., Economidou, M., Labanca, N., ... Zangheri, P. (2019). Analysis of the EU residential energy consumption: Trends and determinants. *Energies*, 12(6), 1065. <https://doi.org/10.3390/en12061065>

Wilson, C., Crane, L., & Chryssochoidis, G. (2015). Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. *Energy Research & Social Science*, 7, 12–22. <https://doi.org/10.1016/j.erss.2015.03.002>

Wilson, C., & Dowlatabadi, H. (2007). Models of decision making and residential energy use. *Annu. Rev. Environ. Resour.*, 32, 169–203. <https://doi.org/10.1146/annurev.energy.32.053006.141137>

Zambotti, S., Pezzutto, S., & Bisello, A. (2018). Multiple-Benefits from Buildings' Refurbishment: Evidence from Smart City Projects in Europe. In *International Symposium on New Metropolitan Perspectives*, Edited by Calabrò Francesco, Della Spina Lucia and Bevilacqua Carmelina, pp. 157–164. Springer. https://doi.org/10.1007/978-3-319-92099-3_19

8 Appendix

List of OSS case studies

Title	Geographical coverage	Timing
RenoBooster	Vienna, Austria	Planned (Set up within a H2020 project for 42 months)
HomeGrade	Brussels Capital Region, Belgium	2019 - (operational)
RenoWatt	Started in Liege, extended to whole Walloon Region, Belgium	2014 – (operational)
CLEAR-BE	Belgium	2014 – (operational)
CLEAR-ES	Spain	2014 – (operational)
CLEAR-PT	Portugal	2014 – (operational)
CLEAR-IT	Italy	2014 – (operational)
CLEAR-NE	The Netherlands	2014 – (operational)
Huisdokter	Limburg city, Belgium	2005 - (operational)
Vlaams Energiebedrijf	Flanders region, Belgium	2015 - (operational)
Rhodoshop Programme Development Unit	6 municipalities from the Rhodope Region, Bulgaria	September 2017 – August 2020
EEE Consortium	Sofia, Bulgaria	2005 - (operational)
Aradippou Municipality One-Stop-Shop	Municipality of Aradippou, Larnaca District, Cyprus	Planned (Pilot within a H2020 project (INNOVATE))
Litoměřice	Litoměřice city, Czech Republic	Planned (Pilot within a H2020 project (INNOVATE))
Bauteam Hamburg	Hamburg city, Germany	n/a
Energiesprong Germany	Germany	2017-2020 (operational)
Frederikshavn OSS	Frederikshavn Municipality, Denmark	Planned
CLEAN Green Business Growth	4 cities, Denmark,	Ceased
BedreBolig (BB) (Better Housing) initiative	Denmark	2013 - (operational)
BetterHome	Denmark	2014 – (operational)
CleanTech	Denmark	n/a, probably closed
ProjektLavenergi	South Demark, mainly Kolding	n/a, probably closed
Sustain Solutions	Denmark	2015 – (operational)
KredEx	Estonia	2009 – (operational)
OSS-Ex	Extremadura Region, Spain	Planned (to be launched at the end of 2019 or early 2020, part of a H2020 project (INNOVATE))
Opengela	Bilbao and Eibar, and will go up to all the Basque Country, Spain	Planned (March 2020)
HolaDomus	Started in the city of Olot, Catalonia, Spain. With a capacity to expand to region of Catalonia. Spain	Planned (As a pilot within a H2020 project (INNOVATE))
ENRA concept	Finland	Ceased (closed in 2010)
SEM Ile-de-France Energie (formerly Energies POSIT'IF)	Ile-de-France Region, France	2013-(operational)
ARTEE (Agence Régionale pour les Travaux d'Economies d'Energie)	Nouvelle-Aquitaine Region, France	n/a

Picardie Pass Rénovation (Régie Régionale du Service Public de l'Efficacité Energétique)	Picardie Région (individual houses) / Hauts-De-France Region (condominiums), France	2013-(operational)
Oktave	Alsace Champagne-Ardenne Lorraine region (France)	2017 – (operational)
Bordeaux Métropole Energies (BME)	Bordeaux Region, France	Operational (n/a start date)
AREC Occitanie	Occitanie Region, Spain	Operational (n/a start date)
Région Centre-Val de Loire OSS	Val de Loire Region, France	Operational (n/a start date)
Région Normandie OSS	Normandie Region, France	Operational (n/a start date)
Brest Métropole OSS	Brest Region, France	Operational (n/a start date)
Espace-Info Energie	Toulouse Metropole, France	Operational (n/a start date)
Energiesprong France	Several locations, France	2016 – (operational)
RenoHUB	Hungary	Planned (Pilot in a H2020 project, started in November 2019)
Projekt Doktor	Hungary	Operational (n/a start date)
Superhomes	Tipperary city, Ireland	2017 – (operational)
Project Development Assistance for Local Authorities in Piemonte	Piemonte Region, Italy	Operational (n/a start date)
Center for Sustainability	Region of Parkstad, including the City of Heerlen, Netherlands	2014 – (operational) (Started in the scope of a H2020, continues to operate with local support)
Reimarkt	Netherlands (currently 6 locations: Enschede, Delft, Den Bosch, Groningen, Zoetermeer, Hoozeveen)	2014 – (operational)
WoonWijzerWinkel Rotterdam	Rotterdam and other cities, Netherlands	Operational (n/a start date)
Haarlemse Huizenaanpak	Haarlem, the Netherlands	2014 – (operational)
Stroomversnelling (previously Energiesprong)	Several locations, Netherlands	2013 – (operational)
Slim Wonen in Leeuwarden	Leeuwarden region, Netherlands	2013 – (operational)
Bolig Enøk	Østfold, Akershus and south east of Oslo, Norway	2011 - (operational)
Vaxjo OSS (no name yet)	Kronoberg (region), Vaxjo, Sweden	Pilot Not continued. It was part of the H2020 project (INNOVATE)
SlovSEFF, MunSEFF	Slovakia	MunSEFF (2010-2015), SlovSEFF (2007-2012),
REECL	Bulgaria	2006-2015
Servicio de Información de Rehabilitación Eficiente (SIRE)	Spain	2019 - (operational)
Zerohome Program	Sonderborg city, Denmark	2020 (unclear) - (operationa)
Mantova OSS	Mantova City, Italy	Planned (pilot within a H2020 project (INNOVATE))
FinEERGo-Dom	Various country in Eastern Europe (PL, BG, SK, LV, RO, NL, AT)	pilot H2020 project starting in 2020

Retrofit Works	The UK	2013 – (operational)
Ecofurb	London city, The UK	Planned (Started early 2020)
AlIenergy's Affordable Warmth Service	Argyll & Bute region, Scotland, The UK	Operational (n/a start date)
Tighean Innse Gall	Western Isles, The UK	Operational (n/a start date)
Renovation Underwriting	The UK	2020 - (operational)
Energiesprong UK	The UK	2018 - (operational)

Declaration of interests

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.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: