The One-Stop Shop Business Model for Improving Building Energy Efficiency: Analysis and Applications

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Abstract. Due to the significant contribution of the building stock to total greenhouse gas emissions, policies and measures have been focused on efficiency improvement and renovation works of old and outdated buildings. Those measures are often shaped as subsidies, tax rebates, and other economic incentives for the building owner. In turn, that has stimulated the rise and development of innovative business models meant to exploit the opportunities offered by incentive policies. This research aims to analyze the "One-stop shop" business model, which is among the most used in building redevelopment. It is based on the assumption that the customer interfaces with a single contractor, usually an Energy Service Company, which takes care entirely of the efficiency improvement works, acting as the proponent and guarantor of all the interventions. Here, the "One-stop shop" business model's primary features are derived through a case study analysis focused on refurbishment projects carried out in Germany, France, Spain, Belgium, and the Netherlands. The case studies are analyzed using the Rough Set approach. By identifying meaningful, well-defined clusters and sometimes vague and fuzzy subsets of the case studies, the significant relationships among their characteristics are highlighted. Major results are as follows. Concerning the business models, Energy Service Companies are not overrepresented, while construction firms are important players, too. Furthermore, incentive measures are used in nearly half the case studies, especially in France. Concerning the renovation works, they mostly feature replacing the heating system, adding insulation layers to the building envelope, and installing a mechanical extract ventilation system.

Keywords: Business models · Energy Service Company · Construction industry · Real estate market · Energy efficiency

1 Introduction and Background Literature

Starting from the seventies, energy saving first and energy efficiency later have been among the main concerns of several western nations [1, 2]. Energy performance improvement has been pursued - using a variety of policies - in several sectors, with the building industry holding a prominent place [3]. Concerning the construction industry and

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the real estate market of the European Union (EU) countries, Directives 2002/91/EC, 2010/31/EU, and 2018/844/EU set the framework for the national policies and measures, which include mandatory standards, subsidies, tax rebates, as well as other cash and in-kind incentives [4, 5].

In turn, the wide range of incentive policies and measures put in place so far by EU member countries has stimulated the rise and development of innovative and tailored business models (BMs) [6–10], which are seen as essential for promoting the circular economy in the building industry and pursuing the long-term sustainability goals [11, 12]. According to the literature, the BMs meant to attain building energy efficiency - and to exploit the related public incentives - differ for the players involved, the relationships they establish, and the link to an energy certification system or not. More to the point, some BMs feature an individual contractor responsible for all the energy efficiency improvement works while, in other BMs, the customers interface with two contractors or more [11, 13]. In addition, the relationships established between customers and contractors can be modeled according to different settings, such as energy performance contracting (EPC) [14], energy service contracting (ESC) [15], and integrated energy contracting (IEC). The agreed contract further implies different allocations of costs and energy savings among the involved parties [16–19]. Lastly, the BMs may or may not be directly linked to a mandatory or voluntary energy certification system, such as EPCs [20, 21], LEED, and BREEAM [22–24].

One of the most used BMs in the construction industry is the so-called "One-Stop Shop" (OSS) business model [25] (Fig. 1). It is characterized by the involvement of an individual contractor, which is typically an Energy Service Company (ESCo) [26–30]. The contractor is responsible for the project's quality and outcomes; it bears the upfront costs and performs the efficiency improvement works. Side players in the OSS BM are energy consultants and market facilitators, assisting the customers in the financial closing of the energy refurbishment projects.

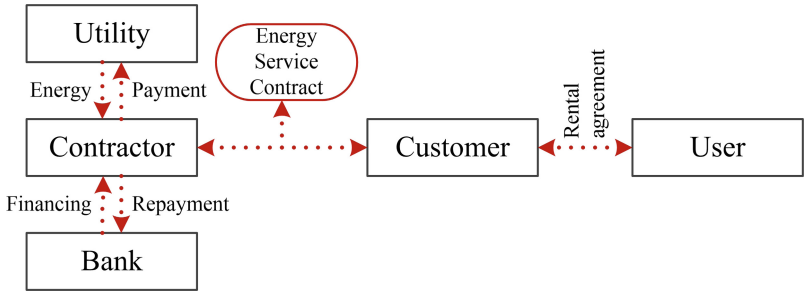


Fig. 1. Players and relationships in the One-Stop Shop business model.

The literature has identified four sub-model concepts related to the OSS BM, though implemented with mixed success; they are as follows: Dong-CleanTech, ProjektLavenergi, ENRA, and ENRENOV [31]. The first - Dong-CleanTech - has been used in Denmark to improve the energy performance of buildings dating back to the seventies, mainly by using cladding insulation, installing heat pumps and solar panels, and replacing frames

and windows. Likewise, the second sub-model concept - ProjektLavenergi - has been used in Denmark, especially for refurbishing single-family houses built between the seventies and the eighties; the efficiency works mainly concern the heating systems. The third - ENRA - has been developed in Finland to renovate residential properties, especially by improving insulation and windows.

A recent search for innovative business models in the building industry specially meant to carry out efficiency-related works has led to the identification of about fifty case studies across Germany, France, Spain, Belgium, and the Netherlands. Of them, fourteen cases fall within the framework of the OSS BM. This study aims to provide an overview of their distinctive features. In particular, we are interested in recognizing and determining the commonalities among the case studies as well as their differentiation factors concerning both the BM's arrangement and the efficiency works carried out on the properties.

The following section describes the data processing method. Section 3 introduces the case studies and the data gathering process. Section 4 is devoted to the presentation and discussion of the results. The last section draws the conclusions.

2 Method

Given the goal of identifying the commonalities and the differentiation factors of the projects carried out under the framework of the OSS BM, data is processed using the Rough Set analysis. The Rough Set theory was introduced and developed by the Polish mathematician Z. Pawlak [32]. The rationale behind the approach [33] makes it suitable for dealing with incomplete and imprecise information systems [34–36], as well as for multi-criteria decision aid [37–42].

This analytical tool allows us to identify the relationships between the attributes we use to describe the OSS BM and then cluster the case studies into sets described by a selection of significant features. The boundaries of those sets are sometimes well-defined, while other times somewhat vague. Several case studies are clustered together into a given group because they share all the attributes defining that set; instead, other case studies only partially belong to a set since some - but not all - of its features characterize them. In other words, a boundary region is assumed to surround each distinguishable set of the analyzed objects. The objects falling in that boundary region possibly, but not certainly, belong to the group due to the occurrence of somewhat vague, imprecise, and ambiguous relationships [43–48].

The Rough Set approach's various applications include the study of urban renewal projects [49, 50] and building energy efficiency measures [51, 52]. The analysis below is performed using the package ROSE2[1], a software developed by the Laboratory of Intelligent Decision Support Systems at the Poznań University of Technology [53, 54].

3 Case Studies

The case study list has been identified by consulting reports of EU-funded projects and fact sheets of public monitors on the energy refurbishment of outdated buildings across Central Europe. Several cases are located in France and Belgium, especially in

[1] See https://fcds.cs.put.poznan.pl/IDSS/software/rose.htm, last accessed 19.02.2023.

the capital cities, only a couple in the Netherlands, and just one in Germany and Spain (Fig. 2). Most cases involve outdated housing. However, there are a few commercial buildings, provided the arrangement of the relationships among the parties involved in the renovation works can be related to the OSS BM.

Data collection focuses on three domains (Table 1): the distinctive features of the business model, the characteristics of the real estate asset to be refurbished, and the kind of efficiency-related works. Concerning the business model, we consider the public or private nature of the property owner (distinguishing among publicly-owned and semi-public organizations, private non-profit companies, and private for-profit companies), the financial promoter, the upfront cost - namely, the invested capital - and the use of subsidies and tax incentives.

As far as the property features are concerned, the following data is considered: construction year, building typology, construction materials, floor area, energy rating band before and after the efficiency project is carried out, and energy performance index (EPI) before and after the efficiency measures are taken up. Furthermore, regarding the kind of efficiency improvement works carried out, the adopted measures are listed according to the following categories: insulation and cladding system (the latter including windows and frames), heating and cooling system, photovoltaic and solar thermal system, mechanical extract ventilation system, and rainwater harvesting system.

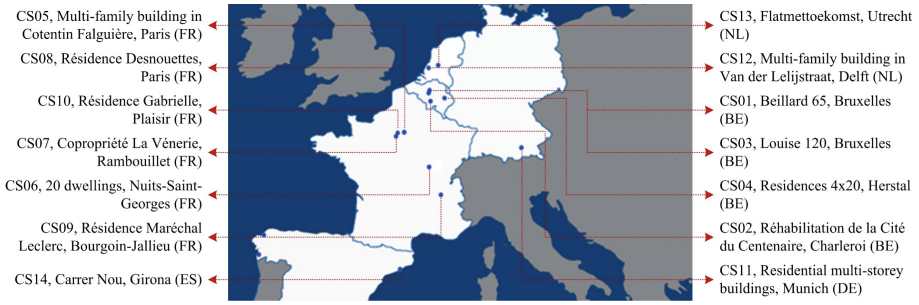


Fig. 2. The fourteen case studies and their location.

Two-page summary sheets have been prepared for each case study. An excerpt from them can be found below (Figs. 3–4). The first page recaps information about the property's characteristics, such as location, ownership, size, building typology, construction year, energy rating band, and the energy performance index before and after the renovation works. A summary of the efficiency improvement measures and a more detailed description of them is also included. On the other hand, the second page focuses on the information relating to the adopted business model with a characterization of the financial promoter and the building owner, besides a diagram representing the relationships among the players.

Table 1. The variables and the coding system.

Domain	Variable	Code	Categories
Business model	Ownership	OW	1: publicly-owned and semi-public organization; 2: private non-profit company; 3: private for-profit company
	Financial promoter	FP	1: ESCo; 2: construction company; 3: architecture firm
	Incentive measures	IM	(binary) 1: use of subsidies or tax rebates
	Upfront cost	UC	1: $\leq$ 2mln Euros; 2: $\leq$ 4mln Euros; 3: $\leq$ 8mln Euros
Real estate asset	Size (net floor area)	SZ	1: $\leq$ 3,000 m2; 2: $\leq$ 10,000 m2; 3: $\leq$ 22,000 m2
	Construction year	CY	1: 1950–1965; 2: 1970–1980; 3: 1990–2010
	Building typology	BT	1: condo; 2: terraced house; 3: other
	Construction material	CM	1: reinforced concrete; 2: steel; 3: bricks
	Rating band (ante)	RBa	1: D; 2: E; 3: F; 4: G
	Rating band (post)	RBp	1: A; 2: B; 3: C; 4: D
	EPI (ante)	PIa	1: 160–199 kWh/m2 y; 2: 200–229; 3: 230–299; 4: 300–399; 5: higher than 400
	EPI (post)	PIp	1: 20–39 kWh/m2 y; 2: 40–64; 3: 65–89; 4: 90–149; 5: 150–200
Efficiency-related works	Insulation	INS	(binary) 1: renovation works include measures on the element or system
	Cladding (including windows and frames)	CLA	(binary) 1: renovation works include measures on the element or system
	Ventilation	MEV	(binary) 1: renovation works include measures on the element or system
	Cooling	COO	(binary) 1: renovation works include measures on the element or system

(*continued*)

Table 1. (*continued*)

Domain	Variable	Code	Categories
	Heating	HEA	(binary) 1: renovation works include measures on the element or system
	Photovoltaic	PVS	(binary) 1: renovation works include measures on the element or system
	Solar thermal	STS	(binary) 1: renovation works include measures on the element or system
	Rainwater harvesting	RHS	(binary) 1: renovation works include measures on the element or system

4 Results and Discussion

Using the first variable describing the BM - namely, ownership - as a discriminating factor leads to identifying three primary, well-defined clusters mirroring the categories of the variable itself (Fig. 5).

The first group includes five publicly-owned real estate assets; four are condos relying on construction companies for renovation work, which always involves adding insulation layers to the building envelope and often includes replacing the heating system. Notably, only one case study features the intervention of an ESCo as the financial promoter of the transaction and the interface between the involved parties.

The second set features only three case studies where a private non-profit company owns old, middle-sized properties; again, the refurbishment is essentially pursued by adding insulating layers to the buildings. Two of the properties are reinforced concrete condos facing high upfront costs in the range of 4 to 8 million Euros. Two cases feature the involvement of an ESCo. The property assets owned by private for-profit companies belong to the third cluster, which includes two subsets: on the one hand, four reinforced concrete buildings renovated as far as the cladding system is concerned; on the other hand, two relatively recent nonresidential buildings.

The information provided by the above three sets is relatively scarce and scattered. The description of the case studies and the relationships among the analyzed variables improves when considering - sometimes vague and fuzzy - subsets. Pertinent examples are the layered subsets in the first group (Fig. 6). It turns out that reinforced concrete is the most common construction material for those case studies, and properties predominantly have an average size between 3,000 and 10,000 square meters. Furthermore, renovation often involves installing a mechanical extract ventilation system besides replacing the heating system and adding insulation layers to the building envelope.

CASE STUDY N°01

Belliard 65

BUILDING INFORMATION

Location: Bruxelles
Ownership: private
Net floor area: 5134 m2
Building typology: 11 floors building (3 of them underground) with concrete pillars
Construction year: 1990's
Intervention typology: Extension

EPC before energy measures: /
EPI before energy measures: /

EPC after energy measures: B
EPI after energy measures: 83,00 kWh/m2 yr

Energy measures:
- Heating system + production od domestic hot water
- Cooling system
- Ventilation system
- Lighting system
- Renewable sources

Description of the efficiency improvement measures:

- Heating system
- Heat production (heating) via two HR condensing gas boilers and production of local domestic hot water via air/water heat pump.

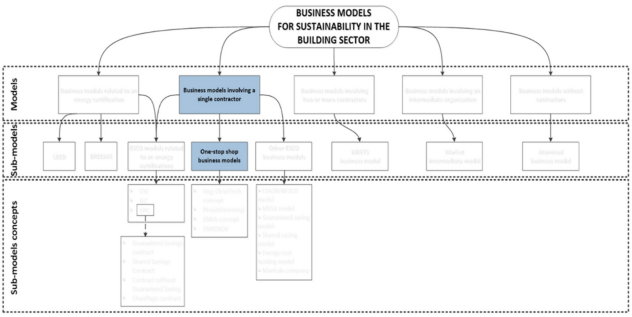
- Cooling system
- Cold production by two high performance refrigerating machines with freechilling.
- Emission of hot and cold via reversible hot and cold radiant metal ceilings with access to the thermal mass.

- Ventilation system
- "Oversizing" of the ventilation system (double-flow mechanical ventilation with plate heat exchanger and by-pass) .

- Lighting system
- Presence-motion detectors that control the switching on and off of the lights.
- Installation of high efficiency LED type luminaire and luminaire luminous flux adjustment through twilight sensors.

- Renewable sources
- Photovoltaic installation ensuring a production of 65,000 kWh/year.

Fig. 3. Excerpt from the summary sheets of the case studies: CS01.



BUSINESS MODEL: One-stop shop

Financial promoter: Herpain Entreprise
Building owner: AXA REIM Belgium

Relationships among business model subjects:

- **Herpain Enterprise** is the main contractor of the project and thanks to the collaboration with others actors like Matriciel sa (thermal consultant agency), Pirnay Engineering (structure calcolist), B4F (certification agency), François De Bloudts (assistance to the Contracting Authority Advisers), Tom Vandervorst (structure calcolist), Company SPIE (company in charge of HVAC and sanitary batches), Company ITB (company in charge of the elevator lot), Company Nizet (company in charge of photovoltaic panels and high voltage booths) is able to realise the measure of efficiency. It provides AXA REIM Belgium with all the information and types of services required and frees the customer from any responsibility.
- **AXA REIM Belgium** is the customer and it's a management company that invest in energy long savings. As foreseen in the One-stop shop BM, it is responsible for repaying the Herpain Enterprise for the works performed after they are completed.

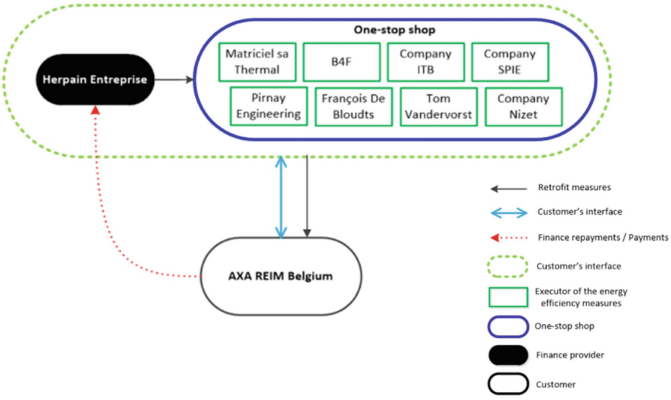


Fig. 3. (*continued*)

CASE STUDY N°07

Copropriété La Vénerie - Rambouillet

BUILDING INFORMATION

Location: Rambouillet
Ownership: private
Net floor area: 13350 m2
Building typology: collective housing of 148 flats and 5 commercial locals
Construction year: 1977
Intervention typology: renovation

EPC before energy measures: D
EPI before energy measures: 169,00 kWh/m2 yr

EPC after energy measures: B
EPI after energy measures: 90,00 kWh/m2 yr

Energy measures:
- Building's envelope
- Ventilation system
- Lighting system

Description of the efficiency improvement measures:

- Building's envelope

- Renovation with thermal insulation from the outside of the 7 buildings of the residence
- Insulation of attic floors and demossing of the roof
- Insulation of lower floors facing the outside
- Replacement of shutters
- Replacement of the original private and collective carpentry

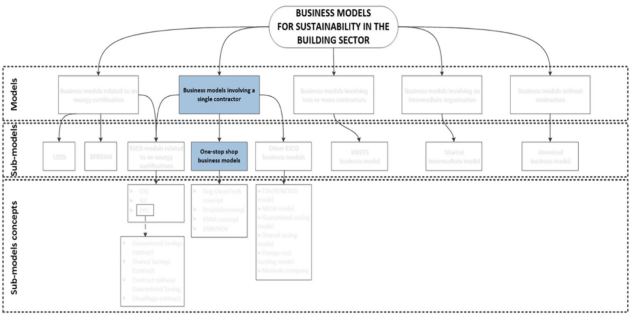
- Ventilation system

- Condemnation or adaptation of refuse chutes
- Improved radiators
- Installation of heating cost allocators
- Improved intercoms

- Lighting system

- Improved lighting in common areas

Fig. 4. Excerpt from the summary sheets of the case studies: CS07.



BUSINESS MODEL: One-stop shop

Financial promoter: Ile de France energie
Building owner: Private owners of the flats

Relationships among business model subjects:

- **Ile de France energie** is the main contractor of the project. Thanks to the collaboration with other companies such as SEEF (energy company), ZA consulting (engineering company) and Cidelec it is responsable for the efficiency measures and for the energy contract.
- **The private owners of the flats** decided to carry out the efficiency works in order not to see the value of their properties depreciated since the neighboring condominiums had had efficiency works. They promote energy efficiency measures and are responsible for repaying Ile de France energie for the works performed. They are not responsable for the execution of efficiency measures.

Use of government's funding or tax incentives:

- 1 030 000 € state aids:
- CEE : 110 800 €
- Region : 200 000 €
- CITE (Crédit d'impôt): 125 000 €
- Anah, Commune, Département des Yvelines total : 590 103 €

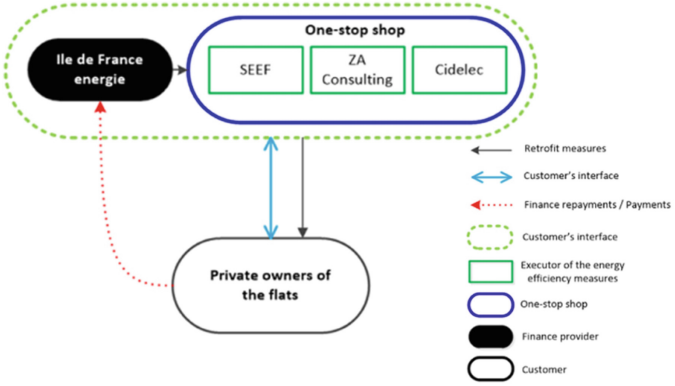


Fig. 4. (*continued*)

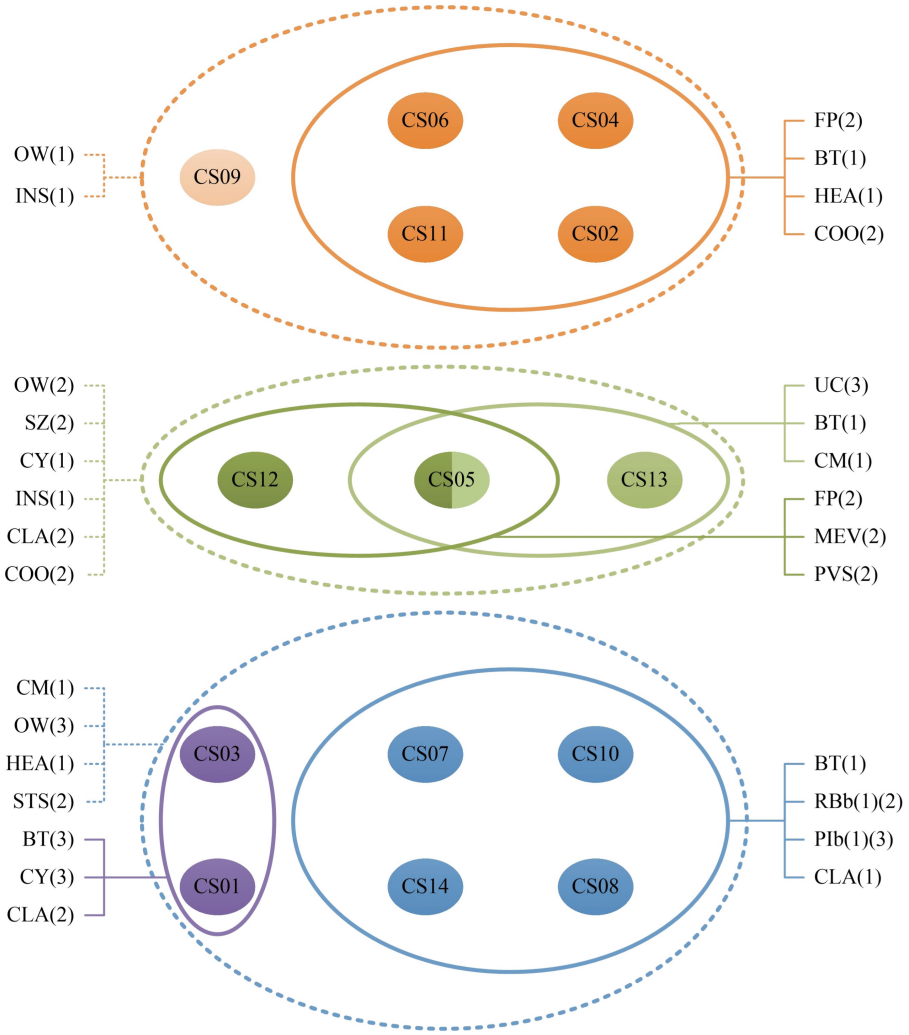


Fig. 5. Main clusters of the case studies.

A further detailed view of the case studies and the relationships among the analyzed domains and variables is offered by the consideration of additional subsets in the first cluster (Fig. 7). The involved real estate assets are essentially outdated, having been built in part between 1950 and 1965 and partly during the seventies. Despite the physical obsolescence due to age, the refurbishment works led to an overall acceptable energy performance for three of them: the rating band after the renovation is B, with the EPI in the range of 65–89 kWh/m2 y. The result is even better for the remaining two case studies, which are now A-rated. Finally, there is little to add regarding efficiency-related works, except for using photovoltaic panels in just two cases. Incentive measures are also used in two cases; we will get back to that later.

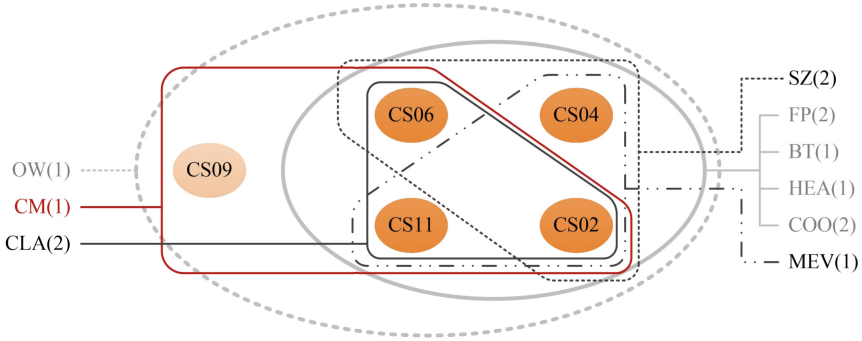


Fig. 6. Layered subsets in the first cluster of the case studies.

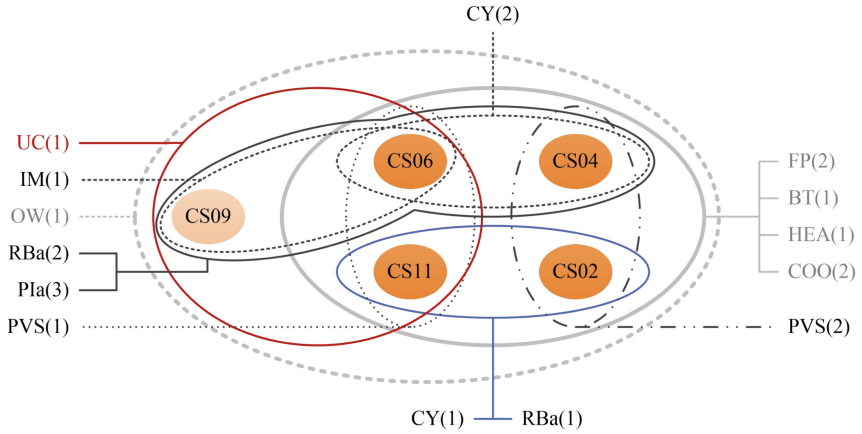


Fig. 7. Additional subsets in the first cluster of the case studies.

Several subsets that intersect each other also characterize the third cluster (Fig. 8). The subset that includes three French case studies - CS07, CS08, and CS10 - is quite interesting due to two characteristics: the largest properties in the sample with a size up to 22,000 square meters and the use of incentive measures to support the investment. In fact, the use of those measures is a distinctive feature of the French case studies (Table 2).

Additional specific subsets that cluster the case studies in pairs can be found for the third group (Fig. 9). Although each represents a fraction of the whole dataset, their joint reading is helpful to deepen the interpretation and expand the knowledge of the OSS BM. A couple of case studies feature an ESCo as the financial promoter, and incentive measures are used in both cases. Instead, incentives are usually not exploited when construction firms act as financial promoters.

The empirical evidence above suggests revising the hypothesis put forward in the introduction of this paper. The OSS BM is not intrinsically dependent on the measures meant to incentivize building energy efficiency, at least not as much as one of the OSS BM players, especially the ESCo.

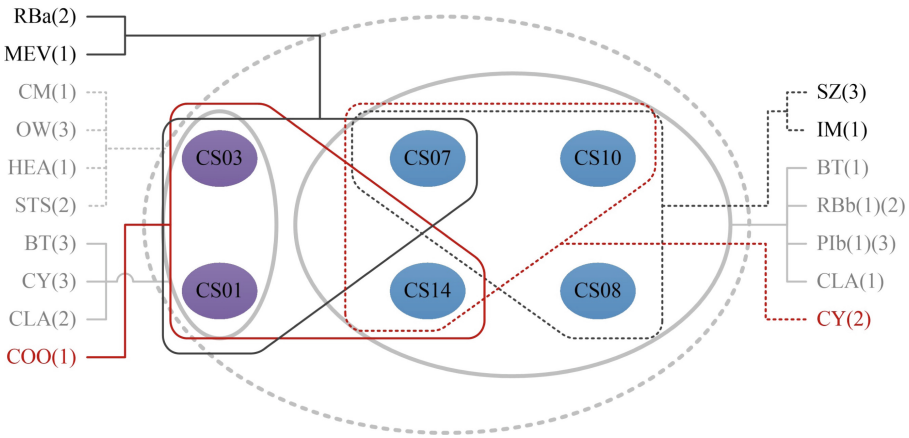


Fig. 8. Layered subsets in the third cluster of the case studies.

Table 2. Sources for the incentive measures adopted in the French case studies

Organization	Description
ADEME	The French ecological transition agency is responsible for evaluating and financing innovations that can help reduce energy consumption and greenhouse gas emissions This funding source was used in CS06 and CS09; the latter was selected in two calls for regional projects by ADEME and the Rhône-Alpes region and benefited from grants covering 26% of investment costs
ANAH	The French national agency for housing improvement subsidizes home comfort enhancement. Subsidies vary between 25% and 50% of the investment depending on renovation work and rent This funding source was used in CS07 and CS10
banks	Eco-PTZ is an interest-free loan that can be used by the owner-occupant or lessor of a dwelling to finance energy renovation work up to 50,000 Euros The case studies CS08 and CS10 benefited from this financial support

Furthermore, the third cluster shows interesting findings concerning building energy performance before and after the completion of renovation work. Several case studies in this group involve mid-tier buildings as far as energy performance is concerned. Their rating bands were D or E before the refurbishment. Nevertheless, none of them makes the shift to the A rating band after the refurbishment is carried out; some are B-rated, others C and even D. The outcome seems to be unrelated to the amount of the investment. Instead, it appears to be the consequence of the combination of constraints due to building age and kind of efficiency-related works primarily focused on the envelope and heating, with much less attention paid to other systems, such as mechanical extract ventilation, cooling, and photovoltaic or solar thermal.

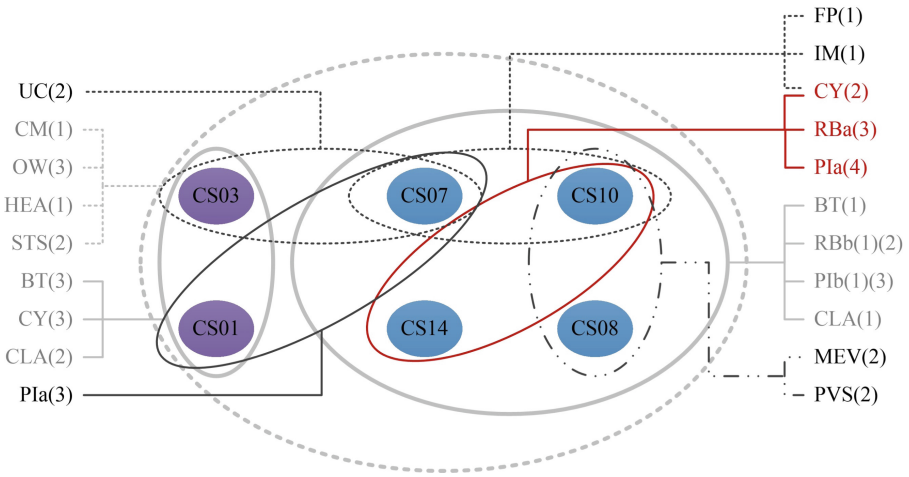


Fig. 9. Additional subsets in the third cluster of the case studies.

5 Conclusions

This study analyzed the use of the One-Stop Shop business model for improving building energy efficiency. Based on fourteen case studies across Central Europe, the relationships among variables belonging to three domains are investigated: distinctive features of the business model, characteristics of the buildings to be refurbished, and nature of the efficiency-related works. According to the above variables, the Rough Set approach enabled us to cluster the case studies into a few groups with well-defined boundaries and several further subsets that are vague, fuzzy, and often intersect each other.

The OSS BM is used equally by publicly-owned organizations and semi-public bodies, private non-profit entities, and private for-profit companies. The single contractor that takes care entirely of the efficiency improvement works - namely, the interface between the property owner and the other players - was expected to be often an Energy Service Company. It turns out that the role is played mainly by private entities other than the ESCos, especially construction companies, seldom architecture firms. Nevertheless, the presence of an ESCo as the contractor is clearly related to the exploitation of incentive measures meant to improve the energy performance of the building stock.

The OSS BM is chiefly used for the purpose of refurbishing outdated multi-family residential buildings, especially condos with a reinforced concrete load-bearing structure, built between the fifties and the seventies, likely characterized by poor insulation and barely efficient heating systems. Building size is highly variable; most cases are below 10,000 square meters, though a few case studies are characterized by a net floor area twice the above threshold. The buildings of the case studies are relatively not homogeneous as far as the starting energy rating band and energy performance index are concerned. Some of them were low-tier buildings relating to energy performance, as they were rated from G to E before the renovation work. Contrary to the expectations, others were mid-tier facilities rated D. Interestingly, the rating band after renovation is not strictly related to the one before. Thus, most buildings rated D before being renovated

do not make it through the B rating band after the works are completed, and one ends up gaining the C rating band only. Notable is also the case of an E-rated building that shifts simply to the D-rating band once the renovation is complete. Only about a fifth of the refurbished buildings are awarded the A-rating band.

The preferred renovation works involve building insulation, cladding, and heating systems. In several case studies, energy refurbishment is limited to the above domains. That is enough to reach an acceptable energy performance, which can be identified with the B and C energy rating bands. Occasionally, energy refurbishment is pursued by installing or improving other systems, especially mechanical extract ventilation or photovoltaic panels. That is essential to reach the highest energy performance, namely, the A energy rating band and an energy performance index lower than 40 kWh/m2 y, regardless of the starting rating band and the initial performance index. The renovation works seldom involve components such as cooling, solar thermal, and rainwater harvesting systems.

The analysis performed here lends itself to be extended to the other innovative BMs, the rise and development of which have been stimulated by the legal framework set at the EU level, as well as by the coherent incentive measures adopted by member countries. The forthcoming steps of the analysis in this field should be focused on comparing the pros and cons, strengths and weaknesses of the OSS and the other BMs to identify which one is best suited to pursue the energy refurbishment of the building stock.

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