Contracting the Gap:
Energy Efficiency Investments and Transaction Costs

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Glossary

ACT	Cleantech Agentur Schweiz (Energy Agency)
ANA	Attribute non-attendance
ASC	Alternative-specific constant
BBL	Bundesamt für Bauten und Logistik
BM	Business model
Clogit	Conditional logit
ECLCM	Equality-constrained latent class model
EnAW	Energieagentur der Wirtschaft (Energy Agency)
EE or *ee*	Energy efficiency
EPC	Energy Performance Contracting
ESC	Energy supply contracting
ESCO	Energy Service Company
IEC	Integrated Energy Contracting
IIA	Independence of irrelevant alternatives
IFRS	International Financial Reporting Standards
LCM	Latent class model
M	Million
MuKEn/MoPEC	Mustervorschriften der Kantone im Energiebereich / modèle de prescriptions énergétiques des cantons / model of energy directives for cantons
OVH or *ovh*	Overhaul
SFOE	Swiss federal office of energy
SME	Small and Midsize Enterprises
Swiss GAAP FER	Swiss accounting standards
TCE	Transaction cost economics
VAT	Value added tax

General abstract

Energy Performance Contracting (EPC) consists in outsourcing the design, the implementation, the maintenance and sometimes the financing of energy-conservation project to a contractor called Energy Service Company (ESCO). In such long-term contracts, the contractor provides its client with a reduction in energy costs in exchange for a fixed fee or part of the savings achieved. EPC can be considered as an important market driver for efficiency investments. Yet the market in Switzerland is only emerging, lagging behind other countries such as Germany or the US.

Using data from existing markets, interviews and two surveys from the supply and demand sides, this study analyzes the development and potential roles of the Energy Performance Contracting market in Switzerland. The focus is on the impacts on the energy efficiency gap and related transaction costs. The results are used to identify relevant policy measures for promoting the market and possible interactions with other instruments used for energy efficiency.

In Switzerland, the transaction costs related to EPC are exacerbated by the municipal and cantonal divergences in terms of legal requirements. In this context, bottom-up approaches, such as the use of intermediaries (or ESCOs themselves) offering advices on a case by case basis, may be more valuable in Switzerland than top-down methods (e.g. standardized documents, general guidelines) in order to adapt to the divergences occurring in each political jurisdiction.

As compared to other countries, EPC's potentials in terms of financing opportunities are probably less needed in Switzerland. Indeed, we provide empirical evidence that ESCO's financing is valued positively only by a minority of potential clients, presumably credit-constrained by debt ceilings. On the other hand, the results show that the performance guarantee offered by EPC represents an attractive approach to unlocking cost-effective energy efficiency improvements. The importance of guaranteeing energy savings results in a crucial policy guidance. If EPC cannot reach all EPC segments such as smaller energy consumers due to the entailed transaction, the policy maker could use other instruments to ensure that the energy savings meet the expectations.

The delay of the EPC market in Switzerland conjugates with a lack of awareness on the demand side and on the supply side. We show that this lack of information results in misperceptions. While most of information dissemination can be led by suppliers themselves, the authorities benefit from neutrality, which is needed to convince public and private potential clients, other public authorities as well as potential suppliers. The final decision regarding the federal energy strategy is also likely to mitigate important uncertainties regarding the potentials of EPC. Still, successful ESCOs will likely be the firms who react and adapt their business model to better fit to the Swiss specificities.

Extended summary

Motivation: energy service contracting and the Swiss context

Energy service contracting (hereafter referred to as energy contracting) consists in outsourcing energy-related services and decision rights over energy equipment to a contractor called Energy Service Company (ESCO) through a long-term contract. The literature refers to two main types of energy contracting (Sorrell (2007)):

1. Energy Supply Contracting (ESC) typically covers one or more streams of useful energy (e.g. heat, hot water, electricity) but exerts no or little control of final energy demand. Because the ESCOs have the incentive to maintain equipment performance over time, ESC is expected to promote renewable or innovative energy technologies.
2. In Energy Performance Contracting (EPC), the ESCO has a control over the demand for final energy services. Typical measures proposed within EPC are efficient lighting, heating control systems or energy automation systems. Because the contractor is remunerated according to the energy savings achieved, these contracts are seen as promising to induce investment in energy efficiency actions. Two dominant EPC models are seen in practice (Hansen (2006)):
    a) *Shared savings EPC*: the ESCO typically finances the project. Energy cost savings are then shared between the two parties during the contractual period.
    b) *Guaranteed savings EPC*: In this model, the client carries the financing or gets financing by a third party. The ESCO guarantees that the value of energy saved will meet a certain threshold. Otherwise, the ESCO covers the gap. In these types of contracts, the ESCO is typically paid a fixed fee during the contractual period.

In both ESC and EPC, the client benefits from risk sharing mechanisms, from the ESCO's financial and technical knowhow as well as a minimization of the project-cycle cost and maintained equipment performance and controlled user's behaviour over the contractual period. Therefore, these contracts have been seen in the literature as promising market-based instruments to overcome barriers to both energy efficiency and renewable energy investments (Globerman and Vining (1996), Painuly (2001), Sorrell (2005), Sorrell (2007), Capelo (2011), IEA-RETD (2013)). Despite the apparent advantages, the ESC market in Switzerland seems to experience a slow growth and EPC is only emerging. Even mature ESCO markets such as in the US or in Germany are also facing several barriers hampering this business to fully exploit all the potentials (Marino et al. (2010), Bleyl (2011), Langlois and Hansen (2012)).

In the Swiss context, in which the authorities are considering to progressively abandon nuclear power via a smooth transition to a sustainable and low carbon economy, while ensuring security of energy supply (cf. the Swiss New Energy Policy, Bundesamt für Energie (2012)), it is crucial to attract sufficient investments in both renewable technolo-

gies and energy efficiency. The success of the energy policy programs will depend on the extent to which they can identify and overcome market barriers to investment. Market-based instruments such as energy contracting may especially be important because public concerns about governments' direct interventions such as taxes and subsidies could raise barriers against energy transition policies. A relevant illustration is the Swiss energy strategy being recently questioned by a public referendum. It is therefore of particular concern to assess the barriers, the drivers and the potentials of these market-based instruments.

Research project overview

This research project focuses on the market of energy performance contracting (EPC). Starting with a critical literature review and lessons learned from more mature foreign ESCO markets, this study explores the framework conditions for EPC in Switzerland and the potentials in the demand and supply sides of the Swiss EPC market. This report's chapters are described as follows:

I. Literature review

This chapter describes in depth ESC and EPC and their expected roles in promoting investments in renewable technologies and energy efficiency as described in the literature. It also reviews the general trends in the ESCO markets abroad and in Switzerland as well as existing theoretical and empirical studies regarding barriers and drivers to energy contracting. The rationality for government support is also explored using a review of literature regarding the government's involvement and role in fostering ESCO markets growth.

II. Analysis of framework conditions of EPC in Switzerland

While Switzerland a priori represents a fertile ground for EPC, the chapter aims at understanding why the Swiss EPC market is only emerging and lagging behind other markets such as in Germany or in the US. Using experts' interviews, an analysis of the actors having a role to play in the Swiss EPC market is provided. A special emphasis is drawn on the government's involvement at cantonal and federal levels. The business model developed by early entrants on the Swiss EPC market is also studied together with the barriers and drivers they stated as hampering the market development. For each barrier, we explore the legal and political framework and provide the readers with potential solutions and guidelines.

III. Market Demand for EPC and its future potentials

The government's support to mitigate EPC market barriers is justified only if EPC is proven to be an efficient instrument to facilitate investments in energy efficiency or renewable energy. Despite the abundant literature on EPC, it lacks quantitative evidence on the decision mechanisms through which EPC can induce investments, and on their underlying trade-offs and heterogeneity. Using a web-based survey and a choice exper-

iment among 297 potential EPC clients in Switzerland, we econometrically assess through which channels EPC can mitigate barriers to energy efficiency investments. The respondents are building managers, owners or municipal councillors in charge of large privately or publicly-owned energy-consuming buildings, such as schools, offices, hospitals, hotels, shopping centres, sport facilities and large residential buildings. By detecting the mechanisms through which EPC facilitate investment, this study also informs about the most binding constraints hampering investments in energy efficiency. It does so while accounting for heterogeneity in preferences and decision processes among respondents.

IV. Analysis of the EPC market provision

The number of EPC providers as well as their past experience has been shown as an important determinant of EPC projects' quality (Iimi (2016)). Therefore, not only a sufficient number of ESCOs is needed for the Swiss EPC market to exploit all its potentials, but potential entrants should also enter the market as soon as possible. Using a web-based survey and a choice experiment among 208 potential suppliers in Switzerland, including 9 active ESCOs, this study aims to determine how to foster EPC market supply. Respondents represent in majority (72%) public or publicly controlled firms, mostly providing electricity, engineering consulting, gas and energy efficiency services. A qualitative analysis is lead on the current EPC Swiss market as well as on the barriers, drivers and business models from the point of view of incumbents vs. potential entrants. Finally, a quantitative analysis is lead on the willingness to supply energy service contracts depending on the firms' characteristics, under different hypothetical changes on the market and on the energy regulatory framework.

The following section reviews the key results of this study. Each subsection summarizes the results that can come from different chapters of this report. For each element, the chapters and sections are provided in parentheses in order to guide the interested reader willing to gain additional information towards the relevant parts.

Key results

The current Swiss EPC market

EPC is a market niche in Switzerland, which has started to be developed only recently. The first public tender for EPC was published in fall 2016 and a few others are currently being developed. In spring 2017 to our knowledge, 5-10 ESCOs have implemented EPC projects in Switzerland with a total of around 25 EPC contracts signed. A slightly larger share of these contracts was concluded with private entities. The clients are hotels, industries, education and health facilities, private office buildings, residential buildings and shopping centers. In addition to ESCOs with some contracts signed already, 5-10 additional ESCOs are active on the EPC market but without any contract signed in Switzerland yet. We estimate around 40 contracts under negotiation mainly with private entities (chapter IV, section 4.1).

EPC is never stated as the main activity of active ESCOs in Switzerland. These firms are medium to large size enterprises, in which only a small group of employees are currently working on EPC (chapter IV, section 4.1.1.). Swiss ESCOs are primarily electricity utilities, energy consultants, energy control and optimization appliances providers, ESC providers or gas utilities. While these early entrants are likely to benefit from the risk diversification provided by their large size and important other activities, we find no empirical evidence that the size of the firm affects potential suppliers' interest to enter the EPC market. In the future, therefore, smaller ESCOs may be expected on the market (chapter IV, section 4.1).

The survey gathered information about 208 potential EPC suppliers from which 199 are still inactive on the EPC market and include mostly electricity utilities, engineering consulting, gas and other energy services providers. Out of the 199 inactive firms, 59 (29.6%) stated to be potentially interested to provide EPC in the future (chapter IV, section 3.2). From the 59 interested firms, 68% have already undertaken some actions to prospect the EPC market (mostly interviews with potential clients, looking for business partner or market research) (chapter IV, section 4.1).

An important actor on the Swiss EPC market is the association swissesco. Founded in 2015, it aims to promote the EPC market in Switzerland. In 2016, the association provided public entities with guidelines to implement EPC projects and public tendering procedures for EPC (Swissesco (2016)). The 2017 agenda of the association includes the finalization of standardized contracts, information dissemination and training courses on EPC. With more than 30 members in spring 2017, the association also relates all the important stakeholders in the Swiss EPC market (chapter II, section 4.8).

Intermediaries, also called facilitators, are perceived abroad as important EPC market players (Bleyl et al. (2013), Nolden et al. (2016)). Facilitators can be engineering firms or consulting firms that work as a third party between the client and the ESCO. They represent an interesting bottom-up approach to circumvent and mitigate barriers on the EPC market. A few firms already offer this kind of services in Switzerland.

The public authorities have also an important role to play in the context of EPC (chapter II, section 7). On the one hand, they are defining the legal framework under which the EPC market takes place. On the other hand, the public sector is a potential client for EPC since he owns and manages buildings with often large energy consumption. Furthermore, the authorities can act as energy agencies facilitating EPC. Chapter II, section 7 summarizes policy instruments on energy efficiency in Switzerland and their potential synergy with EPC. While the Swiss federal office of energy and some cantons already stepped in to promote EPC, other cantons would also be ready to do so under certain conditions (chapter II, section 7.2.3).

The EPC business model: the point of view of active and potential Swiss ESCOs

The main activity implemented by active ESCOs and potential entrants to prospect the market is to run interviews with potential clients (chapter IV, section 4.1.1). A majority of active ESCOs have also elaborated a business model, as described in this section. A

large share of potential entrants has not thought about a business model for EPC yet. Nevertheless, we still gathered their point of view on this subject. The structure used to gather information on the business models developed by suppliers and described in the following subsections is based on the canvas from Osterwalder and Pigneur (2010). Additional information regarding the business models elaborated by Swiss ESCOs, such as stated competitive advantage, resources, partnerships and business targets, are not summarized here but provided in chapter IV (section 4.1.2) and chapter II.

Value proposition to clients

ESCOs are unanimous on this: energy savings is not the primary argument to sell an EPC project to a client. The ESCOs' experience indeed reveals that energy savings are typically perceived by the client as the "icing on the cake" and that the client values mostly other characteristics of EPC projects. The value proposition behind EPC goes beyond performance guarantees and financial solutions. The elements mentioned by the suppliers include optimized technical parameters of equipment, comfort, system reliability, turnkey solutions for large energy consumers subject to legal requirements regarding energy consumption (chapter II, section 3.1), a single interlocutor for the whole project, transparency regarding costs, detectable and measurable energy savings, a carefree package, operation and maintenance optimization (chapter IV, section 4.1.1).

Value delivery

The challenge for ESCOs is to detect ex ante what the client will value the most and propose tailor-made contractual solutions to satisfy her needs. We indeed find empirical evidence of important heterogeneity of preference and decision-mechanisms across potential clients regarding energy efficiency investments (chapter III, section 5.6). The success of EPC projects will likely depend on the capacity of ESCOs and/or intermediaries such as facilitators to properly account for this heterogeneity and adapt their offer accordingly. This study also emphasizes the need for ESCOs to work closely with the facility managers at the client's site, and this from the negotiation process up until the operation and maintenance of the installation (chapter II, section 3.4).

Clients target

The ideal client for an EPC project satisfies the following criteria (chapter II, 4.2):

- Centralized, large energy consumption
- Refurbishment or optimization needs for existing infrastructure and operations (either because of legal requirements, inefficient operations or desuetude)
- Limited financial resources for non-core-activity investments
- No reluctance towards long term partnerships
- Defined utilization of the building in the next years
- Clear and preferably not changing ownership/tenant of the building in the next years

- Building older than 3 to 5 years or new building with bad monitoring

In practice and according to our survey among 208 active ESCOs and potential entrants, the clients and type of projects targeted in Switzerland seems to contrast with those favoured in foreign ESCO markets in the following ways:

1. The primary client's type targeted in Switzerland is industries. This contrasts with foreign markets where EPC has been mostly implemented in public schools, municipality buildings and hospitals (chapter I, section 4.3).
2. While EPC is seen as unlikely to be economically viable for small energy consumers because of the transaction costs involved (chapter II, section 4.2, chapter I, section 4.3), the results of our survey show that potential suppliers in Switzerland do not necessarily target the largest clients. Some even favoured small clients (chapter IV, section 4.6.2).
3. While EPC involving complete refurbishments and envelope insulation are quite rare in foreign markets (chapter I, sections 5.1.1 and 4.4), a majority of the surveyed Swiss firms did not show any preference regarding the measures implemented within EPC. As swissesco (2016) emphasizes, EPC can involve comprehensive refurbishments including the envelope. But these projects are likely to necessitate financing from both the ESCO and the client. Such a mechanism of risk and financing-sharing seems promising to target all kinds of energy efficiency investments.

The following two reasons may explain these divergences between the Swiss and the foreign EPC markets:

1. The Swiss market is only emerging and the targets may considerably evolve with the market expansion
2. In a current Swiss conjuncture with low interest rates, the clients may be less credit constrained to finance energy efficiency projects than in other countries.

Revenue stream

The firms surveyed did not unanimously favoured EPC shared-savings or guaranteed savings scheme. This suggests that the choice between revenue streams is more likely to be driven by the client's choice or the context than by the ESCO's preference (chapter IV, section 4.3).

Empirical evidence on the role of EPC to foster investments in energy efficiency

The empirical evidence is based on a web survey among 297 potential EPC clients, with buildings including education and sport facilities, public administration buildings, public and private office buildings, hotels, hospitals, residential buildings and shopping centres. 82% of the buildings are publicly-owned and 38% are rented buildings at least partly. Most of the buildings in the sample are eligible for EPC projects: 85% of the buildings

are built before 1990 and a majority of them (57%) have a heated surface larger than 2000m^2 (chapter III, section 4.2).

In the survey, respondents had to imagine the situation in which a revision on the building would be soon necessary. Through stated preferences the respondents were invited to decide if they would opt for different energy efficiency measures, with or without EPC, or if they would rather choose a simple overhaul (e.g. revision of the boiler or painting of the windows and facade). The alternatives proposed differed in upfront costs, expectation and risk on energy savings and EPC contractual attributes (e.g. guarantee on savings, ESCO's financing, contract's duration and payment). This method allows to quantitatively assess the impact of each of these attributes on the willingness to invest in energy efficiency. Key empirical results are (chapter III, section 5.6):

1. ESCO's financing is positively affecting investment only for a minority of respondents. These are mostly public entities (schools), presumably with debt ceilings. This result implies that for the majority, limited access to credit at reasonable costs is not a determinant of underinvestment in energy efficiency, at least in our sample. This result has also to be put in the current context of the general Swiss situation and the business cycle with low interest rates. For constrained public entities with debt ceilings, on the other hand, the ESCO's financing's advantage will only exist if it is possible to account for the EPC project as an operational expenditure off-balance sheet, which is currently not clarified. A first policy implication is the need to clarify the extent to which public entities can indeed legally use ESCO's financing to circumvent credit constraints such as debt ceilings. The rationality for legally allowing off-balance sheet in that case is supported by the ESCO's guarantee that the credit will be entirely financed by the energy savings achieved.
2. ESCO's guarantee has a persistent and significant positive impact on the willingness to invest. The risk sharing advantage of EPC is an important driving factor in all market segments considered in this sample. This result has the following policy implications:
    a) This provides rational for policy support on EPC, especially if it is less costly to mitigate barriers to EPC (such as lack of information) than circumvent risk and imperfect information hampering energy efficiency investments.
    b) This provides guidance regarding smaller energy consumers that may not be targeted by EPC. Because risk and imperfect information on energy efficiency seems to be an important barrier to investment, other solutions than EPC could be found for this market segment. These include for instance services of follow up on users' behavior and technical operation and maintenance in order to guarantee ex post that the energy savings achieved meet expectations.
3. This study failed to capture any impact of landlord tenant split incentives as a barrier to energy efficiency investments. This should however be tested further using a sample with a larger share of privately-owned rented buildings.
4. We find heterogeneity in preferences and in the decision-making processes when it comes to energy efficiency and energy performance contracting. This was translated in the simplified decision processes in which respondents ignored some attributes,

and the reluctance towards EPC, which cannot solely be explained by observed contractual clauses. These results provide interesting insights about the behavioral complexity in the decision process regarding energy efficiency investment and suggest that further research in that domain will provide interesting and crucial answers to reduce the energy efficiency gap. Also, this emphasizes the necessity for ESCOs to detect each customer's needs and propose tailor-made solutions

5. The building and individual characteristics significantly affecting the willingness to adopt energy efficiency or EPC are summarized in the following table. For instance, when the respondent was an energy manager, the willingness to invest in energy efficiency (with or without EPC) increased. This result was the opposite when the respondent was the building owner.

Table 1: Impacts of building's and respondent's characteristics

	Willingness to adopt EE	Willingness to adopt EPC
The respondent was already familiar with EPC	+	+
Energy manager employed for the building	+	
Respondent=energy manager	+	+
Respondent=owner	-	-
Respondent=politician (executive)		-
Number of years' experience of the respondent in his function		-

Note: Positive significant effects are described by a "+" and negative effects by "-", nothing when no significant impact

6. Other characteristics did not have any significant impact on the willingness to invest. Amongst others, these include the building's size (in terms of yearly electricity or energy costs and heated surface), the building being rented or not, the respondent's age, gender, education, language or role in the decision process. Also, we did not find any divergence in the decision-making or in the valuation of contractual attributes between private and public entities.
7. Finally, while EPC can mitigate important barriers to investments, it is also facing an intrinsic reluctance from potential clients which is likely to be partly caused by a lack of awareness. The respondents' stated reasons for this reluctance are summarized in the following section (and in chapter III 5.4). We argue that a large part of this reluctance could be mitigated via further information dissemination.

Barriers on the demand-side: potential solutions and policy implications

Active Swiss ESCOs unanimously stated the client's lack of knowledge and awareness towards EPC as the most important barrier to the market deployment in Switzerland

(chapter II, section 6.1.1. and chapter IV, section 4.2.1). From this unawareness follows misperceptions and reluctance towards this new business model. This reluctance is visible in the fact that more than 50% (149) of the sample of 297 potential clients surveyed never opted for energy performance contracting[1]. Respondents were asked to give the reason why they would not choose EPC and the results are illustrated in Figure 1 (chapter III, section 5.4).

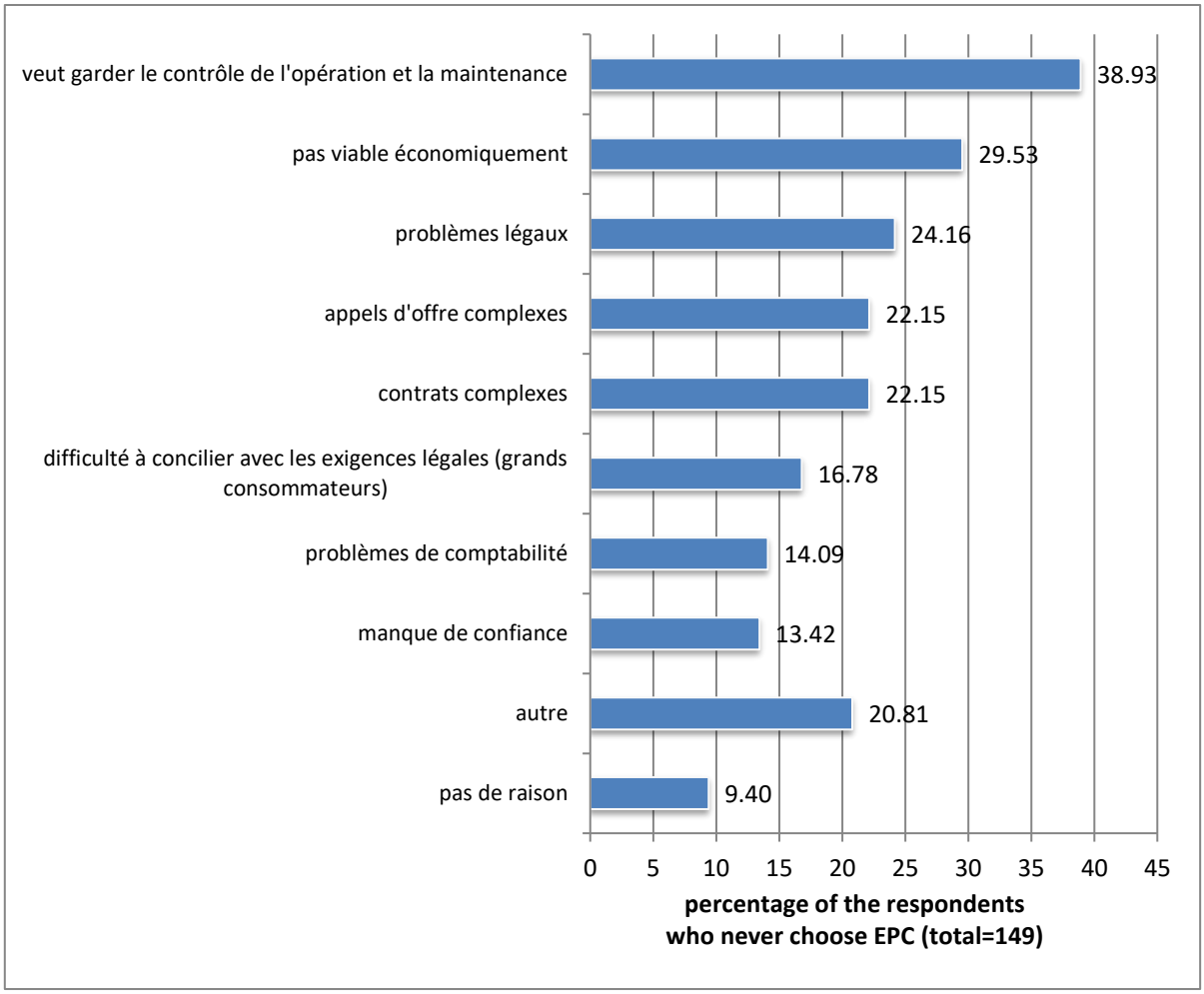


Figure 1 Stated barriers to EPC.

1. The main reason mentioned is the **unwillingness to outsource the control of operation and maintenance**. This may come from a misperception of respondents that perceived the ESCO's control of operation and maintenance as a necessity to forgive existing facility managers or employees in charge of the technical equipment. Information dissemination is therefore needed to show that it is not the case since

[1] As a comparison, 26 respondents never choose energy efficiency investments (with or without EPC). These respondents claimed to be unwilling to invest (as opposed to overhaul) mainly for the following reasons: building already efficient, energy efficiency investments are not economically viable and the building is protected.

the ESCO controls the operation by providing the facility managers with training courses on how to use and understand the new equipment or efficiently managing the building (swissesco (2016)).

2. The **economic viability** of these projects is also largely questioned. The respondents mentioning this issue are however not less eligible in size or savings potentials than the average respondent in the sample.
3. **Legal issues, complexity** of the tendering process and of the contract are also concerning for potential clients. These can directly relate to transaction costs and are difficult to mitigate in Switzerland where the law can vary between municipalities and cantons. Intermediaries will likely play an important role to provide tailor-made advices on a case by case basis. The situation may also evolve positively when the EPC market will be more mature and legislations on the matter will be clarified. In chapter II, we provide the current knowledge on the following issues and provide some guidelines and solutions:
   a) right for a private firm to invest on a public building (chapter II 6.3.1.)
   b) transferring the costs onto tenants (chapter II 6.3.3.)
   c) off-balance sheet financing for EPC (chapter II 6.3.2)
   d) tendering process for EPC (chapter II 6.1.2)
   e) legal disputes regarding measure and verification of the energy savings achieved (chapter II 6.1.3)
4. 14 respondents (9.4%) **did not provide any reason** to explain the fact that they never chose EPC. This could suggest an unexplained unwillingness to adopt EPC. Interestingly, 13 of these respondents were unfamiliar with EPC before completing the survey. While this cannot provide information on the causality, the correlation between unexplained distaste for EPC and unfamiliarity with the concept can suggest that information campaigns with best practices are needed to overcome the barriers linked to the novelty of this model in some people's mind.
5. This lack of information and **biased perception** of EPC are also visible in the other reasons respondents mentioned for not choosing the contracts. For instance, some respondents stated that EPC was not possible since the building is public or because they were financially constrained. In fact, EPC are typically targeted to buildings with these characteristics.
6. Other legitimate reasons mentioned are the **long commitment** to an external firm that these contracts involve, the willingness to **invest themselves** especially in a context where credit is as cheap as now and **qualified human resources** already available internally. One participant was also concerned about the **difficulty to sell a building** committed with an EPC. Other respondents gave the same reasons as those who always chose overhaul such as protected buildings where transformation is difficult.

While we find empirical evidence that EPC can reduce and mitigate barriers to investments in energy efficiency, in an emerging market such as Switzerland where a lot of interrogations remain on the concept, it appears a priori that the perceived barriers are even stronger and more numerous for EPC than for energy efficiency investments without contracts. Hard work is still needed to mitigate transaction costs linked to those

contracts. A large part of this task will probably include information campaigns and dissemination of best practices examples, which has already started under the impulse of the swissesco association and the Swiss federal office of energy.

How to foster high quality and competitive EPC offers? Empirical evidence on barriers and drivers from the supply-side

Supply drivers

From the conducted interviews, we can observe that EPC is provided for the following reasons (chapter II, 4.1.1):

- Increasing market volume for equipment and maintenance portfolio
- Binding clients in the long term
- Stabilizing and planning cash flow on annual basis
- Covering client's needs
- Keeping control on business processes, resources, inventions
- Preserving competitive advantage

We also explored how the regulatory framework in Switzerland could affect business decisions regarding EPC.

1. None of the active ESCOs interviewed considered the **electricity market liberalization** (for large consumers) as having been a trigger to provide EPC. Only one actor mentioned it as having played a potential role in their decision to enter the EPC market, in order to retain their clients, but only as a conjunction to other more important factors, such as a general willingness within the firm to promote sustainability through market instruments (chapter II, section 7.4). The empirical evidence in chapter IV (4.5), also shows that liberalizing the electricity market for small consumers does not impact significantly the willingness to enter the EPC market.
2. The new constitutional article (131.a) currently in consultation has also been mentioned as a factor that could increase general interest in providing EPC. The suppliers will indeed have to respond to a demand increase for energy efficiency solutions, triggered by the **system based on fuel and electricity tax levies provided in this new law** (chapter II, section 7.4). The empirical evidence from chapter IV (section 4.5) however shows that it does not significantly impact the consideration to enter the EPC market. It may result from the difficulty for suppliers to foresee its concrete impacts on the market. Since this policy is only likely to be implemented in the second phase of the energy strategy 2050, if at all, respondents may not have evaluated its potential consequences yet.
3. The **"Lex Weber"**, prohibiting the construction of secondary residences after a certain threshold, has also been mentioned as having a potential impact on the EPC provision in some cantons (chapter II, 7.4). In some highly-impacted cantons, such as in Valais, this law provokes an important slow-down in the construction sector and particularly affects the business of small local entrepreneurs. According to Prof. Stéphane Genoud (HES-SO Valais), this is likely to give a forced incentive to these

actors to retarget the construction sector towards energy refurbishment of existing buildings, and to possibly involve themselves in EPC projects, either as ESCOs, in a consortium of small entrepreneurs, or as suppliers of the ESCOs.

In chapter IV (section 4.5), potential suppliers stated whether their firm would consider offering a certain type of contract provided that the situation on the market would hypothetically change in several possible ways. The econometric analysis based on these answers leads to the following evidence:

- The willingness to enter the EPC market is significantly affected **by an increase in demand only if it combines both public and private demands.** Entering the EPC market represents an important investment in terms of technical knowledge, risk appraisal expertise, and multidisciplinary knowledge with respect to contractual arrangements, legal prescription, measure and verification of savings. We show that for potential suppliers, this investment is more important in terms of competencies and human resource than in terms of financial resources.
- An **exogenous supply increase from electric utilities** affects positively the probability that the firm will offer EPC. The supply increase was presented as resulting from an obligation for the utilities to increase their clients' energy efficiency, as in a white certificates scheme. The hypothetical implementation of such a policy does not only affect electricity providers, but all types of providers. Possibly due to increased competition or imitation, other suppliers in the energy market are likely to respond by increasing their offer of EPC services as well.
- **Activities already offered by the firm can work as a complement to EPC.** We find that providers of gas, heating systems and energy control and optimization systems are more likely to enter the EPC market.
- The size of the firm in terms of number of employees or the location scope of the firm's activities have no significant impact on the consideration to enter the EPC market.
- Being a private or a public firm does not affect the willingness to enter the EPC market. However, if the respondent stated that **the public entity in charge of the organization exerts some pressure to increase the energy efficiency of its clients**, then the firm is more likely to consider providing EPC or ESC. This result suggests that a solution to foster EPC supply would be to sensitize and inform the public entities in charge of utilities or gas companies.

Supply barriers

The barriers perceived by active ESCOs are different from those encountered by the firms who have not entered the market yet. For the latter, the following issues are likely to apply:

- 62% of the firms inactive in EPC surveyed (199 firms) were unfamiliar with the concept before the survey (chapter IV, 4.1). The results show a positive relationship between the respondent's **familiarity with the EPC concept** and the consideration to offer these contracts (chapter IV, 4.5). Although this variable may suffer from en-

dogeneity, it still suggests that information campaigns may be useful on the supply side of the EPC market.

- 140 (67%) of the 208 respondents did not show interest in entering the EPC market in the future. A majority of them (58%) stated to **lack the internal competencies and personnel capacity** to do so (chapter IV, 4.2.2.). The firms are unwilling to invest or find strategic partnerships because of the following barrier.
- The **EPC market volume and potentials are unknown to potential suppliers** (chapter II, sections 4.1.2 and 6.2.2., chapter IV section 4.2.2.). Some respondents stated that due to the existing legislation, the Swiss assets and machinery parks are in good conditions and there are not enough large energy consumers with consequent energy savings potentials. Also, the lack of interest from clients and the uncertainty concerning the energy strategy at the federal level jeopardize the remaining potentials according to them. While we found evidence that EPC have the potential to facilitate investments in energy efficiency for large consumers, further research is needed regarding the potential market volumes. On the other hand, training programs and facilitated partnerships to share human resources and competencies may be needed to allow firms to enter the EPC market at reasonable costs.
- More structural barriers at the firm level, such as inadequacy of EPC with the core business, objection from the direction or no interest from the firm, were stated as barriers by a minority of respondents. This is encouraging with respect to the potential development of the supply side. Indeed, these barriers are more difficult to mitigate than those mentioned above, but they are also less recurrent.

In addition to provide important insight regarding barriers perceived by their clients, some active ESCOs mentioned the following issue on the supply side:

- ESCOs must be **accredited by the Energy Agency (EnAW) or ACT**, in order to supply solutions to large energy consumers subject to legal requirements and willing to contract a universal convention of objectives[2]. However, this represents a barrier to potential entrant ESCOs who cannot acquire the accreditation easily (chapter II, sections 6.4.2 and 5). Indeed, without such a certification, they consequently lose an important EPC advantage for this segment of clients. This represents a barrier to entry to suppliers on the Swiss EPC market.

Finally, the following issues were mentioned by both active ESCOs and potential entrants:

- The (currently) **low energy prices** induce a lack of profitability (chapter IV, sections 4.2.1 and 4.2.2.)
- The **risks** for the ESCO are high (chapter IV, 4.2.2.)
- 8 out of the 9 active ESCOs surveyed stated that they sometimes struggle to **finance** a project. It does not concern all EPC projects, but it has been a problem that almost all ESCOs have faced. Lack of financing is a barrier that has also been stated

[2] This convention is required to qualify for the CO2 tax exemption, a reduction or a reimbursement of the supplement on electricity network transmission costs.

by 23% of the firms stating to be unwilling to enter the EPC market (chapter IV, section 4.2.2).

In chapter II, we analyzed further the risks borne by the ESCO in an EPC project and provide some guidelines and solutions. Table 2 provides a summary of this analysis.

Table 2: Risks for the ESCO

Risks for the ESCO	
Risk on the performance (chap. II, 6.2.1.)	
cause	Ex ante uncertainty about energy savings
consequences	-ESCOs need technical knowledge and risk appraisal expertise -Third party investors may be reluctant to invest or interested only in very large EPC projects. (chap. II, 4.7 p.19)
solutions	-EPC "forfaiting" Scheme -appropriate follow-up of users' behavior and technical settings -elaboration of comprehensive tools for financial institutions to compute technical and economic risk related to each project -risk diversification (e.g. Super ESCO, pool of energy efficiency measures)
Risk on realization costs (chap. II, 6.2.1- 2)	
cause	the ESCO is paid through a fixed fee or a share of the savings achieved (% CHF)
consequence	any unexpected costs are borne by the ESCO unless contractually stated otherwise
Solutions	-risk diversification (e.g. different projects, ESCO's other activities) -Clear contractual clause defining the responsibilities of each party: The risk should be borne by the agent which is the most able to mitigate it. -In theory, the ESCO should be contractually responsible for any additional costs resulting from errors of estimations or technical issues -The client should bear unexpected costs resulting from drastic changes in user's behaviour, malpractice from its employees and from changes in regulations framework (if public client)
Risk of client's relocation or bankruptcy (chap. II, 6.2.3 – 3)	
cause	EPC often involves services, measures or installations, whose property cannot be transferred to the investor
consequence	a large part of the investment cannot be covered by collaterals owned by the investor
solutions	-risk diversification (e.g. projects with different types of clients, ESCO's other activities) -contractual clauses requiring the client to pay an indemnity in case of relocation -guarantee fund among several ESCOs to diversify the risk of client's defaults -public guarantees against bankruptcy (e.g. canton Fribourg) -real estate liens (chap. II, 6.2.1. a)

Conclusion and policy implications

The EPC market in Switzerland is a market niche which has recently emerged. Yet, the market is likely to evolve significantly in the following years according to the potentials we found on both the demand and the supply sides. The current delay of the Swiss market can be explained by a conjunction of factors.

The transaction costs related to EPC are exacerbated by the municipal and cantonal divergences in terms of legal requirements. As emphasized abroad (Nolden et al. (2016)) and especially in this context, bottom-up approaches, such as the use of intermediaries (or ESCOs themselves) offering advices on a case by case basis, may be more valuable in Switzerland than top-down methods (e.g. standardized documents, general guidelines) in order to adapt to the divergences occurring in each political jurisdiction. Policy support is however likely to be needed to clarify legal requirements applying more broadly on the territory[3].

As compared to other countries, EPC's potentials in terms of financing opportunities are probably less needed in Switzerland (at least in the current conjuncture). ESCO's financing is indeed valued positively only by a minority of potential clients, presumably credit-constrained by debt ceilings. The performance guarantee offered by EPC[4] on the other hand, represents the most attractive approach in Switzerland to unlocking cost-effective energy efficiency improvements. The importance of guaranteeing energy savings results in a crucial policy guidance. If EPC cannot reach all EPC segments such as smaller energy consumers due to the entailed transaction, the policy maker could use other instruments targeted to follow up the users' behavior and optimize the equipment to ensure that the energy savings meet the expectations.

The delay of the EPC market in Switzerland unsurprisingly conjugates with a lack of awareness on the demand side as well as on the supply side. We show that this lack of information results in misperceptions. While most of information dissemination can be led by suppliers themselves and the swissesco association, policy support from federal entities (such as the Swiss Federal office of energy) benefit from neutrality, which is needed to convince public and private potential clients, cantonal authorities as well as potential suppliers. The final decision regarding the federal energy strategy is also likely to mitigate important uncertainties regarding the potentials of EPC and energy prices. Still, successful ESCOs will likely be the firms who react and adapt their business model to better fit to the Swiss specificities.

[3] This is the case for instance to clarify how EPC should be accounted according the standardized accounting methods for cantons and municipalities.

[4] Either through shared savings schemes, in which the ESCO has the incentive to maintain performance, or more directly through a financial guarantee on the energy savings achieved.

Generelle Übersicht

Beim Energiespar-Contracting (EPC) werden die Planung, die Umsetzung, der Unterhalt sowie teilweise die Finanzierung von Energie-Effizienz-Projekten von einem Projekteigentümer an eine Dienstleistungsfirma (ESCO) ausgelagert. Dabei kommen mehrheitlich langfristige Verträge zum Einsatz, in welchen der Auftragnehmer dem Kunden eine Energiekostenreduktion auf Grund von Effizienzmassnahmen garantiert und im Gegenzug eine finanzielle Vergütung aus der Kosteneinsparung erhält, um die umgesetzten Massnahmen zu finanzieren. EPC kann auf Grund seiner Eigenschaften als wichtiges Marktangebot für Energieeffizienz-Investitionen gesehen werden, bei welchem ein wichtiger Teil der Projektkosten vom Eigentümer auf einen Dienstleister übergehen. In der Schweiz ist das Marktvolumen für EPC bis heute sehr gering, im Gegensatz zu anderen Märkten wie Deutschland, Österreich oder den USA.

In der hier vorliegenden Studie werden Daten von bestehenden Märkten, aus Interviews und zwei Umfragen genutzt, um die Marktentwicklung und die potenzielle Rolle von EPC in der Schweiz zu untersuchen. Dabei liegt der Fokus auf dem möglichen Einfluss von EPC zur Reduktion der sogenannte Energieeffizienz-Lücke und auf den Transaktionskosten für EPC-Projekte. Die Resultate werden genutzt, um politische und regulatorische Massnahmen zu identifizieren, welche Hürden für den EPC-Markt reduzieren können und mögliche Interaktionen mit anderen Instrumenten zur Energieeffizienz-Steigerung aufzeigen.

Im Vergleich zu anderen Ländern scheint der Bedarf für externe Finanzierungen von EPC-Projekten limitiert zu sein. Diese Einschätzung wird durch die empirischen Daten gestärkt, welche aufzeigen, dass nur wenige EPC-Anwender eine Projektfinanzierung durch den Dienstleister als positiv bewerten. Zusätzlich zeigen die Resultate, dass die Performance-Garantie welche durch den Dienstleister angeboten wird, einen attraktiven Ansatz bietet, die Anwendung von kosteneffektiven Effizienzmassnahmen zu erhöhen. Die Wichtigkeit der garantierten Energieeinsparungen ist für die weiteren politischen und regulatorischen Schritte von grosser Bedeutung. Anzumerken ist, dass sich nicht alle Energiesparprojekte für EPC eignen, da insbesondere bei geringen Einsparungen die Transaktionskosten zu hoch sind. In diesen Fällen sind andere Massnahmen häufig sinnvoller, um das entsprechende Einsparpotenzial zu erzielen

In der Schweiz werden die Transaktionskosten für EPC stark durch die unterschiedlichen lokalen und kantonalen gesetzlichen Grundlagen beeinflusst, welche insbesondere bei Ausschreibungsverfahren sehr unterschiedliche Rahmenbedingungen aufweisen. In diesem Zusammenhang können unabhängig beratende Dienstleister eine wichtige Rolle spielen, welche die lokalen Rahmenbedingungen kennen, um den EPC-Markt weiter zu entwickeln. Unterstützt werden deren Bestrebungen durch allgemeingültige Musterverträge und Richtlinien, welche schweizweit Gültigkeit haben.

Die verspätete Marktentwicklung von EPC in der Schweiz hängt eng mit einem Informationsmangel zu EPC zusammen, welches sowohl auf der Anbieter- als auch auf der Nutzerseite festgestellt werden konnte. Wir zeigen auf, dass der Informationsmangel auch zu einer Falschwahrnehmung führt, was mittels EPC erreicht werden kann. Auf der einen

Seite ist es zielführend, wenn durch EPC-Anbieter informiert wird, aber auch unabhängigen Informationen seitens der Behörden kommt eine wichtige Rolle zu, Private und öffentliche Institutionen über die Vorteile von EPC zu informieren. Der Schweizerischen Energiestrategie kommt ebenfalls eine wichtige Rolle zu, bei der möglichen Reduktion von Hindernissen zur Umsetzung von EPC-Projekten. Es liegt aber insbesondere in der Hand der Energiedienstleister, attraktive Marktangebote zu gestalten, um das Potenzial von EPC umsetzen zu können.

Ausführliche Zusammenfassung

Energiedienstleistungsverträge im Schweizerischen Umfeld

Energiedienstleistungsverträge regeln die Auslagerung von energiebezogenen Leistungen und die Kontrolle über Energieanlagen von einem Eigentümer an einen Energiedienstleister (ESCO). In der Literatur werden zwei unterschiedliche Haupttypen von Energiedienstleistungsverträgen beschrieben (Sorrell (2007)):

1. Energieliefer-Contracting (ESC) umfasst typischerweise die Bereitstellung einer oder mehrerer Nutzenergien (z.B. Raumwärme, Heisswasser oder Strom), aber beinhaltet keine oder nur eine geringe Einflussnahme auf die Nutzenergienachfrage.
2. Beim Energiespar-Contracting (EPC), registriert und überwacht eine ESCO zusätzlich zur Bereitstellung der Nutzenergie auch die Nutzenergienachfrage. Da der EPC-Anbieter auf Basis der erzielten Energieeinsparung entschädigt wird, werden EPC-Verträge als vorteilhaft gesehen, zusätzliche Energieeffizienz-Investitionen auszulösen bzw. die erwarteten Einsparungen auch zu erzielen (z.B. in den Bereichen Beleuchtung, Heizungssteuerung oder Gebäude-Automation). Zwei EPC-Varianten kommen in der Praxis am häufigsten zum Einsatz (Hansen (2006)):
   a) EPC mit "geteilter Einsparung": Eine ESCO finanziert typischerweise ein Energieeffizienz-Projekt. Durch den Einsatz der effizienten Technologie können Energiekosten eingespart werden. Während der Vertragslaufzeit realisiert der Kunde einen Teil der Kosteneinsparung direkt und verwendet den weiteren Teil der eingesparten Energiekosten für die Entschädigung des Dienstleisters.
   b) EPC mit "garantierter Einsparung": In diesem Modell garantiert eine ESCO eine definierte Energieeinsparung gegenüber dem Ist-Zustand. Wird die Einsparung nicht erreicht, trägt die ESCO die Differenz zwischen effektiver Einsparung und garantierter Einsparung. Die ESCO wird dabei meist mittels einer fixen Entschädigung vergütet. Die Finanzierung der Energie-Anlagen trägt in diesem Modell entweder der Eigentümer direkt oder sie wird durch einen Dritten übernommen.

In beiden Modellen (ESC und EPC) profitiert der Kunde davon, dass er einen Teil der normalerweise getragenen Risiken (z.B. Anlagen-Ausfallrisiken, ineffiziente Betriebsführung, etc.) an einen dritten auslagern kann. Zusätzlich profitiert der Kunde vom Knowhow der ESCO durch tiefe Projektkosten, einer laufenden und professionellen Zustandsüberwachung der Anlagen und allenfalls einer Nutzenkontrolle während der Vertragslaufzeit. In der Literatur werden solcherart Verträge daher als vielversprechende, Markt-basierte Instrumente gesehen, um Investitionen in Energieeffizienz und erneuerbaren Energien zu steigern (Globerman and Vining (1996), Painuly (2001), Sorrell (2005), Sorrell (2007), Capelo (2011), IEA-RETD (2013)). Trotz der offensichtlichen Vorteile von ESC und EPC kommt der Einsatz von ESC-Projekten in der Schweiz nur langsam voran und der EPC-Markt ist erst in der Entstehung. Selbst weiter fortgeschrittene EPC-Märkte wie Deutschland, Österreich oder die USA sind mit Hürden konfron-

tiert, welche die Ausnutzung des vollen Marktpotenzials erschweren bzw. verzögern (Marino et al. (2010), Bleyl (2011), Langlois and Hansen (2012)).

Im Rahmen der schweizerischen Energiestrategie, in welcher ein schrittweiser Ausstieg aus der Nuklearenergie mit dem Aufbau zusätzlicher erneuerbarer Energien und der Steigerung der Energieeffizienz einhergehen soll (Energiestrategie 2050, Bundesamt für Energie (2012)), ist es implizit notwendig, ausreichende Investitionen in den entsprechenden Geschäftsfeldern zu ermöglichen. Der Erfolg von politischen Massnahmen zur Zielerreichung 2050 ist daher abhängig vom Umfang und Reduktion der identifizierten Hürden, welche diese Investitionen verzögern oder verhindern. Markt-basierte Instrumente wie Energiedienstleistungsverträge sind daher besonders wichtig, um politischen Bedenken bezüglich regulatorischer Direkt-Interventionen wie Steuern oder Subventionen im Rahmen der Energiewende zu begegnen. Es ist daher von grundlegendem Interesse, die Hürden, Treiber und Potenziale der marktnahen Instrumente wie ESC und EPC aufzuzeigen und zu analysieren.

Projektübersicht

Dieses Forschungsprojekt fokussiert auf den Markt für Energiespar-Contracting (EPC). Beginnend mit einer kritischen Literaturreview und den Erkenntnissen aus der Analyse weiter ausgebildeter EPC-Märkte, untersucht die hier vorliegende Studie die Rahmenbedingungen für EPC in der Schweiz sowie dessen Potenzial auf Angebots- und Nachfrageseite. Der hier vorliegende Schlussbericht gliedert sich in folgende Kapitel:

I. Literatur Review

Die Literatur Review beschreibt detailliert die bestehende wissenschaftliche Literatur zu ESC und EPC und deren erwartete Rolle bei der Förderung bzw. Unterstützung von Investitionen in erneuerbare Energie und Energieeffizienz. Dazu werden die generellen Entwicklungen der ESCO-Märkte in der Schweiz und im Ausland bewertet sowie die Hürden und Treiber für die Marktentwicklung analysiert, welche in theoretischen und empirischen Studien beschrieben wurden. Die Begründung für einen politisch-regulatorischen Support bezüglich der Ausbildung und Stützung eines ESCO-Marktes wird ebenfalls untersucht, unter Berücksichtigung der entsprechenden Quellen.

II. Analyse der Rahmenbedingungen für EPC in der Schweiz

Da die Schweiz einen fruchtbaren Boden für einen EPC-Markt bieten kann, leiten wir in diesem Kapitel das Verständnis her, warum der Schweizerische EPC-Markt erst im Entstehen begriffen ist und anderen Märkten hinterherhinkt. Aufbauend auf Experten-Interviews wird eine Marktakteurs-Analyse durchgeführt und beschrieben. Dabei wird ein wesentliches Augenmerk auf die Rolle der öffentlichen Hand gerichtet sowohl auf Landes- als auch auf Kantonsebene. Zusätzlich wird das Geschäftsmodell der aktiven und frühen EPC-Marktteilnehmer in der Schweiz untersucht sowie deren Wahrnehmung der Markttreiber und -Hürden beschrieben. Für jede genannte Hürde untersuchen wir die gesetzlichen und politischen Rahmenbedingungen und schlagen geeignete Lösungen und Massnahmen vor, diese zu beseitigen.

III. Marktnachfrage für EPC und dessen zukünftiges Potenzial

Die Unterstützung zur Reduktion der Markthürden für EPC durch die öffentliche Hand ist nur gerechtfertigt, falls der Nachweis erbracht werden kann, dass EPC als effektives Instrument zur Steigerung der Investitionen in Energieeffizienz und erneuerbare Energien beiträgt. Obwohl zahlreiche Literatur zu EPC besteht, fehlt es an quantitativen Grundlagen zu den Entscheidungsmechanismen, durch welche EPC Investitionen auslösen kann. Durch den Einsatz einer Web-basierten Umfrage, mit einem Choice-Experiment mit 297 Teilnehmern als potenziellen EPC-Kunden, können wir mittels ökonometrischen Analysen dieser Frage nachgehen. Zusätzlich können die wichtigsten Rahmenbedingungen aufgezeigt werden, welche diese Art von Investitionen unter Berücksichtigung der Heterogenität von Entscheidungsprozessen verhindern.

Die Umfrage-Teilnehmer sind private Gebäudemanager, Eigentümer oder deren Energieverantwortliche sowie Vertreter der öffentlichen Hand, in Funktion von Bauamtsleitern, Liegenschaftsverantwortlichen oder ähnlichen. Der Teilnehmerkreis ist verantwortlich für Gebäude mit einem hohen Energiebedarf wie z.B. Schulen, Spitälern, grossen Hotels, Einkaufszentren und grossen Bürogebäuden.

IV. Analyse der EPC-Marktanbieter

Die Anzahl von EPC-Anbietern und deren bestehende Erfahrung als wichtige Einflussgrösse auf die Qualität von EPC-Projekten wurde bereits in Iimi (2016) beschrieben. Daher gilt auch für die Schweiz, dass eine ausreichende Anzahl Energiedienstleister dieses Marktsegment abdecken sollte und dies möglichst zeitnah, um die entsprechenden Erfahrungen aufzubauen. Anhand einer Web-basierten Umfrage unter 208 möglichen EPC-Anbietern (darunter 9 aktive EPC-Anbieter), zielt dieser Teil der Studie darauf ab, zu untersuchen, wie die Anbieter-Seite gestärkt werden kann. Eine qualitative Analyse zum bestehenden Schweizer EPC-Markt wurde mit Blick auf bestehende und mögliche EPC-Anbieter und deren Geschäftsmodelle durchgeführt. Zusätzlich wurde quantitativ die Bereitschaft der Firmen analysiert, zukünftig EPC-Verträge anzubieten, in Abhängigkeit von Firmencharakteristika und hypothetischen Änderungen der Markt- und regulatorischen Rahmenbedingungen. Die Antwortenden vertreten in einer Mehrzahl (72%) Firmen, welche durch die öffentliche Hand kontrolliert werden und als Strom- und Gasversorger tätig sind sowie Dienstleistungen im Bereich Energieeffizienz anbieten.

In den folgenden Abschnitten werden die Schlüsselergebnisse dieser Studie kurz eingeführt. Dazu fasst jeder Unterabschnitt die Resultate der einzelnen Kapitel des Hauptberichtes zusammen. In Klammern stehen jeweils die Kapitel- und Abschnittsnummern, welche auf den Hauptbericht und damit weiterführende Informationen verweisen.

Resultatübersicht

Derzeitiger EPC-Markt in der Schweiz

EPC führt derzeit in der Schweiz ein Nischendasein, entwickelt sich aber seit Kurzem auf Grund von verschiedenen Massnahmen weiter. Eine erste öffentliche Ausschreibung für ein EPC-Projekt wurde zum Beispiel im Herbst 2016 durchgeführt. In den vergangenen

Jahren haben etwa 5 bis 10 Energiedienstleister EPC-Projekte in der Schweiz realisiert, mit insgesamt ca. 25 unterschriebenen Verträgen. Mehrheitlich wurden diese Verträge mit privaten Eigentümern für Gebäude aus den Bereichen Hotellerie, Industrie, Bürogebäude und Wohngebäude abgeschlossen. Neben diesen aktiven ESCOs sind weitere 5-10 Firmen im EPC-Markt aktiv, welche aber noch keine entsprechenden Projekte realisiert haben. Basierend auf den geführten Gesprächen und Rückmeldungen, gehen wir davon aus, dass zu Beginn des Jahres 2017, zu etwa 40 EPC-Verträgen in verschiedenen Angebotsstadien Gespräche stattfinden (siehe Kapitel IV, Abschnitt 4.1).

Von den Unternehmen wurde EPC in den Erhebungen nie als Hauptgeschäftstätigkeit genannt. Dabei handelte sich um mittlere bis grosse Unternehmen, mit einer kleinen Gruppe von Beschäftigten, die sich auf das Thema EPC konzentrieren (siehe Kapitel IV, Abschnitt 4.1.1.). Die Dienstleistungsunternehmen gehören primär den Sektoren Strom- und Gasversorgung, Beratende Ingenieure und Anlagenlieferanten an. Während diese frühen Marktteilnehmer wahrscheinlich von einer Risikodiversifizierung in ihrem Unternehmen profitieren, konnten wir keine empirischen Hinweise finden, dass die Grösse eines Unternehmens das Interesse bzw. die Bereitschaft beeinflusst, in den EPC-Markt einzusteigen. Es kann daher erwartet werden, dass in Zukunft auch kleinere Dienstleister in diesen Markt eintreten (siehe Kapitel IV, Abschnitt 4.1).

Über die Umfrage bei möglichen EPC-Anbietern wurden 208 Unternehmen erreicht von denen 199 noch nicht auf dem EPC-Markt in der Schweiz aktiv sind. Von diesen 199 Unternehmen haben 59 (entspricht 29.6%) in der Umfrage angegeben, sich vorstellen zu können, EPC in der Zukunft anzubieten (Kapitel IV, Abschnitt 3.2). Von den 59 interessierten Firmen haben 68% bereits erste Aktivitäten unternommen, den EPC-Markt kennenzulernen (z.B. durch Interviews mit potenziellen Kunden, durch die Suche nach möglichen Partnern oder durch Marktforschung) (Kapitel IV, Abschnitt 4.1).

Ein wichtiger Akteur auf dem Schweizerischen EPC-Markt ist der Verband swissesco, welcher im Herbst 2015 gegründet wurde und EPC in der Schweiz bekannt machen soll. Im Jahr 2016 hat der Verband die ersten Richtlinien zur Ausschreibung und Implementierung von EPC-Projekten der öffentlichen Hand zur Verfügung gestellt (swissesco (2016)). Weiter sollen Standardverträge, Informationsveranstaltungen und Trainingskurse folgen (Kapitel II, Abschnitt 4.8).

Technische Beratungsfirmen wurden im Ausland als wesentliche Marktakteure erkannt (Bleyl et al. (2013), Nolden et al. (2016)). Als unabhängige Berater arbeiten diese Firmen als Mittler zwischen Kunden und Anbietern von EPC-Lösungen. Diese Firmen arbeiten mit interessanten Ansätzen, um spezifischen Hürden bei der Realisierung von EPC-Projekten zu überwinden. Einige wenige Firmen in der Schweiz sind bereits aktiv in dieser Rolle.

Die öffentliche Hand nimmt eine wesentliche Rolle in Bezug auf EPC ein. Auf der einen Seite definiert sie die rechtlichen Rahmenbedingungen des EPC-Marktes, und auf der anderen Seite kann die öffentliche Hand als Gebäudeeigentümerin von EPC profitieren. Über öffentlich finanzierte Energieagenturen kann zusätzlich die Bekanntheit von EPC weiter gesteigert werden. Das Kapitel II, Abschnitt 7 fasst die entsprechenden Politikinstrumente zum Thema Energieeffizienz und deren potenziellen Synergien zu EPC zu-

sammen. Während der Bund mit dem Bundesamt für Energie und einige Kantone das Thema EPC aktiv vorantreiben, sind andere Kantone noch zurückhaltend und warten erste Ergebnisse ab (Kapitel II, Abschnitt 7.2.3).

Das Geschäftsmodell EPC aus Sicht von aktiven und potenziellen Dienstleistern

Um den EPC-Markt in der Schweiz zu analysieren, haben die aktiven und interessierten Dienstleister Gespräche mit möglichen Kunden geführt, um deren Interesse an EPC-Lösungen abzuklären (Kapitel IV, Abschnitt 4.1). Die aktiven ESCOs haben darüber hinaus spezifische Geschäftsmodelle entwickelt, welche im Folgenden kurz eingeführt werden, während andere Unternehmen diese noch nicht definiert haben. Um zu den verschiedenen Geschäftsmodellen strukturierte Informationen sammeln zu können, wurde das Business Model Canvas von Osterwalder (2010) in dieser Studie herangezogen. Weitere Informationen zu den Geschäftsmodellen (wie z.B. Wettbewerbsvorteile, Ressourcen oder Partnerschaften) sind in Kapitel IV, Abschnitt 4.1.2 aufgeführt.

Das Nutzenversprechen für Kunden

ESCOs äussern sich einstimmig: Energieeinsparungen sind nicht das primäre Nutzenversprechen, um einen Kunden von einem EPC-Projekt zu überzeugen. Die Erfahrung der ESCOs zeigt, dass die Energieeinsparungen als das "Sahnehäubchen" wahrgenommen werden und andere Aspekte von EPC-Dienstleistungen im Vordergrund stehen. Dabei geht das Nutzenversprechen über Leistungsgarantien und Finanzierungslösungen hinaus. Die am häufigsten genannten Elemente beinhalten die optimierte technische Betriebsführung, die Systemverlässlichkeit, das Angebot von schlüsselfertigen Lösungen sowie einen hohen Komfort durch EPC-Angebote für Energie-Grossverbraucher (Kapitel II, Abschnitt 3.1). Weiter wurden genannt, ein einziger Ansprechpartner für verschiedene Gewerke bei Erneuerungen, Kostentransparenz oder messbare Energieverbräuche und –Einsparungen (Kapitel IV, Abschnitt 4.1.1).

Massgeschneiderte Dienstleistungen

Wie in anderen Märkten besteht die Herausforderung für Energiedienstleister, genaue Kenntnis über die Wünsche ihrer Kunden zu gewinnen, um ihnen massgeschneiderte Lösungen anbieten zu können. Wir haben in den Umfragen wesentliche empirische Evidenz zur Heterogenität der Präferenzen und Entscheidungsmechanismen in Bezug auf Investitionen in Energieeffizienz gefunden, unabhängig von der jeweiligen Kundengruppe. (Kapitel III, Abschnitt 5.6). Der Erfolg von Unternehmen auf dem EPC-Markt wird daher im Wesentlichen davon abhängen, wie diese die unterschiedlichen Kundenbedürfnisse am besten durch ihre Leistungen abdecken können. Aus den Umfragen ging dabei klar hervor, dass ein wichtiges Kriterium die Zusammenarbeit zwischen EPC-Anbietern und den vor Ort arbeitenden Betriebsleitern ist (Kapitel II, Abschnitt 3.4).

Kundensegmente

Könnten ESCOs auswählen, hätten die EPC-Kunden folgende Eigenschaften:

- Einen zentralen, hohen Energieverbrauch
- Einen ausgewiesenen Bedarf, die Betriebseinrichtungen energetisch zu erneuern

- Eingeschränkte finanzielle Ressourcen für Investitionen ausserhalb des Kerngeschäftes
- Keine Abneigung gegen langfristige Partnerschaften und Verträge
- Gesicherte Nutzung und Eigentümerschaft der Betriebsgebäude für die kommenden Jahre (langfristige Planung)
- Gebäude mit mangelhaftem Monitoring der Energieflüsse

Nach Auswertung der Umfrageergebnisse unter den 208 Dienstleistungsanbietern konnte festgestellt werden, dass in der Schweiz unterschiedliche Zielgruppen für EPC-Projekte anvisiert werden als im Ausland:

1. In der Schweiz werden primär Industriekunden angesprochen. In anderen EPC-Märkten wurden jedoch hauptsächlich Projekte in öffentlichen Gebäuden wie Schulen, Krankenhäusern oder Amtsgebäuden realisiert (Kapitel I, Abschnitt 4.3).
2. Eine Projekt-Hypothese ist, dass auf Grund von zu erwartenden höheren Transaktionskosten bei EPC-Projekten nur Projekte ab einer bestimmten Investitionsgrösse wirtschaftlich realisierbar sind (Kapitel II, Abschnitt 4.2 und Kapitel I, Abschnitt 4.3). Die Ergebnisse der Umfrage zeigen, dass mögliche EPC-Anbieter nicht grundsätzlich die grössten Energieverbraucher als Kunden ansprechen und manche sogar Kundensegmente mit geringerem Energieverbrauch anvisieren (Kapitel IV, Abschnitt 4.6.2).
3. In ausländischen Märkten sind EPC-Projekte welche eine komplette Erneuerung und Sanierung der Gebäudehülle (Wärmedämmung) mit einschliessen selten (Kapitel I, Abschnitt 4.4 und 5.1.1). Eine Mehrheit der untersuchten Firmen in der Schweiz wies aber keine Präferenz bezüglich der umsetzbaren Massnahmen aus und sah Sanierungen der Gebäudehülle als Teil der möglichen EPC-Anwendungsbereiche. Darauf wird auch von swissesco (2016) hingewiesen, dass EPC die Sanierung der Gebäudehülle miteinschliessen kann. In diesen Fällen wären aber weiter greifende Finanzierungs- und Risikomanagement-Systeme notwendig.

Die folgenden Erklärungen weisen auf die möglichen Ursachen der Unterschiede zwischen dem Schweizerischen und den ausländischen EPC-Märkten hin:

1. Der EPC-Markt in der Schweiz befindet sich im Aufbau, und die Zielgruppen und Nutzenversprechen können sich bei den Anbietern mit dem weiteren Erfahrungsaufbau noch stark verändern.
2. Im derzeitigen Schweizer Wirtschaftsumfeld mit tiefen Zinsen und hoher Liquidität, sind Investoren wahrscheinlich weniger eingeschränkt, ausreichend finanzielle Mittel für Investitionsprojekte bereit zu stellen und daher weniger auf externe Finanzierungen angewiesen als in anderen Ländern.

Erwartete Erträge

Aus den Umfrageergebnissen konnte keine eindeutige Präferenz für ein bestimmtes Ertrags-Schema festgestellt werden. Werder das Schema «geteilte Einsparung» noch das Schema der «garantierten Einsparungen» fand dabei eine klare Mehrheit. Dies lässt da-

rauf schliessen, dass die Wahl des Ertragsschemas während der jetzigen Marktentwicklung mehr durch die Präferenz des Kunden bestimmt wird, als durch die Firmen selbst (Kapitel IV, Abschnitt 4.3).

Empirischer Nachweis zum Einfluss von EPC auf die Investitionsentscheidungen in Energieeffizienz

Der empirische Nachweis wird auf die Daten von 297 potentiellen EPC-Kunden gestützt, welche an einer Web-basierten Umfrage teilgenommen haben. Es wurden Energieverantwortliche befragt, welche Gebäude aus den Bereichen Schulen, Verwaltungsgebäude, Bürogebäude, Hotels, Krankenhäuser und Einkaufszentren betreuen. 82% der Antwortenden sind für Gebäude der öffentlichen Hand zuständig. 85% der berücksichtigten Gebäude wurden vor 1990 errichtet und 57% dieser Gebäude haben eine beheizte Fläche grösser als 2000m^2. Basierend auf diesen Kennwerten, gehen wir davon aus, dass diese Gebäude per se für EPC-Projekte in Frage kommen (Kapitel III, Abschnitt 4.2).

In der Umfrage wurden die Teilnehmer gebeten, sich die Situation vorzustellen, dass das von ihnen betreute Gebäude in Kürze saniert werden muss. Die Teilnehmer wurden daraufhin gebeten anzugeben, welche Präferenzen sie bezüglich der Wahl von Energieeffizienzmassnahmen (mit oder ohne EPC) haben, oder ob sie nur eine sog. Pinselsanierung (wie. z.B. Revision der Heizungsanlage, Streichen der Fassade oder Fenster) ins Auge fassen würden. Die angebotenen Alternativen wurden variiert bezüglich Investitionskosten, erwarteten Energieeinsparungen und damit verbundene Preisrisiken sowie über verschiedene vertragliche EPC-Klauseln (z.B. Garantie auf Einsparungen, verschiedene Finanzierungen, Vertragslänge oder Zahlungs-Schemen). Dieses Vorgehen erlaubt, quantitativ zu untersuchen, welchen Einfluss die einzelnen Präferenz-Attribute auf die Bereitschaft haben, in Energieeffizienz zu investieren. Folgende Hauptergebnisse können zusammengefasst werden (für weitere Resultate Kapitel III, Abschnitt 5.6):

1. Die Finanzierung von EPC-Projekten durch Energiedienstleister hat nur für wenige Umfrageteilnehmern einen positiven Einfluss auf ihre Entscheidungen EPC zu berücksichtigen. Die so Antwortenden bezogen sich hauptsächlich auf öffentliche Gebäude (insb. Schulen). Aus diesen Ergebnissen lässt sich schliessen, dass für einen Grossteil der möglichen EPC-Nutzer die finanziellen Ressourcen keinen limitierenden Faktor bezüglich Investitionen in Energieeffizienz darstellen.

2. Für öffentliche Verwaltungen mit limitierten finanziellen Ressourcen wird der Vorteil einer Projektfinanzierung durch eine ESCO aber nur eine Option sein, wenn es möglich ist, die entsprechenden Kosten als Betriebsausgaben auszuweisen und nicht als Investition in der Bilanz aktivieren zu müssen. Diese Möglichkeit muss aber je nach Kanton im Einzelfall noch geklärt werden. Dieses Resultat kann die mögliche politische Entwicklung beeinflussen:

   a) Politisch- regulatorischer Support für EPC scheint berechtigt, insbesondere wenn dieser kostengünstiger ist als andere Massnahmen zur Steigerung von Investitionen in Energieeffizienz.

b) Die Ergebnisse weisen auf mögliche Massnahmen für Kunden mit geringerem Energieverbrauch hin, welche nicht in erster Linie im Fokus von EPC-Anbietern stehen. Da Projektrisiken und unvollständige Informationen bezüglich Energieeffizienz-Potenzialen wichtige Hürden sind, können andere Instrumente helfen, das Effizienzpotenzial besser zu nutzen. Dies könnten beispielsweise nachgängige Dienstleistungen sein, welche sicherstellen, dass erwartete Energieeinsparungen auch im alltäglichen Gebrauch durch einen Nutzer erzielt werden können.

3. Garantien durch die ESCO haben einen nachhaltigen und signifikant positiven Einfluss auf die Investitionsbereitschaft der möglichen Kunden. Der Vorteil der Risikominderung bzw. –Teilung ist ein wichtiger Treiber, welcher in allen betrachteten Marktsegmenten beobachtet werden konnte.
4. Innerhalb dieser Studie konnte kein Hinweis darauf gefunden werden, dass Investitionshürden auf Grund der Kosten-Nutzenteilung zwischen Vermieter und Mieter in den betrachteten Marktsegmenten bestehen. Diese Aussage gilt aber nicht für andere Kunden- bzw. Eigentümergruppen (wie z.B. private Gebäudeeigentümer).
5. Die Eigenschaften welche die Bereitschaft in Energieeffizienz zu investieren am meisten beeinflussen, sind in der folgenden Tabelle aufgeführt. Je nach beruflichem Hintergrund der Umfrageteilnehmer, stieg oder sank die Bereitschaft, in Energieeffizienz (mit oder ohne EPC) zu investieren.
6. Andere Eigenschaften hatten keinen signifikanten Einfluss auf die Investitionsbereitschaft. Darunter gehören Eigenschaften wie die Gebäudegrösse, ob das Gebäude gemietet oder im Eigentum ist, die Ausbildung, Alter oder Sprache der Umfrageteilnehmer bzw. deren Rolle im Entscheidungsprozess.
7. Abschliessend kann festgehalten werden, dass EPC Hürden in Bezug auf Energieeffizienzinvestitionen reduzieren kann. Gleichzeitig wird EPC aber auch Zurückhaltung von möglichen Kunden entgegengebracht, welche zumindest Teilweise auf mangelnde EPC-Kenntnisse zurückzuführen ist. Die Gründe für diese Zurückhaltung werden im folgenden Abschnitt und in Kapitel III, Abschnitt 5.4 weiter ausgeführt. Auf Grund der Ergebnisse argumentieren wir, dass ein grosser Teil dieser Zurückhaltung durch verbesserte Informationen und EPC-Kenntnisse bei Kunden und Anbietern abgebaut werden kann.

Tabelle 3: Einfluss von ausgewählten Charakteristika der Antwortenden auf die Bereitschaft, EPC-Projekte umzusetzen.

	Bereitschaft, Energieeffizienz zu steigern	**Bereitschaft EPC anzuwenden**
Der Antwortende kennt die Grundlagen von EPC	+	+
Der Antwortende ist verantwortlich für Energie im Gebäude	+	

Der Antwortende ist Energiefachmann	+	+
Der Antwortende ist der Gebäudeeigentümer	-	-
Der Antwortende ist Behördenmitglied (Exekutive)		-
Erfahrung des Antwortenden in seiner Position		-

Hinweis: Positiv signifikante Effekte sind mit "+" gekennzeichnet, negative Effekte mit "-". Keine Kennzeichnung bei nicht signifikanten Einflüssen.

Hemmnisse auf der Nachfrageseite: Mögliche Lösungen

In der Schweiz aktive EPC-Anbieter haben offen festgehalten, dass die Unkenntnis von Kunden bezüglich EPC ein wesentliches Markthemmniss darstellt (Kapitel II, Abschnitt 6.1.1. und Kapitel IV, Abschnitt 4.2.1). Basierend auf dieser Unkenntnis wird dem EPC-Geschäftsmodell entsprechende Zurückhaltung von den Kunden entgegengebracht. Dies zeigt sich darin, dass mehr als 50% der möglichen Kunden (oder 149 von 297 Antwortenden) nie eine Sanierungsvariante mit EPC ausgewählt haben[5]. Die Antwortenden wurden gebeten, ihre Entscheidung EPC nicht zu berücksichtigen, zu begründen (siehe die folgende Abbildung und Kapitel 3, Abschnitt 5.4).

[5] Zum Vergleich, 26 Antwortende haben nie eine Variante mit Energieeffizienz-Investitionen ausgewählt (mit oder ohne EPC), mit den folgenden Hauptbegründungen: das Gebäude ist bereits auf einem hohen Effizienzstandard; Effizienz-Investitionen sind nicht wirtschaftlich; das Gebäude steht unter Denkmalschutz, daher sind keine Effizienzmassnahmen möglich.

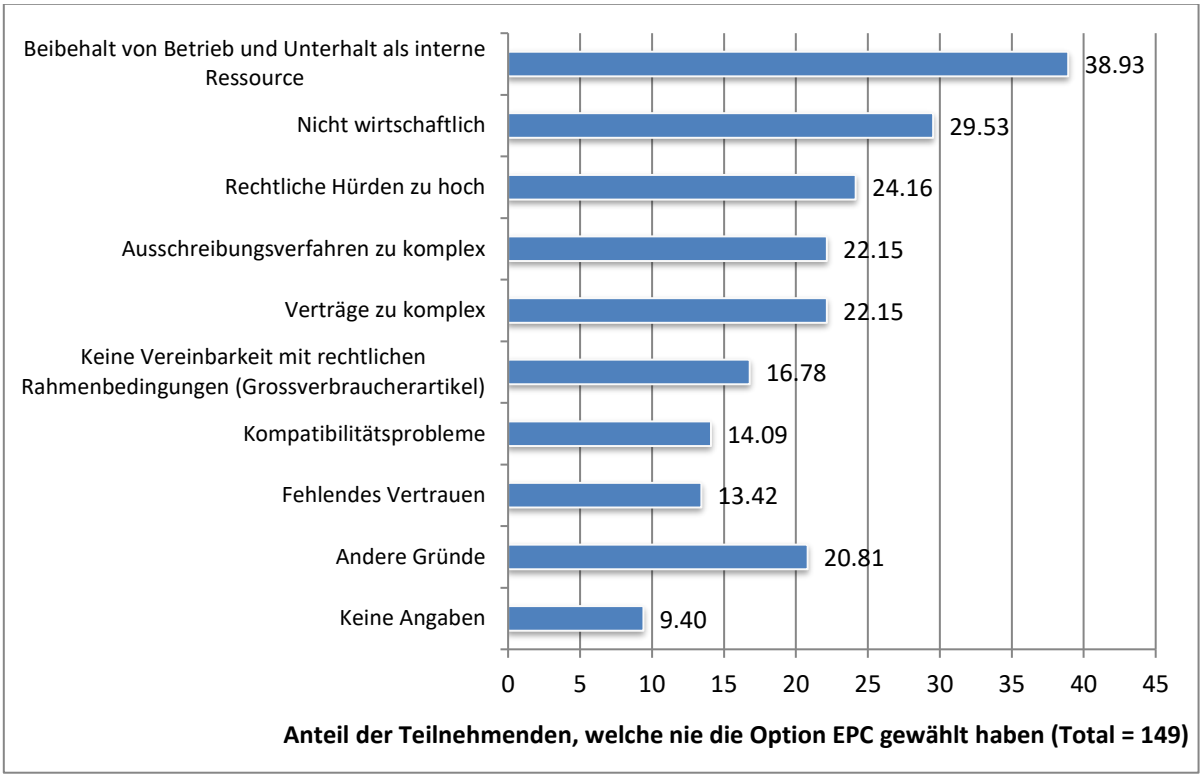


Abbildung 2 Von potenziellen Kunden genannte Hemmnisse, EPC nicht zu berücksichtigen.

1. Der Hauptgrund für die Nicht-Berücksichtigung von EPC liegt darin, dass Betreiber nicht bereit sind, die Kontrolle und den Betrieb und Unterhalt von Energieanlagen an Energiedienstleister auszulagern. Einige der Antworten lassen jedoch darauf schliessen, dass hier zumindest teilweise ein Missverständnis vorliegt, welche Arbeiten durch den Energiedienstleister durchgeführt werden und welche Arbeiten weiterhin intern (z.B. durch eigenes Betriebspersonal oder den Gebäudeunterhalt) sichergestellt werden. Durch eine verbesserte Darstellung der effektiven Arbeitsteilung und den Schulungsangeboten für Betriebsmitarbeiter durch die ESCOs, könnte ein Teil dieser Markt-Hemmnisse abgebaut werden.

2. Die Wirtschaftlichkeit von EPC-Projekten wird von einigen Teilnehmern in Frage gestellt. Diese unterscheiden sich jedoch nicht von anderen Teilnehmern (z.B. in Unternehmensgrösse oder Einsparpotenzial), welche EPC als mögliche Option bei Sanierungsmassnahmen sehen. Entsprechende Informationen zur Wirtschaftlichkeit sind daher von hoher Wichtigkeit für den weiteren Aufbau des Marktpotenzials.

3. Rechtliche Themen und die Projekt-Komplexität im Ausschreibungsverfahren beschreiben weitere Teilnehmer als wesentliche Hürde für EPC. Auf Grund der räumlichen Kleinteiligkeit der Märkte und entsprechenden unterschiedlichen Regulierungen (Ausschreibungs-Verfahren), hat dies direkten Einfluss auf die Höhe der Transaktionskosten. Vermittlern wird in diesem Zusammenhang eine wesentliche Rolle zugesprochen, die entsprechenden Grundlagen gezielt für die Kunden aufzubereiten und Hemmnisse abzubauen.

4. 14 Antwortende (9.4%) gaben keine Gründe an, EPC unter keinen Umständen als Option anzunehmen. Interessanterweise kannten 13 dieser Antwortenden EPC vor der Umfrage nicht. Obwohl die Antworten keine Aussagen bezüglich der Kausalität zulassen, scheint die Korrelation zwischen nicht-begründetem Unwillen zur EPC-Adaption und der Unkenntnis dieses Geschäftsmodells darauf hinzudeuten, dass eine entsprechende Informationsbereitstellung zu Best-Practice-Beispielen notwendig ist, um die Bereitschaft zur Annahmen von EPC-Konzepten zu erhöhen.
5. Der Mangel an Information bzw. die falsche Wahrnehmung von EPC wurde auch bei weiteren Antworten ersichtlich. Einige Antwortende gaben zum Beispiel an, dass EPC nicht möglich ist, da das Gebäude in öffentlicher Hand ist oder das Unternehmen nicht über die finanziellen Ressourcen verfügt. Typischerweise sind es jedoch gerade diese Zielgruppen, für welche EPC eine valable Option für Energieeffizienz-Investitionen darstellt.
6. Andere genannte Gründe betreffen die lange Vertragsdauer oder die Bereitschaft selbst in Energieeffizienz zu investieren. Ein Teilnehmer war vorsichtig bezüglich der Verkaufsmöglichkeit eines Gebäudes mit einem EPC-Vertrag.

Wie bereits eingeführt, konnten empirische Grundlagen gefunden werden, dass EPC die Hürden bezüglich Energieeffizienz-Investitionen reduzieren kann. Es sind derzeit aber noch viele Fragen bei möglichen Kunden offen, betreffend des EPC-Konzepts und dessen Umsetzung. Den involvierten Akteuren steht daher noch viel Arbeit bevor, die bestehenden Transaktionskosten effektiv zu senken und über Informationen und Best-Practice-Beispiele die relevanten Grundlagen des Energiespar-Contractings anschaulich aufzubereiten.

In Kapitel II, gehen wir detaillierter auf die genannten Themen betreffend der Nachfrageseite ein und zeigen mögliche Lösungen auf:

a) Ausschreibungsverfahren bei EPC (Kapitel II, Abschnitt 6.1.2)
b) Möglichkeiten für private Firmen in öffentliche Gebäude zu investieren (Kapitel II, Abschnitt 6.3.1.)
c) Kostenteilung Vermieter/Mieter (Kapitel II, Abschnitt 6.3.3.)
d) Bilanzierungsregeln für EPC (Kapitel II, Abschnitt 6.3.2)
e) Rechtliche Auseinandersetzungen bezüglich "Messen und Verifizieren" der effektiv erzielten Energieeinsparungen (Kapitel II, Abschnitt 6.1.3)

Wie die Qualität von wettbewerbsfähigen EPC-Angebote gestärkt werden können? Empirischer Grundlagen zu Hürden und Treibern auf der Anbieter-Seite

Angebotstreiber

Basierend auf den Antworten aus den Experten-Interviews können folgende Gründe für das bestehende EPC-Angebot zusammengefasst werden (Kapitel II, Abschnitt 4.1.1), welche als Grundlagen für die Erstellung der Umfrage unter möglichen EPC-Anbietern herangezogen wurden:

- Steigerung des Marktvolumens für Ausrüstungs- und Unterhaltsportfolio
- Langfristige Kundenbindung
- Stabilisierung und planbare Erträge auf jährlicher Basis
- Abdeckung von Kundenwünschen
- Beibehalten der Kontrolle über Geschäftsprozesse, Ressourcen und Erfindungen
- Erarbeiten eines Wettbewerbsvorteils

Zusätzlich haben wir die regulatorischen Randbedingungen in der Schweiz untersucht, welche die Geschäftsentscheidung bezüglich des EPC-Angebots beeinflussen können. Einige der genannten möglichen Einflüsse werden im Folgenden kurz beschrieben:

1. Keine der interviewten Dienstleister hat die Strommarktliberalisierung als Auslöser für die Lancierung von EPC-Projekten genannt. Nur ein Gesprächspartner hat auf eine geringe Rolle bei der Entscheidungsfindung hingewiesen, EPC als Möglichkeit zu nutzen, Kunden langfristig an das Unternehmen zu binden. Andere Gründe wie die Bereitstellung von Nachhaltigkeitsdienstleistungen waren wichtigere Argumente im Entscheidungsprozess (Kapitel II, Abschnitt 7.4). Aber auch der empirische Nachweis in Kapitel IV, Abschnitt 4.5 zeigt, dass die Strommarktliberalisierung keinen signifikanten Einfluss auf Unternehmen hat, in den EPC-Markt einzusteigen.
2. Die "Lex Weber", welche den Zweitwohnungsbau in gewissen Regionen oder Gemeinden einschränkt bzw. verbietet wurde als möglicher EPC-Treiber genannt. In betroffenen Kantonen könnten sich Baufirmen auf Grund der wegfallenden Neubauten neu orientieren und vermehrt energetische Sanierungen anbieten. EPC könnte hier eine Rolle spielen und Anbieter sich aktiv für dieses Marktsegment entscheiden.

In Kapitel IV, Abschnitt 4.5, ist beschrieben, wie Firmen auf unterschiedliche hypothetische gesetzliche Rahmenbedingungen reagieren würden und welche Dienstleistungen sie unter den gegebenen Rahmenbedingungen anbieten würden. Die ökonometrischen Analysen, basierend auf den entsprechenden Antworten, zeigen folgende Ergebnisse:

- Die Bereitschaft der Dienstleister in den EPC-Markt einzusteigen hängt wesentlich von einer erwarteten Nachfragesteigerung durch private und öffentliche Investoren ab, da für viele Unternehmen der Markteintritt mit eigenen Investitionen in Personal, Knowhow, Risikoevaluation und Vertragsmanagement verbunden ist. Entsprechend müssen diese Investitionen durch mögliche Erträge gedeckt werden können. Die Ergebnisse zeigen, dass insbesondere das Risiko von Fehlinvestitionen beim Aufbau von Personal und technischem Knowhow einen höheren Einfluss auf die Entscheidungen hat, als zum Beispiel das Vorhandensein von finanziellen Ressourcen.
- Eine hypothetische Angebotssteigerung von EPC durch Stromversorger (auf Grund von gesetzlichen Vorgaben, die Energieeffizienz von Kunden zu erhöhen), steigert die Wahrscheinlichkeit, dass weitere Anbieter in den EPC-Markt einsteigen. Wahrscheinlich hervorgerufen durch Imitationsverhalten oder einen grösseren Wettbewerb zwischen den Unternehmen, welche in ähnlichen Kundensegmenten aktiv sind.

- Wenn Unternehmen in ähnlichen Bereichen bereits aktiv sind, ist die Bereitschaft höher, das Angebot auf EPC-Märkte zu erweitern. Entsprechend sind Gasversorger, Anbieter von Heizsystemen oder Anbieter von Steuerungen und Optimierungstools eher bereit, EPC zu offerieren.
- Die Unternehmensgrösse (bzgl. Anzahl Angestellter) oder die regionale Ausrichtung hat keinen signifikanten Einfluss auf die Bereitschaft, in den EPC-Markt einzusteigen.
- Die Eigentümerbasis (privates oder öffentliches Unternehmen) hat ebenfalls keinen signifikanten Einfluss auf die Bereitschaft in den EPC-Markt einzusteigen. Wenn jedoch der Eigentümer als öffentlicher Träger bereits Druck auf das Unternehmen ausübt, die Energieeffizienz bei Kunden zu erhöhen, dann steigt die Bereitschaft, EPC als Markterweiterung zu berücksichtigen. Dieses Resultat zeigt auf, das die öffentlichen Unternehmen und deren Eigentümer (z.B. Gasversorger), bei entsprechender Themen-Sensitivität, EPC als Marktlösung stärken können.

Hürden für Anbieter

Aktive EPC-Anbieter und Unternehmen, welche noch nicht aktiv im Markt sind, unterscheiden sich in der Wahrnehmung bezüglich der Hürden, welche aus ihrer Sicht die Marktbedingungen für EPC erschweren. Für die Letztgenannten, sind folgenden Themen ausschlaggebend:

- 62% der im EPC-Markt noch nicht aktiven Firmen (199 Umfrageteilnehmern) kannten das EPC-Konzept vor der Umfrage noch nicht (Kapitel IV, Abschnitt 4.1). Die Resultate zeigen eine positive Abhängigkeit zwischen dem Bekanntheitsgrad von EPC und der Bereitschaft der Unternehmen, diese Vertragsart anzubieten (Kapitel IV, Abschnitt 4.5).
- 140 (oder 67%) der 208 Teilnehmenden gaben an, kein Interesse an einem zukünftigen Einstieg in den EPC-Markt zu haben. Eine Mehrzahl dieser Teilnehmer (58%) begründete dies, mit nicht vorhandenen Kompetenzen bzw. Personalressourcen (Kapitel IV, Abschnitt 4.2.2.).
- Das EPC-Marktvolumen und -Potenzial ist unbekannt (Kapitel II, Abschnitte 4.1.2 und 6.2.2. sowie Kapitel IV, Abschnitt 4.2.2.). Einige der Umfrageteilnehmer gaben an, dass der Maschinenpark in der Schweiz auf Grund der bestehenden Gesetzgebungen, bereits in sehr gutem Zustand ist und entsprechend keine ausreichende Anzahl möglicher EPC-Projekte vorhanden ist.
- Als weitere Hürden wurden von wenigen Teilnehmern mehr firmeninterne Eigenschaften genannt (wie z.B. kein Kerngeschäft, Strukturelle Schwierigkeiten der Integration oder geringes Interesse seitens der Geschäftsleitung), welche den Einstieg in den EPC-Markt behindern.

Abschliessend kann auf folgende Themen hingewiesen werden, welche durch die Teilnehmer ebenfalls genannt wurden:

- Die (derzeitigen) tiefen Energiepreise können die Profitabilität von EPC-Projekten reduzieren (Kapitel IV, Abschnitte 4.2.1 and 4.2.2.)

- Die Projektrisiken für Energiedienstleister können von diesen als hoch empfunden werden (Kapitel IV, Abschnitt 4.2.2.)
- 8 der 9 aktiven ESCOs gaben an, dass manchmal Schwierigkeiten bestehen, Projekte zu finanzieren. Diese Aussage steht teilweise im Widerspruch zu anderen Resultaten, welche grundsätzlich davon ausgehen, dass die Finanzierung von EPC-Projekten möglich ist. Im Einzelfall können aber Schwierigkeiten auftreten, welche aber durch entsprechende Vorbereitungen gemindert werden können. (Kapitel IV, Abschnitt 4.2.2).

In Kapitel II werden die weiteren Risiken analysiert, welche durch den EPC-Anbieter getragen werden müssen. Die folgende Tabelle gibt eine Übersicht der genannten Risiken.

Tabelle 4: Risiken für EPC-Anbieter

Risiken für den EPC-Anbieter	
Finanzielle Performance-Risiken (Kap. II, 6.2.1.)	
Hintergrund	Vor Umsetzung eines Projektes unbekanntes Einsparpotenzial
Mögliche Folgen	-EPC-Anbieter benötigen technisches Knowhow und eine professionelle Risikoevaluation -Externe Investoren können zurückhaltend sein, bzw. nur in sehr grosse Projekte investieren (bei besser bekannten Risiken). (Kap. II, 4.7)
Lösungen	-EPC Forfaitierungs-Angebote -angepasste Kontrolle des Nutzerverhaltens und der technischen Einstellungen -Ausarbeitung von umfassenden Finanzierungs-Tools, um technische und wirtschaftliche Projektrisiken adäquat abzubilden. -Risiko-Diversifizierung (z.B. Zusammenfassung von Projekten, Poolen von Effizienzmassnahmen)
Risiken bzgl. Realisierungskosten (Kap. II, 6.2.1- 2)	
Hintergrund	Mehrheitlich werden EPC-Anbieter über fixe Beträge bzw. Anteile der Einsparungen entschädigt (% CHF)
Mögliche Folgen	Unerwartete Kosten (bei der Projektumsetzung und im Betrieb) müssen vom EPC-Anbieter getragen werden
Lösungen	-Risiko-Diversifizierung (z.B. breites Projektportfolio, professionelles Projektmanagement, etc.) -Klare Vertragsstruktur und -klauseln welche die Verantwortlichkeiten der Projektpartner definieren. Das Risiko muss durch denjenigen getragen werden, welcher es am besten minimieren kann. -Der EPC-Anbieter trägt die zusätzlichen Kosten aus Fehlberechnungen und technischen Umsetzungsfehlern. -Der Kunde trägt die Kosten aus stark geändertem Nutzerverhalten, bzw. falscher Nutzungen
Risiken wegen Zahlungsausfall auf Kundenseite (Kap. II, Abschnitt 6.2.3 – 3)	
Hintergrund	EPC-Projekte beinhalten oft Dienstleistungen, Massnahmen und Installationen bei denen das Eigentum nicht auf den Investor übertragen werden kann.
Mögliche Folgen	Ein (grosser) Anteil der Investitionen kann nicht oder nur teilweise durch Sicherheiten abgedeckt werden.
Lösungen	-Risiko-Diversifizierung (z.B. unterschiedliche Kundengruppen)

-Vertragsklauseln welche Abschlagszahlungen auslösen bei Wegzug eines EPC-Kunden
-Garantie-Fonds von EPC-Anbietern, um Zahlungsausfälle durch Illiquidität von Kunden auszugleichen
-Staatsgarantien gegen Kreditausfälle (wie z.B. Kanton Freiburg)
-Grundbucheinträge (Kap. II, Abschnitt 6.2.1. a)

Schlussfolgerungen und politische Auswirkungen

Der EPC-Markt in der Schweiz ist ein Nischenmarkt, welcher sich derzeit weiterentwickelt und welchem ein signifikantes Wachstum in den kommenden Jahren vorhergesagt wird. Der derzeitige Rückstand gegenüber anderen Märkten (wie z.B. in Deutschland oder Österreich) kann anhand der existierenden Rahmenbedingungen erklärt werden.

In der Schweiz werden die Transaktionskosten für EPC stark durch die unterschiedlichen lokalen und kantonalen gesetzlichen Grundlagen beeinflusst, welche insbesondere bei Ausschreibungsverfahren sehr unterschiedliche Rahmenbedingungen aufweisen. In diesem Zusammenhang können unabhängige beratende Dienstleister eine wichtige Rolle spielen, um den EPC-Markt weiter zu entwickeln. Unterstützt werden deren Bestrebungen durch allgemeingültige Musterverträge und Richtlinien, welche schweizweit Gültigkeit haben. Aber auch politische Massnahmen sind notwendig und hier insbesondere der Abbau von regulatorischen Hürden, um die Rahmenbedingungen für EPC in der Schweiz zu verbessern[6].

Im Vergleich zu anderen Ländern scheint der Bedarf für externe Finanzierungen von EPC-Projekten in der Schweiz beschränkt zu sein. Diese Einschätzung wird durch die empirischen Daten gestärkt, welche aufzeigen, dass nur wenige EPC-Anwender eine Projektfinanzierung durch den Dienstleister positiv bewerten. Zusätzlich zeigen die Resultate, dass die Performance-Garantie welche durch den Dienstleister angeboten wird[7], einen attraktiven Ansatz bietet, die Anwendung von kosteneffektiven Effizienzmassnahmen zu erhöhen. Die Wichtigkeit der garantierten Energieeinsparungen ist für die weiteren politischen und regulatorischen Schritte von grosser Bedeutung. Anzumerken ist, dass sich nicht alle Energiesparprojekte für EPC eignen, da insbesondere bei geringen Einsparungen die Transaktionskosten zu hoch sind. In diesen Fällen sind andere Massnahmen häufig sinnvoller (z.B. verbesserte Standards für Neugeräte), um das entsprechende Einsparpotenzial zu erzielen.

Die verspätete Marktentwicklung von EPC in der Schweiz hängt eng mit einem Informationsmangel zu EPC zusammen, welcher sowohl auf der Anbieter- als auch auf der Nutzerseite festgestellt werden konnte. Wir zeigen auf, dass der Informationsmangel auch zu einer Falschwahrnehmung führt, welche Einsparungen mittels EPC erzielt bzw. wel-

[6] Zum Beispiel ist zu klären, wie EPC buchhalterisch gehandhabt werden soll, einheitlich auf kantonaler und lokaler Ebene.

[7] Z.B. durch ein Schema der "geteilten Einsparungen", oder durch garantierte Einsparungen bei welchen der EPC-Anbieter den Anreiz bzw. die Verpflichtung hat, die versprochene Leistung zu erfüllen.

che weiteren Vorteile genutzt werden können. Auf der einen Seite ist es zielführend, wenn potenzielle Kunden durch EPC-Anbieter informiert werden, aber auch unabhängige Informationen seitens der Behörden oder der Vereinigung swissesco kommt eine wichtige Rolle zu, über die Vorteile von EPC zu informieren. Im Zusammenhang mit der Schweizerischen Energiestrategie und der Ausgestaltung der entsprechenden Gesetzgebungen, können Hindernisse zur Umsetzung von EPC-Projekten reduziert werden. Es liegt aber insbesondere in der Hand der Energiedienstleister, attraktive Marktangebote zu gestalten, um das Potenzial von EPC umsetzen zu können.

Abstract général

Le contrat de performance énergétique (CPE, en anglais EPC) consiste à externaliser la conception, la réalisation, la maintenance et parfois le financement de projets d'amélioration énergétique à une compagnie de service énergétique (Energy Service Company (ESCO)). Dans ces contrats de longue durée, le contracteur offre à son client une réduction des coûts énergétiques en échange d'un prix fixe ou d'une partie des économies réalisées. Le CPE est considéré comme un instrument de marché intéressant pour stimuler l'investissement dans l'efficience énergétique. Le marché émerge pourtant seulement maintenant en Suisse et est en retard sur d'autres pays tels que l'Allemagne ou les Etats Unis.

Basée sur la littérature des contrats de services énergétiques, et sur des entretiens et deux enquêtes destinées aux potentiels demandeurs et offreurs de CPE en Suisse, cette étude explore le développement et les potentiels du marché suisse des CPE. Ce sont premièrement les impacts sur l'investissement dans l'efficience énergétique et les coûts de transactions qui sont étudiés. Les résultats permettent également d'identifier les mesures politiques adéquates pour développer le marché du CPE et les interactions possibles avec d'autres instruments dédiés à promouvoir l'efficience énergétique.

En Suisse, les coûts de transaction des CPE sont exacerbés par les divergences de législations inter et intra-cantonales. Dans ce contexte, les approches ascendantes telles que des conseils prodigués au cas par cas par des assistants maîtres d'ouvrages (ou par les ESCOs elles-mêmes), sont à privilégier par rapport aux approches descendantes (documents standards, guides généraux). Les potentiels du CPE en termes de financement externe sont peu valorisés en Suisse. En effet, cette étude montre que le financement par l'ESCO n'est valorisé positivement que par une minorité des clients potentiels. Cette minorité inclut des collectivités publiques, sans doute contraintes par des plafonds d'endettement. D'un autre côté, les résultats de l'étude suggèrent que la garantie de performance offerte par les CPE représente une approche attractive pour déclencher des projets rentables d'efficience énergétique. L'importance de la garantie d'économie d'énergie fournit une information cruciale pour les décideurs politiques. Si le CPE ne peut pas atteindre tous les segments de marchés, tels que les petits consommateurs à cause des coûts de transaction, alors d'autres instruments doivent être utilisés et être destinés à fournir les économies d'énergie espérées.

Le retard du marché du CPE en Suisse se conjugue à un manque de connaissance du côté de la demande mais également des potentiels offreurs. Nous montrons que ce manque d'information implique des idées reçues. Alors qu'une partie de l'information peut être véhiculée par les offreurs eux-mêmes, les autorités bénéficient d'une neutralité nécessaire pour convaincre les potentiels clients publics ou privés, les autorités d'autres juridictions ou les potentiels offreurs. La décision finale concernant la stratégie énergétique va aussi sans doute réduire d'importantes incertitudes concernant les potentiels du CPE. Quoi qu'il en soit, les ESCOs qui réussiront sont celles qui réagiront et adapteront leur modèle d'affaire pour mieux répondre aux spécificités du marché suisse.

Résumé détaillé

Motivation: les contrats de service énergétiques et le contexte suisse

Les contrats de service énergétique consistent à externaliser des services en lien avec l'énergie et le pouvoir de décision sur les équipements énergétiques à un contracteur appelé ESCO (Energy Service Company), au travers d'un contrat de longue durée. La littérature mentionne deux types principaux de contrats de services énergétiques (Sorrell (2007)):

1. Le contracting énergétique (Energy Supply Contracting (ESC)) implique en général un ou plusieurs flux d'énergie utile (p.ex. chauffage, eau chaude, électricité), mais exerce peu ou pas de contrôle sur la demande d'énergie finale. Parce que l'ESCO a l'incitation et les moyens de maintenir la performance de l'équipement dans la durée, le contracting a le potentiel de promouvoir l'énergie renouvelable et les technologies innovantes.
2. Dans le contrat de performance énergétique (CPE), l'ESCO a le contrôle sur la demande finale de services énergétiques. Les actions mises en place incluent souvent des luminaires efficients et détecteurs de présence, des systèmes de contrôle et d'automation du chauffage, du froid et de la lumière. Parce que ces contrats stipulent que le contracteur est rémunéré en fonction des économies d'énergie réalisées, ils sont considérés comme des instruments intéressants pour induire l'investissement dans des actions de performance énergétique. Deux modèles de CPE dominent sur les marchés (Hansen (2006)) :

    c) *CPE avec économies partagées:* L'ESCO finance le projet et se rémunère en captant une part des économies d'énergie réalisées pendant la période contractuelle.

    d) *CPE avec économies garanties:* Le client finance l'installation (ou cherche du financement auprès d'un tiers). L'ESCO garantit au client que les économies d'énergie atteindront un certain montant, sinon elle lui rembourse la différence. Dans ce type de contrat, l'ESCO est en général rémunérée par un paiement fixe pendant la période contractuelle.

Dans le contracting énergétique comme dans le CPE, le client bénéficie d'un mécanisme de partage des risques ainsi que de la connaissance de l'ESCO sur les aspects techniques et les moyens de financement. Les coûts sur toute la durée du projet (y.c. la maintenance et l'exploitation) sont minimisés, la performance de l'équipement est maintenue et le comportement de l'utilisateur est contrôlé pendant la durée du contrat. Ainsi, ces contrats sont considérés comme des instruments de marché prometteurs pour réduire les barrières aux investissements dans l'énergie renouvelable et l'efficience énergétique (Globerman and Vining (1996), Painuly (2001), Sorrell (2005), Sorrell (2007), Capelo (2011), IEA-RETD (2013)). Malgré ces avantages apparents, le marché du contracting énergétique montre une faible croissance en Suisse et le CPE émerge seulement. Même les marchés de CPE matures, tels que les Etats-Unis, font face à certaines

barrières empêchant le modèle d'exploiter tous ses potentiels (Marino et al. (2010), Bleyl (2011), Langlois and Hansen (2012)).

Dans un contexte suisse dans lequel les autorités ont décidé d'abandonner progressivement l'énergie nucléaire via une transition énergétique soutenable, tout en maintenant la sécurité de l'approvisionnement énergétique (cf. the Swiss New Energy Policy, Bundesamt für Energie (2012)), il est crucial d'attirer suffisamment d'investissements dans l'énergie renouvelable et l'efficience énergétique. Le succès de la stratégie énergétique fédérale dépendra de sa capacité à identifier et résoudre les barrières qui empêchent de tels investissements d'avoir lieu. Les instruments de marché, tels que les contrats de service énergétique sont d'autant plus importants que des réticences émergent vis-à-vis de l'intervention de l'Etat dans le marché de l'énergie, à l'image du récent référendum à l'encontre de la stratégie énergétique de la confédération. Il est donc important d'examiner les barrières et les potentiels de ces instruments de marché.

Le projet de recherche

Ce projet de recherche se concentre sur le marché des contrats de performance énergétique (CPE) en Suisse. Débutant par une étude critique de la littérature et des leçons apprises des marchés plus matures à l'étranger, cette étude explore les conditions-cadres pour le CPE et les potentiels du côté de la demande et de l'offre en Suisse. Les chapitres du présent rapport sont décrits comme suit :

I. Revue de la littérature

Ce chapitre décrit les types de contrats existants (contracting énergétique et CPE) et leur rôle potentiel dans les investissements d'énergie renouvelable et d'efficience énergétique, tel que décrit dans la littérature. Il relate également la situation sur les marchés à l'étranger et en Suisse et résume les résultats des études théoriques et empiriques en ce qui concerne les barrières et les éléments déclencheurs sur les marchés. La rationalité pour un soutien du gouvernement est explorée en analysant la littérature sur son implication et son rôle dans la croissance des marchés de service énergétiques.

II. Analyse des conditions-cadres du CPE en Suisse

Alors que la Suisse représente a priori un terrain fertile pour les CPE, ce chapitre est destiné à comprendre comment le marché émerge seulement maintenant et est en retard par rapport à celui d'autres pays, tels que l'Allemagne ou les Etats-Unis. Basée sur des entretiens avec des experts, une analyse des acteurs sur le marché suisse des CPE est présentée. Une attention particulière est portée sur le rôle du gouvernement aux niveaux cantonal et fédéral. Le modèle d'affaire développé par les premières entreprises présentes sur le marché suisse des CPE est également étudié. Les avantages et les barrières sur le marché, tels que perçu par ces entreprises sont analysés. Pour chaque barrière au marché, nous explorons le cadre légal et politique et proposons des solutions potentielles.

III. La demande pour le CPE et ses futurs potentiels

Le soutien du gouvernement pour réduire les barrières au marché du CPE est justifié seulement si le CPE est prouvé comme étant efficace pour faciliter les investissements dans l'efficience énergétique ou l'énergie renouvelable. Malgré la littérature abondante sur le CPE, il manque des preuves quantitatives qui assertent des mécanismes de décisions par lesquels le CPE peut induire l'investissement. Les compromis et l'hétérogénéité sous-jacents à ces mécanismes sont également méconnus. En nous appuyant sur une enquête en ligne et une expérience à choix discrets auprès de 297 clients potentiels de CPE en Suisse, nous explorons économétriquement par quels biais le CPE peut induire l'investissement dans des mesures d'efficience énergétique. Les répondants sont des gérants d'immeubles, des propriétaires, des conseillers municipaux en charge de bâtiments privés ou publics qui consomment beaucoup d'énergie. Cela inclut des écoles, des bâtiments de bureaux, des hôpitaux, des hôtels, des centres commerciaux, des centres sportifs et de grands bâtiments résidentiels. En identifiant les mécanismes à travers lesquels le CPE facilite l'investissement, cette étude informe aussi sur les barrières les plus contraignantes qui empêchent l'investissement dans l'efficience énergétique. Elle le fait tout en tenant compte de l'hétérogénéité des préférences et des processus de décision entre les répondants.

IV. Analyse de l'offre potentielle de CPE

Il a été démontré que le nombre de fournisseurs de CPE ainsi que leur expérience dans le domaine sont déterminants pour la bonne qualité des projets de CPE (Iimi (2016)). Ainsi, non seulement un nombre suffisant d'ESCO est nécessaire sur le marché suisse, mais les potentiels entrants devraient intégrer le marché le plus rapidement possible. Ce chapitre est basé sur une enquête en ligne ainsi qu'une expérience à choix discrets auprès de 208 offreurs potentiels de CPE en Suisse, y compris 9 ESCOs déjà actives. Le but de cette étude est de déterminer comment promouvoir l'offre sur le marché des CPE. Les répondants sont en majorité (72%) des entreprises publiques ou sous le contrôle d'une entité publique, principalement des fournisseurs d'électricité, de gaz, d'appareils électroniques, de conseils et ingénierie et de services d'efficience énergétique. Une analyse qualitative est menée sur le marché actuel du CPE en Suisse, sur ses barrières, ses moteurs et sur le type de modèle d'affaire du point de vue des ESCOs actives versus les potentiels entrants. Finalement, une analyse quantitative explore comment la volonté d'offrir des contrats de service énergétique dans le futur, peut dépendre de divers facteurs tels que les caractéristiques de l'entreprise, les changements éventuels sur le marché ainsi que les éléments législatifs spécifiques concernant l'énergie.

La section suivante résume les principaux résultats de l'étude. Les chapitres et sections correspondant à chaque élément décrit sont présentés entre parenthèses. Cela permet de guider le lecteur éventuellement intéressé à obtenir des informations plus détaillées sur les différentes parties du rapport.

Le marché actuel du CPE en Suisse

Le CPE est pour l'instant un marché de niche en Suisse, qui a commencé à se développer tout récemment. Le premier appel d'offre public pour un CPE a été publié au printemps 2016 avec quelques autres qui sont en cours de préparation. Au printemps 2017 à notre connaissance, 5 à 10 ESCOs avaient signé environ 25 contrats de performance énergétique. Une légère majorité de ces contrats ont été conclus avec des entités privées. Les clients sont des hôtels, des industries, des écoles, des hôpitaux, des bâtiments de bureaux privés, des bâtiments résidentiels et commerciaux. En plus de ces ESCOs déjà actives, 5 à 10 ESCOs additionnelles sont présentes sur le marché mais n'ont pas encore de contrat signé. Nous estimons qu'environ 40 contrats sont en négociation, principalement avec des entités privées (chap. IV, section 4.1).

Le CPE n'est jamais mentionné comme étant l'activité principale des ESCO actives en Suisse. Ces entreprises sont de tailles moyennes à grandes, avec seulement une petite part d'employés travaillant sur les CPE (chap. IV, section 4.1.1.). Les ESCOs suisses sont d'abord des fournisseurs d'électricité, des consultants en ingénierie, des fournisseurs d'appareils de contrôle et d'optimisation, des fournisseurs de contracting énergétique ou de gaz. Alors que ces entreprises pionnières dans le marché suisse bénéficient sûrement d'une diversification des risques par leur grande taille et l'importance de leurs autres activités, nous ne trouvons pas d'évidence empirique que la taille de l'entreprise affecte l'intérêt d'autres entreprises pour fournir des CPE. Dans le futur donc, de plus petites firmes pourraient entrer sur le marché suisse des CPE (chap. IV, section 4.1).

L'enquête que nous avons menée a collecté des informations sur 208 offreurs potentiels, desquels 199 sont encore inactifs sur le marché des CPE. Les offreurs potentiels contactés incluent principalement des entreprises d'électricité, des consultants en ingénierie, des fournisseurs de gaz et de services liés à l'énergie. Sur les 199 firmes encore inactives, 59 (29.6%) ont mentionné qu'elles pourraient être intéressées à proposer des CPE à l'avenir (chap. IV, section 3.2). Des 59 entreprises intéressées, 68% ont déjà entrepris des actions pour prospecter le marché des CPE (principalement des entretiens avec des clients potentiels, la recherche de partenaires d'affaire ou des études de marché) (chap. IV, section 4.1).

Un acteur important en Suisse est l'association swissesco. Fondée en 2015 et soutenue financièrement par l'Office fédéral de l'énergie, elle a pour but de promouvoir le marché des CPE en Suisse. En 2016, l'association a fourni aux entités publiques, un guide pour la conception de projets et la rédaction d'appels d'offres publics pour les CPE (swissesco (2016)). L'agenda 2017 de l'association inclut la distribution de contrats-type, la distribution de l'information et des cours de formation sur les CPE. Avec plus de 30 membres au printemps 2017, l'association regroupe tous les acteurs importants sur le marché des CPE en Suisse (chap. II, section 4.8).

Les intermédiaires, aussi appelés facilitateurs ou assistants maîtres d'ouvrage, sont perçus à l'étranger comme d'importants acteurs sur le marché des CPE (Bleyl et al. (2013), Nolden et al. (2016)). Les facilitateurs peuvent être des bureaux d'ingénieurs ou de

conseil travaillant comme partie tiers entre le client et l'ESCO. Ils représentent une intéressante approche pour réduire les barrières au marché des CPE en atténuant les coûts de transaction pour le client. Quelques entreprises offrent déjà ce genre de services en Suisse.

Les autorités publiques ont également un rôle important à jouer dans le contexte des CPE (chap. II, section 7). Ce sont elles qui définissent d'abord le cadre légal. Ensuite, le secteur public est également un client potentiel des CPE puisqu'il possède et gère un important parc immobilier, souvent avec de grandes consommations énergétiques. De plus, les autorités peuvent agir en tant qu'agences de l'énergie. Le chapitre II, section 7 résume les différents instruments politiques dédiés à l'efficience énergétique en Suisse et leur synergie potentielle avec les CPE. Alors que l'Office fédéral de l'énergie et quelques cantons ont déjà fait le pas pour promouvoir les CPE, d'autres cantons seraient également prêts à intervenir sous certaines conditions (chap. II, section 7.2.3).

Le modèle d'affaire CPE: Le point de vue des ESCOs actives et potentielles en Suisse

L'activité principale mise en place par les ESCOs actives et les entrants potentiels pour prospecter le marché est de conduire des entretiens avec des clients potentiels (chap. IV, section 4.1.1). Une majorité d'ESCOs actives ont également élaboré un modèle d'affaire, tel que décrit dans cette section. Une large part des offreurs potentiels n'ont pas encore pensé à un modèle d'affaire pour le CPE. Nous collectons tout de même leur point de vue à ce sujet. La structure utilisée pour collecter des informations sur leur modèle d'affaire est décrite dans les sous-sections suivantes et est basée sur le canevas d'Oserwalder et Pigneur (2010).

Des informations additionnelles concernant le modèle d'affaire élaboré par les ESCOs suisses, telles que ce qu'elles considèrent comme étant leur avantage comparatif, ainsi que les partenaires et les objectifs de chiffre d'affaires, sont données au chapitre IV (section 4.1.2) et au chapitre II.

Proposition de valeur pour les clients

Les ESCOs sont unanimes à ce sujet: les économies d'énergie ne sont pas le premier argument pour vendre un projet CPE à un client. L'expérience des entreprises révèle en effet que les économies d'énergie sont souvent perçues comme une « cerise sur le gâteau » et que le client valorise d'autres caractéristiques d'un projet CPE. La proposition de valeur derrière le CPE va au-delà d'une garantie de performance et d'un outil de financement. Les avantages mentionnés par les offreurs incluent une optimisation des paramètres techniques de l'équipement, une amélioration du confort, une sûreté accrue du système, et la mise à disposition de solutions clé en main pour les grands consommateurs d'énergie soumis à des exigences légales (chap. II, section 3.1). D'autres avantages véhiculés au client sont le fait d'avoir un seul interlocuteur pour tout le projet, une transparence sur les coûts, des économies d'énergie mesurables, et une optimisation de la maintenance et de l'exploitation (chap. IV, section 4.1.1).

Délivrer la valeur

L'enjeu pour les ESCOs est de détecter, ex ante, quel aspect du CPE le client valorise le plus et lui proposer en conséquence des solutions contractuelles sur mesure. Notre étude démontre qu'il existe une hétérogénéité importante entre les préférences et les mécanismes de décisions chez les clients potentiels concernant l'efficience énergétique (chap. III, section 5.6). Le succès des projets CPE dépend de la capacité de l'ESCO, et/ou du facilitateur, de tenir compte de cette hétérogénéité et d'adapter son/leur offre en conséquence. Cette étude met également l'accent sur le besoin pour les ESCOs de travailler en collaboration étroite avec le(s) responsable(s) technique(s) du site et ce, du processus de négociation jusqu'à l'exploitation et maintenance de l'installation (chap. II, section 3.4).

Clientèle cible

Le client idéal pour un projet CPE satisfait les conditions suivantes (chap. II, 4.2):

- Grande consommation d'énergie centralisée
- Besoins de rénovation et/ou d'optimisation pour l'infrastructure et les opérations existante (dus aux exigences légales, à une exploitation inefficace ou à une désuétude)
- Des ressources financières limitées pour les investissements qui ne concernent pas l'activité principale
- Pas de réticence envers les partenariats à long terme
- Une utilisation du bâtiment pérennisée pour les prochaines années
- Une situation claire et stable concernant le propriétaire/locataire dans les prochaines années
- Bâtiment plus vieux que 3-5 ans ou neufs mais avec une exploitation inefficace.

En pratique et selon notre enquête auprès de 208 ESCOs actives ou potentielles, les clients et les types de projets ciblés en Suisse semblent différer par rapport à ceux qui sont ciblés à l'étranger. La divergence se situe à différents niveaux :

1. Les premiers clients ciblés en Suisse pour le CPE sont les industries. Cela diffère des marchés étrangers où les CPE ont été implémentés en majorité dans des écoles, des bâtiments municipaux ou des hôpitaux (chap. I, section 4.3)
2. Alors que le CPE est vu comme économiquement non-viable pour des petits consommateurs d'énergie à cause des coûts de transaction liés (chap. II, section 4.2, chap. I, section 4.3), les résultats de notre enquête montrent que les offreurs potentiels en Suisse ne ciblent pas forcément les plus gros consommateurs. Certains ciblent même les petits clients (chap. IV, section 4.6.2)
3. Alors que les projets CPE impliquant des rénovations majeures et des isolations de l'enveloppe sont plutôt rares dans les marchés étrangers (chap. I, sections 5.1.1 and 4.4), une majorité des entreprises suisses questionnées ne montraient pas de

préférence en ce qui concerne les actions menées au sein des CPE. Comme swissesco (2016) le fait remarquer, les CPE peuvent impliquer des rénovations majeures incluant l'enveloppe. Mais ces projets nécessiteront sans doute un financement de la part de l'ESCO et du client. De tels mécanismes de partage des risques et du financement semblent prometteurs pour cibler tous les types d'investissements dans l'efficience énergétique.

Les raisons suivantes peuvent expliquer les divergences entre les marchés du CPE en Suisse et à l'étranger :

1. Le marché suisse est actuellement émergent et les cibles pourront considérablement évoluer parallèlement à son expansion

2. Dans la conjoncture suisse actuelle, avec les taux d'intérêts très bas (voire négatifs), les clients sont moins contraints financièrement pour financer les projets d'efficience énergétique que dans d'autres pays.

Système de rémunération

Les entreprises questionnées ne favorisent pas unanimement les CPE avec économies partagées ou la rémunération avec économies garanties. Cela suggère que le choix entre les systèmes de rémunération est en grande partie dicté par la volonté du client ou le contexte, plutôt que par la préférence de l'ESCO (chap. IV, section 4.3).

Evidence empirique sur le rôle des CPE pour promouvoir les investissements dans l'efficience énergétique

L'évidence empirique se base sur une enquête en ligne auprès de 297 clients potentiels des CPE, gérants ou propriétaires d'immeubles tels que des écoles, des centres sportifs, des bâtiments administratifs et commerciaux, des hôtels, des hôpitaux et de grands bâtiments résidentiels. 82% de ces bâtiments appartiennent à des collectivités publiques et 38% sont en partie loués. Une grande partie de ces bâtiments sont éligibles pour des projets CPE : 85% sont des bâtiments construits avant 1990 et une majorité d'entre eux (57%) ont une surface chauffée de plus de 2000m^2 (chap. III, section 4.2).

Dans cette enquête, les répondants devaient imaginer une situation dans laquelle leur bâtiment aurait prochainement besoin d'une rénovation. Au travers des préférences exprimées, les répondants étaient invités à décider entre plusieurs options impliquant diverses actions de performance énergétique, avec ou sans CPE, et une simple rénovation (p. ex. révision du boiler ou peinture de la façade et du cadre des fenêtres). Les alternatives proposées différaient dans le montant des travaux, la moyenne et le risque sur les économies d'énergie et des attributs contractuels sur le CPE (p.ex. garantie des économies, financement de la part de l'ESCO, durée du contrat et paiement à l'ESCO). Cette méthode permet de quantifier empiriquement l'impact de ces attributs sur la volonté à investir dans l'efficience énergétique. Les résultats principaux sont les suivants (chap. III, section 5.6) :

1. Le financement par l'ESCO affecte positivement l'investissement dans l'efficience énergétique seulement pour une minorité de répondants. Ceux-ci sont en majorité

des entités publiques (école), probablement avec des plafonds d'endettement. Ce résultat implique que pour une majorité, l'accès limité au crédit à des coûts raisonnables n'explique pas le sous-investissement dans l'efficience énergétique (en tout cas dans notre échantillon). Ce résultat doit également être placé dans le contexte et la conjoncture actuelle en Suisse, avec des taux d'intérêts très bas. Pour les entités publiques proches du plafond d'endettement, l'avantage du financement par l'ESCO existera seulement s'il est possible de comptabiliser les CPE en tant que charges d'exploitation (hors bilan), ce qui n'est pour l'instant pas clarifié. Une première implication politique est le besoin de clarifier si les entités publiques peuvent utiliser le financement de l'ESCO pour éviter les contraintes budgétaires telles que les plafonds d'endettement. Légalement permettre cette comptabilisation hors bilan se justifie par le fait que l'ESCO garantit que le crédit sera entièrement financé par des gains d'exploitation, i.e. les économies d'énergie et de maintenance réalisées

2. La garantie de l'ESCO a un impact positif persistant et statistiquement significatif sur la volonté à investir dans l'efficience énergétique. L'avantage du partage des risques apporté par les CPE est un élément-clé dans tous les segments de marché de notre enquête. Ce résultat a les implications politiques suivantes :

   a) Cela justifie le support de l'Etat pour promouvoir les CPE, surtout si cela revient moins cher de réduire les barrières au marché des CPE (p.ex. le manque de connaissance) que d'agir directement sur le risque ou l'information imparfaite qui empêchent les investissements dans l'efficience énergétique
   b) Cela donne une indication pour les plus petits consommateurs d'énergie qui ne seront peut-être pas ciblés par les CPE. Puisque le risque encouru et l'information insuffisante semblent être d'importantes barrières à l'investissement dans l'efficience énergétique, d'autres solutions que les CPE pourraient être trouvées pour ce segment de marché. Cela inclut par exemple des services de suivi du comportement des usagers et sur les installations techniques afin de garantir ex post que les économies d'énergie soient conformes à celles attendues
3. Cette étude n'a pas montré de problèmes d'incitation d'investissements pour les bâtiments loués. Cela devrait être exploré davantage dans la recherche future, en utilisant des échantillons avec une plus grande part de bâtiments privés et loués.
4. Les résultats montrent une hétérogénéité dans les préférences et les processus de décision en ce qui concerne l'efficience énergétique et les CPE. Cela se traduit par des processus de décision simplifiés dans lesquels les répondants ont ignoré certains attributs des choix proposés. Il existe également une réticence envers les CPE, qui ne peut pas seulement être expliquée par les clauses contractuelles. Ce résultat offre un point de vue intéressant sur la complexité du comportement lors de décisions d'investissement dans l'efficience énergétique. La recherche future devrait se concentrer sur cet aspect encore très peu exploré, afin d'apporter des éléments de réponses cruciaux dans le but de réduire mieux encore l'écart d'efficience énergétique. Aussi, cela met en évidence la nécessité et l'importance, pour les ESCOs, d'identifier rapidement les besoins du client et de proposer des solutions sur mesure
5. Les caractéristiques individuelles, qui affectent significativement la volonté d'adopter des actions de performance énergétique ou un CPE, sont résumées dans le tableau

ci-dessous. A titre d'exemple, lorsque le répondant est lui-même un responsable de l'énergie, la volonté d'investir dans l'efficience énergétique (avec ou sans CPE) augmente. On observe le résultat inverse lorsque le répondant est le propriétaire de l'immeuble

Tableau 5: Impact des caractéristiques individuelles

	Volonté d'adopter des mesures d'efficience énergétique	**Volonté d'opter pour un CPE**
Le répondant était déjà familier avec la notion de CPE	+	+
Il y a un responsable de l'énergie employé pour ce bâtiment	+	
Le répondant = le responsable énergie	+	+
Le répondant = le propriétaire de l'immeuble	-	-
Le répondant = membre exécutif de la collectivité publique en charge du bâtiment		-
Nombre d'année d'expérience du répondant dans sa fonction		-

Note: Les effets statistiquement significatifs sont notés par un "+" lorsqu'ils sont positifs et par un "-" s'ils sont négatifs. Rien n'est inscrit lorsque l'impact n'était pas significatif.

6. D'autres caractéristiques n'ont pas montré d'impact sur la volonté d'investir. Entre autres, cela inclut la taille du bâtiment (en termes de coûts annuels de l'énergie, de l'électricité ou de surface chauffée), les bâtiments loués ou non. L'âge du répondant, son sexe, son éducation, sa langue et le rôle qu'il joue dans le processus de décision n'affectent pas non plus la décision. Nous n'avons pas non plus trouvé de divergence dans la décision ou dans l'évaluation des attributs contractuels entre les entités privées ou publiques
7. Finalement, alors que le CPE peut atténuer d'importantes barrières aux investissements, il est aussi sujet à une réticence intrinsèque des clients potentiels, qui est sans doute due en partie à un manque de connaissance. Les raisons d'une telle réticence sont résumées dans la section suivante (et au chap. III, 5.4). Nous estimons qu'une grande partie de cette réticence est due à des idées reçues qui pourraient être atténuées en améliorant quantitativement et qualitativement l'information.

Les barrières du côté de la demande : solutions potentielles et implications politiques

Les ESCOs actives en Suisse ont unanimement déclaré que le manque de connaissance du concept CPE de la part du client est la plus grande barrière au déploiement du marché en Suisse (chap. II, section 6.1.1. and chap. IV, section 4.2.1). De ce manque de connaissance naissent des idées reçues et une réticence à l'égard de ce nouveau modèle d'affaire. Cette réticence est visible dans le fait que plus de 50% (149) des 297 clients potentiels questionnés n'ont jamais opté pour l'option CPE[8]. Il était demandé aux répondants de donner la raison pour laquelle ils n'ont jamais choisi le CPE ; les résultats sont illustrés dans la figure ci-dessous (chap. III, section 5.4).

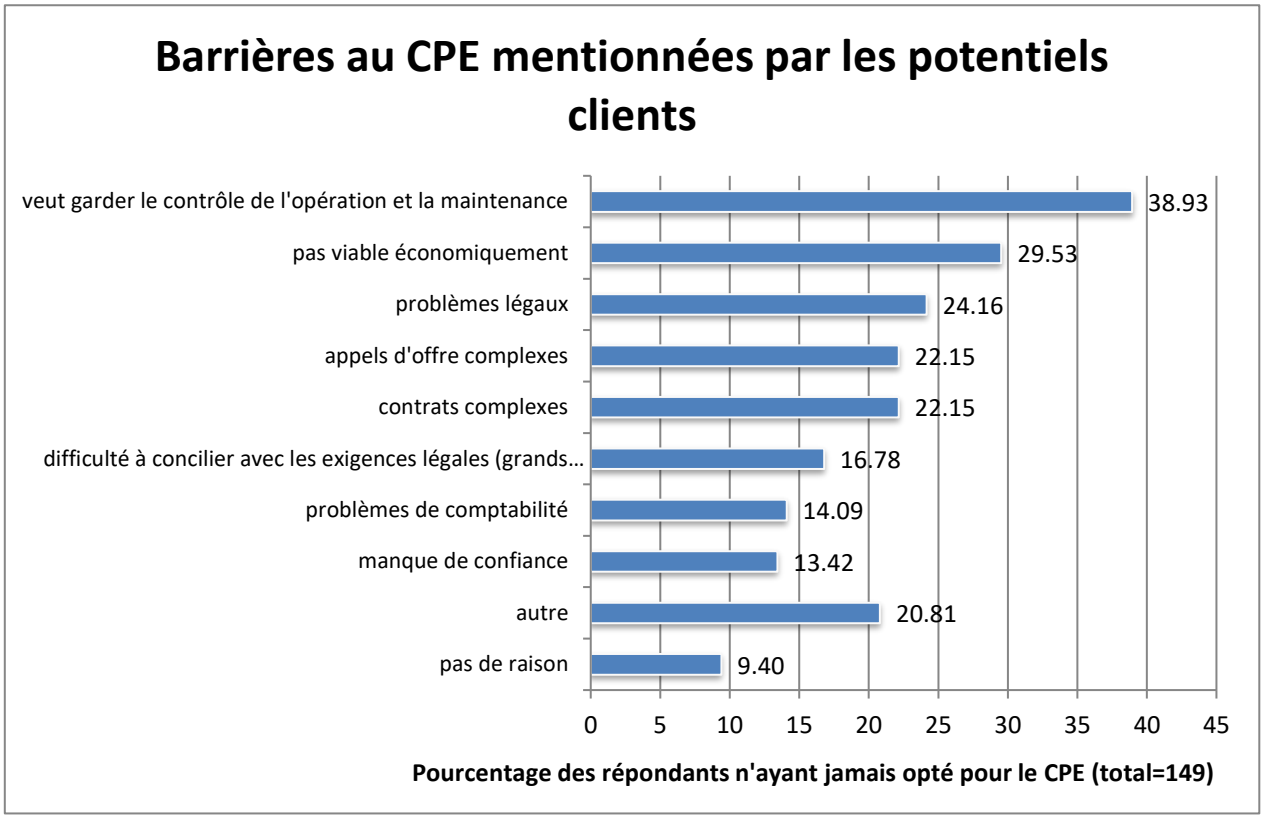


Figure 3 Barrières au CPE exprimées par les clients potentiels

1. La première raison invoquée est la **réticence à externaliser le contrôle de l'exploitation et de la maintenance.** Cela pourrait correspondre à une idée reçue des répondants que cela nécessite d'abandonner le personnel technique actuellement responsable de l'équipement. Il est important d'informer les clients potentiels que ce n'est pas le cas et que l'ESCO supervise l'exploitation et la maintenance en travaillant en étroite collaboration avec le personnel technique et en le formant pour

[8] A des fins de comparaison, 26 répondants n'ont jamais choisi l'investissement dans l'efficience énergétique (avec ou sans CPE). Ces derniers ont déclaré ne pas vouloir investir (et opter pour une simple révision) principalement pour les raisons suivantes : le bâtiment est déjà efficient, les investissements dans l'efficience énergétique ne sont pas viables économiquement et le bâtiment est protégé.

qu'il puisse utiliser et comprendre le nouvel équipement ou gérer plus efficacement le bâtiment (Swissesco (2016)).

2. La **viabilité économique** de ces projets est aussi largement remise en question. Les répondants qui ont mentionné ce problème ne sont pourtant pas moins éligibles pour le CPE que la moyenne dans l'échantillon, en termes de taille ou de potentiels d'économies d'énergie
3. Des **problèmes légaux et la complexité du contrat et du processus d'appel d'offres public** sont aussi perçus comme des barrières par les clients potentiels. Cela est directement lié aux coûts de transaction qui sont difficiles à éviter, d'autant plus en Suisse où la loi peut varier entre les communes et les cantons. Les facilitateurs ont un rôle important à jouer pour proposer des conseils sur mesure et au cas par cas. La situation peut évoluer positivement lorsque le marché du CPE sera plus mature et que les législations spécifiques seront clarifiées. Dans le chapitre II, nous développons l'état des lieux des connaissances sur ces sujets et proposons des guides et des solutions potentielles concernant:
   a) Le droit pour une entreprise privée d'investir dans un bâtiment public (chap. II 6.3.1.)
   b) Le transfert des coûts sur les locataires (chap. II 6.3.3.)
   c) La comptabilisation hors bilan des CPE (chap. II 6.3.2)
   d) Le processus d'appel d'offre pour les CPE (chap. II 6.1.2)
   e) Les disputes légales sur la mesure et la vérification des économies d'énergie réalisées (chap. II 6.1.3)
4. 14 répondants (9.4%) n'ont **pas donné de raison** pour expliquer le fait qu'ils n'ont jamais choisi le CPE. Cela suggère une réticence inexpliquée envers les CPE. Il est intéressant de noter que 13 de ces répondants n'étaient pas familiers avec la notion de CPE avant de répondre à l'enquête. Même si cela ne donne pas d'information sur la causalité, la corrélation entre la réticence inexpliquée et l'ignorance de l'existence de CPE suggère que des campagnes d'information avec des exemples de réussite seront nécessaires pour surmonter les barrières liées à la nouveauté de ce modèle dans l'esprit des gens
5. Ce **manque d'information et cette perception biaisée** des CPE est aussi visible au travers d'autres raisons mentionnées par les répondants. Par exemple, certains individus ont rejeté les contrats car le bâtiment est public ou parce qu'ils étaient financièrement contraints, alors que les CPE sont justement dédiés à de tels bâtiments.
6. D'autres raisons plus légitimes ont été mentionnées, telles qu'un **engagement de longue durée** à établir avec une entreprise externe, la volonté d'**investir soi-même** dans un contexte où le crédit est actuellement particulièrement abordable et enfin, l'**existence de personnel qualifié préexistant** à l'interne. Un participant était aussi préoccupé par la difficulté éventuelle supplémentaire de **vendre ultérieurement un bâtiment engagé dans un CPE.** D'autres répondants ont également mentionné des éléments qui freinent également l'investissement dans l'efficience énergétique, par exemple le fait que la transformation soit difficile avec des bâtiments protégés.

Nous trouvons une évidence empirique que le CPE peut atténuer les barrières à l'investissement dans l'efficience énergétique, dans un marché émergent où beaucoup d'interrogations demeurent. Il apparaît pourtant que les barrières perçues sont plus fortes et plus nombreuses pour les CPE que pour l'investissement dans l'efficience énergétique. Il reste donc encore beaucoup de travail pour réduire les coûts de transaction liés à ces contrats. Une grande part de cette tâche devra probablement inclure des campagnes d'information ainsi que la diffusion d'exemples. Ce travail a déjà démarré sous l'impulsion de l'association swissesco et de l'Office fédéral de l'énergie.

Comment favoriser des offres CPE compétitives et de haute qualité ? Evidence empirique sur les barrières et les éléments déclencheurs du côté de l'offre

a) Eléments déclencheurs de l'offre

A partir des entretiens que nous avons menés, on peut observer que les CPE sont proposés pour les raisons suivantes (chap. II, 4.1.1) :

- Augmenter le chiffre d'affaire pour les activités de vente d'équipement et de maintenance
- Se lier au client dans le long terme
- Stabiliser et planifier les flux de liquidités annuelles
- Couvrir les besoins du client
- Garder le contrôle sur les processus d'affaire, les ressources et les inventions
- Préserver un avantage compétitif.

Nous avons aussi exploré dans quelle mesure le contexte légal en Suisse pourrait affecter les décisions en ce qui concerne l'offre de CPE.

1. Aucune des ESCO actives questionnées ne considère la **libéralisation du marché de l'électricité** (pour les grands consommateurs) comme étant un élément déclencheur pour contracter des offres CPE. Seul un acteur a mentionné que cela avait joué un rôle dans leur décision d'entrer dans le marché des CPE, avec pour argument de garder leurs clients, mais seulement en conjonction avec d'autres facteurs tels que la volonté générale de l'entreprise de promouvoir des solutions durables avec des instruments de marché (chap. II, section 7.4). L'évidence empirique au chapitre IV (4.5) montre également que la libéralisation du marché de l'électricité pour les petits consommateurs n'aurait vraisemblablement pas d'impact sur la volonté d'entrer sur le marché des CPE
2. Le nouvel article constitutionnel (131.a) actuellement en consultation a aussi été mentionné comme un facteur qui pourrait augmenter l'intérêt général dans l'offre des CPE. Les offreurs devront en effet répondre à une demande plus grande de solutions d'efficience énergétique, déclenchée par le **système basé sur des taxes sur l'électricité et les carburants prévu par cette nouvelle loi** (chap. II, section 7.4). L'évidence empirique au chapitre IV (section 4.5) démontre pourtant que cela n'a pas d'impact significatif sur la considération d'entrer sur le marché des CPE. Cela peut être dû à la difficulté pour les potentiels offreurs de prévoir l'impact qu'une telle loi aurait sur le marché. Aussi, puisque cette politique serait implémentée (si elle

l'est un jour) seulement dans la deuxième phase de la stratégie énergétique 2050, les répondants n'en ont peut-être pas encore mesuré les conséquences potentielles

3. La **"Lex Weber"**, interdisant la construction de résidences secondaires après un certain pourcentage dans les communes, a aussi été mentionnée comme ayant un impact potentiel sur la volonté d'offrir des CPE (chap. II, 7.4). Dans certains cantons très impactés, tel le Valais, cette loi provoque un important ralentissement dans le secteur de la construction et affecte principalement les petits entrepreneurs locaux. Selon le Prof. Stéphane Genoud (HES-SO Valais), cela va inciter ces acteurs à cibler les projets de rénovations énergétiques des bâtiments existants et donc possiblement, de mettre en place des projets CPE, soit en tant qu'ESCO, soit en tant que consortium de petits entrepreneurs ou en tant que fournisseurs des ESCOs.

Dans le chapitre IV (section 4.5), les offreurs potentiels devaient exprimer si leur entreprise considérerait l'idée d'offrir certains types de contrat si la situation sur le marché changeait de différentes façons. L'analyse économétrique basée sur ces réponses conduit aux résultats suivants :

- La volonté d'offrir des CPE est impactée significativement par une **augmentation de la demande, seulement si elle combine la demande des secteurs privé et public.** Entrer dans le marché des CPE représente un investissement important en termes de connaissance technique, d'expertise dans l'évaluation du risque et de connaissances pluridisciplinaires concernant les aspects contractuels légaux ainsi que la mesure et la vérification des économies d'énergie. Nous montrons que pour les potentiels offreurs, cet investissement est plus important en termes de compétences et de ressources humaines qu'en termes de ressources financières.
- Une **augmentation exogène de l'offre de la part des fournisseurs d'électricité** affecte positivement la probabilité des entreprises d'offrir des CPE. Cette augmentation de l'offre était présentée aux répondants comme résultant d'une obligation pour ces fournisseurs d'améliorer l'efficience énergétique de leurs clients, comme dans le système des certificats blancs. Nous montrons que la mise en vigueur hypothétique d'un tel système n'affecterait pas seulement les fournisseurs d'électricité, mais tous les types de fournisseurs. A cause d'une augmentation possible de la concurrence ou par imitation, les autres fournisseurs sur le marché de l'énergie répondraient en augmentant leur offre de services énergétiques avec par exemple les CPE.
- **Les activités déjà offertes par l'entreprise peuvent fonctionner comme complément au CPE.** Nous montrons que les fournisseurs de gaz, de systèmes chauffage ou d'automation et contrôle sont plus intéressés à entrer sur le marché des CPE.
- La taille de l'entreprise, en termes de nombre d'employés ou d'étendue territoriale de ses activités, n'a pas d'impact significatif sur la volonté d'offrir des CPE.
- Que l'entreprise soit une entité publique ou privée n'affecte pas non plus la volonté d'entrer sur le marché du CPE. Cependant, si le répondant déclare que **l'entité publique contrôlant la firme exerce des pressions pour augmenter l'efficience énergétique de ses clients**, alors l'entreprise va plus proba-

blement considérer d'offrir des CPE ou du contracting énergétique. Ce résultat suggère que pour promouvoir l'offre de CPE, une solution serait de sensibiliser et d'informer les entités publiques en charges des compagnies de gaz et d'électricité.

b) Les barrières à l'offre de CPE:

Les barrières perçues par les ESCOs actives sont différentes de celles rencontrées par les entreprises qui n'ont pas (encore) investi le marché. Pour ces dernières, les problèmes suivants apparaissent :

- 62% des entreprises questionnées et encore inactives dans les CPE (199 firmes) n'étaient pas familières avec le concept avant notre enquête (chap. IV, 4.1). Nous montrons qu'il y a une relation positive entre la **familiarité avec le concept des CPE** et la volonté d'offrir ces contrats (chap. IV, 4.5). Même si cette variable souffre sans doute d'un biais d'endogénéité, cela suggère quand même que des campagnes d'informations seraient également utiles du côté de l'offre.
- 140 (67%) des 208 répondants de notre enquête n'ont pas montré d'intérêt envers les CPE. Une majorité d'entre eux (58%) a déclaré manquer de compétences **internes et de capacité de personnel** pour entrer dans le marché des CPE (chap. IV, 4.2.2.). Les firmes sont réticentes à investir ou à trouver des partenariats stratégiques à cause de l'incertitude concernant les potentiels d'un tel marché.
- **Le volume du marché des CPE et ses potentiels sont inconnus** (chap. II, sections 4.1.2 and 6.2.2., chap. IV section 4.2.2.). Certains répondants ont déclaré que le parc immobilier et technique en Suisse est déjà dans de bonnes conditions et que par conséquent, les potentiels d'économies d'énergie sont insuffisants. Aussi, le manque d'intérêt de la part des clients et l'incertitude (qui régnait alors) concernant la stratégie énergétique fédérale compromet les potentiels restants selon eux. Alors que nous démontrons que les CPE représentent des potentiels pour faciliter les investissements dans l'efficience énergétique pour les grands consommateurs, la recherche devra à l'avenir s'intéresser aux volumes potentiels du marché. D'un autre côté, des cours de formation ainsi que des partenariats facilités pour partager les ressources humaines et les compétences seront nécessaires pour permettre aux entreprises d'investir le marché des CPE à des coûts raisonnables.
- Des barrières plus structurelles au niveau de l'entreprise, telles que l'inadéquation du CPE avec l'activité principale, l'objection ou l'inintérêt, n'ont été mentionnées que par une minorité des répondants. Ceci est encourageant en ce qui concerne les potentiels de déploiement du côté de l'offre des CPE. En effet, ces barrières sont plus difficiles à surmonter que celles décrites plus haut, mais elles sont également moins récurrentes.

En plus d'apporter des réponses intéressantes sur les barrières perçues par les clients, les ESCOs actives sur le marché ont mentionné les problèmes suivants du côté de l'offre :

- Les ESCOs doivent être **certifiées par des agences énergétiques (AEnEC ou ACT)** pour pouvoir offrir des solutions aux grands consommateurs sujets aux exigences légales et voulant conclure une convention d'objectifs universelle[9]. Ceci représente une barrière pour les entrants potentiels qui ne peuvent pas obtenir une certification facilement (chap. II, sections 6.4.2 and 5). En effet, sans cette accréditation, ils perdent un avantage important pour vendre les CPE à ce type de clients. Cela constitue une barrière à l'entrée du marché suisse des CPE.

Finalement, les problèmes suivants ont été mentionnés par les ESCOs actives et les entrants potentiels:

- Les **prix actuellement bas de l'énergie** induisent un niveau bas de profitabilité (chap. IV, sections 4.2.1 and 4.2.2.)
- Les **risques** pour l'ESCO sont élevés (chap. IV, 4.2.2.)
- 8 des 9 ESCOs actives questionnées ont déclaré avoir parfois des difficultés à **financer** un projet. Cela ne concerne pas tous les projets CPE, mais c'est un problème que presque toutes les ESCOs ont rencontré. Le manque de financement est une barrière qui a aussi été mentionné par 23% des entreprises intéressées à entrer dans le marché des CPE à l'avenir (chap. IV, section 4.2.2).

Dans le chapitre II, nous analysons les risques supportés par l'ESCO dans un projet CPE et proposons diverses solutions. Le tableau suivant fournit un résumé de cette analyse.

[9] Cette convention est exigée pour obtenir une exemption de taxe CO_2, une réduction ou un remboursement du supplément réseau pour les coûts du réseau électrique.

Tableau 6: Risques pour l'ESCO

Risques pour l'ESCO	
Risque sur la performance (chap. II, 6.2.1.)	
Cause	Incertitude ex ante des économies d'énergie
Conséquences	-Les ESCOs ont besoin de connaissance technique et une expertise dans l'évaluation du risque -Les investisseurs tiers peuvent être réticents à investir ou intéressés seulement par des projets CPE de grande envergure (chap. II, 4.7 p.19)
Solutions	-CPE type "à forfait" (forfaiting) -Suivi approprié du comportement des usagers et des réglages techniques -Elaboration d'outils pour aider les institutions financières à évaluer le risque technico-économique de chaque projet -Diversification du risque (p.ex. Super ESCO, pool d'actions de performance énergétique)
Risque sur le montant des travaux (chap. II, 6.2.1- 2)	
Cause	L'ESCO est rémunérée via un montant fixe ou une part des économies d'énergie réalisées (% CHF)
Conséquence	Tout coût additionnel imprévu est supporté par l'ESCO à moins que ça ne soit mentionné autrement dans le contrat
Solutions	-Diversification du risque (p.ex. projets différents, autres activités de l'ESCO) -Clauses contractuelles définissant clairement la responsabilité de chaque partie : le risque devrait être supporté par l'agent le plus à même de le modérer -En théorie, l'ESCO devrait être contractuellement responsable des coûts additionnels résultant d'erreurs d'estimation ou de problèmes techniques -Le client devrait supporter les coûts inattendus liés à des changements drastique du comportement des usagers, de mauvaises pratiques de ses employés ou du cadre légal (s'il s'agit d'une collectivité publique)
Risque de déménagement ou de faillite du client (chap. II, 6.2.3 – 3)	
Cause	Les CPE impliquent souvent des services, des mesures et des installations dont la propriété ne peut pas être transférée à l'investisseur
Conséquence	Une grande partie de l'investissement ne peut pas être couverte par un collatéral possédé par l'investisseur
Solutions	-Diversification du risqué (p. ex. projets de type différent, autres activités de l'ESCO) -Clauses contractuelles exigeant au client de payer une indemnité en cas de déménagement et de non-reprise du contrat par un tiers -Création d'un fond de garantie entre plusieurs ESCOs pour diversifier le risque de faillite des clients -Garantie publique contre la faillite lors d'investissements pour l'efficience énergétique (p. ex. canton de Fribourg) -Gages immobiliers (chap. II, 6.2.1. a)

Conclusion et implications politiques

Le marché des CPE en Suisse est un marché de niche qui n'a émergé que récemment. Pourtant, le marché risque bien d'évoluer de façon significative dans les années à venir étant donné les potentiels trouvés du côté de la demande comme de l'offre. Le retard actuel du marché suisse peut être expliqué par une conjonction de facteurs.

Les coûts de transaction liés aux CPE sont exacerbés par les divergences légales entre les communes et les cantons. Comme mis en évidence à l'étranger (Nolden et al. (2016)) et particulièrement dans ce contexte, les approches ascendantes telles que des conseils prodigués au cas par cas par des assistants maîtres d'ouvrages (ou par les ESCOs elles-mêmes), sont à privilégier par rapport aux approches descendantes (documents standards, guides généraux). L'intervention de l'Etat est cependant nécessaire pour clarifier les problèmes légaux qui s'appliquent plus largement sur le territoire[10].

Comparés à la situation dans d'autres pays, les potentiels des CPE en tant qu'outil de financement sont moins valorisés en Suisse (en tout cas dans la conjoncture actuelle). Le financement par l'ESCO n'est en effet évalué positivement que par une minorité de clients potentiels, certainement soumis à des contraintes budgétaires ou à des plafonds d'endettement. La garantie de performance offerte par les CPE[11], en revanche, représente une approche attractive pour déclencher des projets rentables d'amélioration énergétique en Suisse. L'importance de la garantie d'économie d'énergie fournit une information cruciale pour les décideurs politiques. Si les CPE ne peuvent atteindre tous les segments de marchés, tels que les petits consommateurs à cause des coûts de transaction, alors d'autres instruments doivent être utilisés et être destinés à fournir les économies d'énergie espérées.

Le retard du marché des CPE en Suisse se conjugue à un manque de connaissance du côté de la demande mais également du côté des offreurs potentiels. Nous montrons que ce manque d'information conduit à des idées reçues. Alors qu'une partie de l'information peut être véhiculée par les offreurs eux-mêmes, les autorités bénéficient d'une neutralité nécessaire pour convaincre les clients potentiels publics ou privés, les autorités d'autres juridictions ou les offreurs potentiels. La décision finale concernant la stratégie énergétique va aussi sans doute réduire d'importantes incertitudes concernant le potentiel des CPE. Quoi qu'il en soit, les ESCOs qui réussiront sont celles qui réagiront et adapteront leur modèle d'affaire pour mieux répondre aux spécificités du marché suisse.

[10] C'est le cas par exemple en ce qui concerne la comptabilisation du CPE telle que préconisée par le plan comptable harmonisé pour les cantons et communes.

[11] Cette garantie de performance est présente dans les deux types de CPE: soit par les économies d'énergie partagées, par lesquelles l'ESCO a l'incitation de maintenir la performance pour se rémunérer, soit plus directement via la garantie financière sur les économies d'énergie réalisées.

I. Literature Review

1 Introduction

This report provides a critical literature review on energy service contracting (hereafter referred to as energy contracting). Energy contracting consists in outsourcing part or all energy-related services to a contractor called Energy Service Company (ESCO) through a long-term contract. This business model increasingly used by energy companies has also been seen in the literature as a promising market-based instrument to overcome barriers to both energy efficiency and renewable energy investments.

Yet, the market in Switzerland seems to experience a slow growth and some types of contracts are only emerging. Other ESCO markets such as in Germany, on the other hand, are already well developed. In the Swiss context where the authorities are considering to progressively abandon nuclear power via a smooth transition to a sustainable and low carbon economy, while ensuring security of energy supply (cf. the Swiss New Energy Policy, Bundesamt für Energie (2012)) it is crucial to attract sufficient investments in both renewable technologies and energy efficiency. The success of the energy policy programs will depend on the extent to which they can identify and overcome market barriers to investment. Thus, the potentials of promising instruments such as energy contracting should be explored. This begins by a critical review of the existing research in this domain.

Energy contracting is often seen as an interesting instrument, which combines business opportunities with social benefits. As a result, it is not surprising that the literature in this field is wide. Moreover, since these contracts typically involve the expertise of many different domains, such as engineering, law, politics, business, economics or finance, the corpus of studies is very heterogeneous. In fact, it is rather interesting to see that this has forced experts to understand each other and collaborate for the deployment of the ESCO markets. Despite this abundance of research, mostly consisting of market analyses and engineering research, studies that specifically rely on economic theory are rather scarce, and some important questions remain to be answered.

This report is structured in the following chapters:

- Chapter 2 reviews the definition of energy contracting, its scope and the different types of contracts that exist in practice.
- In chapter 3, the potentials of energy contracting as an instrument to mitigate the barriers to investments in renewable technologies and energy efficiency are reported.
- Chapter 4 is dedicated to determine whether these potentials are exploited in practice. This will be done by first reviewing the market analyses concerning foreign ESCO markets and then explore the Swiss case. The common trends on the ESCO markets worldwide will be used to understand the concept of a possible *energy service gap*.
- In order to assess whether this gap exists or not, one has to investigate whether energy contracting can be further developed, by targeting new consumers' type or

by involving different kind of technologies. If this potential of development exists but is not exploited, then the barriers that are hampering such an expansion must be explored. This is the objective of chapter 5, which reviews the literature on the barriers and drivers of the ESCO markets, both theoretically and empirically.

- Because the discussion in chapter 5 leads to the observation of a general consensus about the fact that several barriers prevent the ESCO markets to reach all the market segments effectively, this calls for the possible need of policy support. "Should the government step in, and if so using which instruments?" This is the question asked in chapter 6. Again, the literature in this context seems consensual about the necessity of public involvement in the ESCO markets. But this point will be discussed by exploring whether it is economically rational to invoke government support in this area and whether other market-based instruments could be exploited.
- In conclusion, chapter 7 provides a summary of the questions that remain unanswered in the energy contracting literature. This will lead to the exposition of the further research that is needed. Based on this, a program of research, specific to the Swiss case but hopefully transposable to other countries, is presented.

2 Energy Contracting

2.1 Definition and concept

The conditions under which an activity can be considered as energy contracting, is disputed in the literature. The key characteristics are determined by Sorrell (2005):

> *A necessary feature of an energy contract appears to be the transfer of decision rights over key items of energy equipment under the terms and conditions of a long-term contract, including incentives to maintain and improve equipment performance over time.*

Firms, public communities and house-owners usually outsource some of the activities related to the provision of energy services. However, these activities are considered as energy contracting only if the contractor has a control over the installations and their operation and an incentive to optimize equipment performance once the project is completed. As a result, conventional projects of construction or retrofit where the contractor or the engineer is paid at project delivery are not considered as energy contracting, since the contractor is not involved in operating the installation and there is no long-term contract. This is the case even if the contractor is responsible for most of the activities before the project's completion, such as design, installation or energy commodities purchase (Sorrell (2005)). In other words, conventional energy provision diverges from energy contracting because the client is provided with energy, but the further energy-related conversion processes, including operation, maintenance and control of useful energy and energy services, is left to the customer. Under contracting on the other hand, the client receives a useful energy service included in a full-service package (Helle (1997)).

2.2 Contracts classification

The definition proposed by Sorrell (2005) allows energy contracting to take many different forms. There is neither a commonly agreed system of classification nor a terminology in the relevant literature. This research again relies on Sorrell's (2007) attempt to classify those contracts according to three differentiating characteristics. First, the number of useful energy streams (e.g. steam/hot water, coolant, electricity) and/or final energy services (e.g. lighting, heating) that are under the partial or full control of the contractor determines the scope of the contract (see Figure 4a). Second, the depth is characterized by the number of organizational activities required to provide the service in question (see Figure 4b). Finally, whether the project is financed by the contractor or the client leads to very different implications on the viability of the project and on the structure of the market.

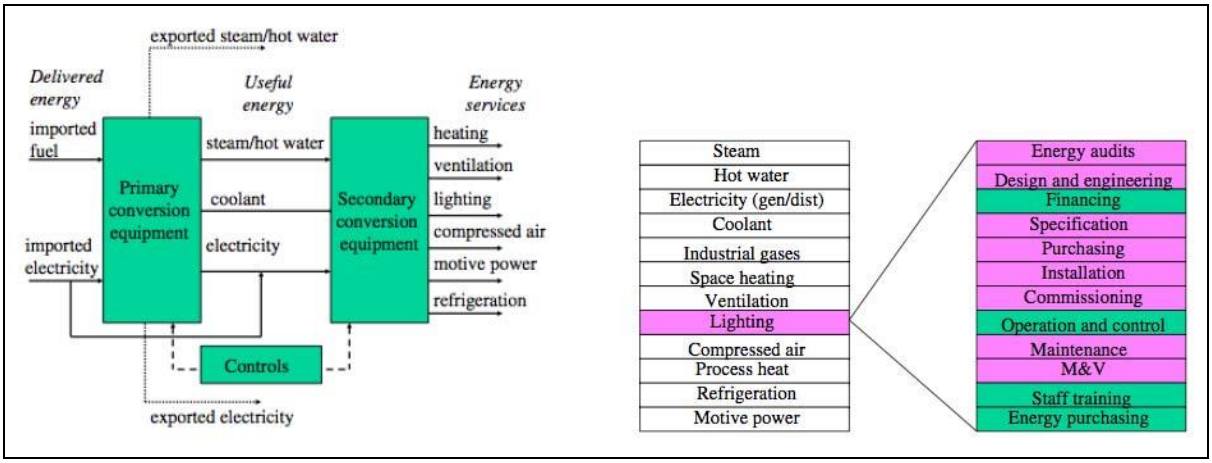


Figure 4 a) Left: Scope of the contract. b) Right: Depth of the contract for single energy demand service (Sorrell (2007), p. 509)

The literature often refers to two different types of energy contracting: Energy Supply Contracting (ESC) and Energy Performance Contracting (EPC) that are defined in the following sections.

2.2.1 Energy Supply Contracting (ESC)

ESC, also called Delivery Contracting (DC) (Marino et al. (2011)), covers usually one or more streams of useful energy (e.g. steam/hot water, coolant, electricity), but the contractor exerts no or little control over the demand for final energy services (e.g. heating, ventilation lighting). This does not exclude ESC to finance and install secondary conversion equipment as well. However, in these contracts, the ESCO typically has no incentive to reduce energy service demand because it is usually paid by an indexed unit price for delivered energy plus a fix amount for the equipment. Helle (1997) provides an interesting definition of ESC:

> *The characteristics feature of that type of contracting is to be found in its shifting the interface between energy suppliers and energy consumers by one (conversion) stage along the energy chain (primary energy - final energy -useful energy - energy services). While with the traditional energy market structure the interface between energy supplier and energy consumer is placed at the stage of supplying final energy, contracting from the energy supplier's point of view constitutes a forward integration.*

The definition given by Helle (1997) implies that the adoption of ESC by the client consists in some way to outsource useful energy provision to an ESCO. This remark has been used by Sorrell (2007) to relate the decision to opt for ESC to the literature of vertical integration, and more precisely to transaction costs economics. This framework applied to the ESC choice will be reviewed in a following section.

Energy supply contracting in Europe mostly promotes energy efficiency, renewable energy provision or innovative technologies for the delivery of heat (Bleyl (2011)). Primary conversion equipment in these types of contracts often involve technologies such as

heat pumps, biomass heating (pellets or woodchips), or solar (thermal). Usually, the ESCO keeps the ownership of the installation during the contract's duration.

2.2.2 Energy Performance Contracting (EPC)

The basic principle of EPC is that a contractor assesses, develops and finances energy efficiency measures. The contractor guarantees energy savings to the owner and receives in turn a share of the money saved by energy efficiency measures or a fixed fee. EPC differs from ESC in the fact that the contractor does have an influence on the demand for final energy services. By monitoring secondary conversion equipment, the contractor provides its client with a reduction in energy costs in exchange for a fixed fee or part of the savings achieved. Typical measures proposed within EPC are efficient lighting, heating control systems, energy automation systems, and occasionally improved insulation of the building envelope and combined heat and power (CHP) systems (IEA-RETD (2013)). The two dominant EPC models are shared savings and guaranteed savings (Hansen (2006)):

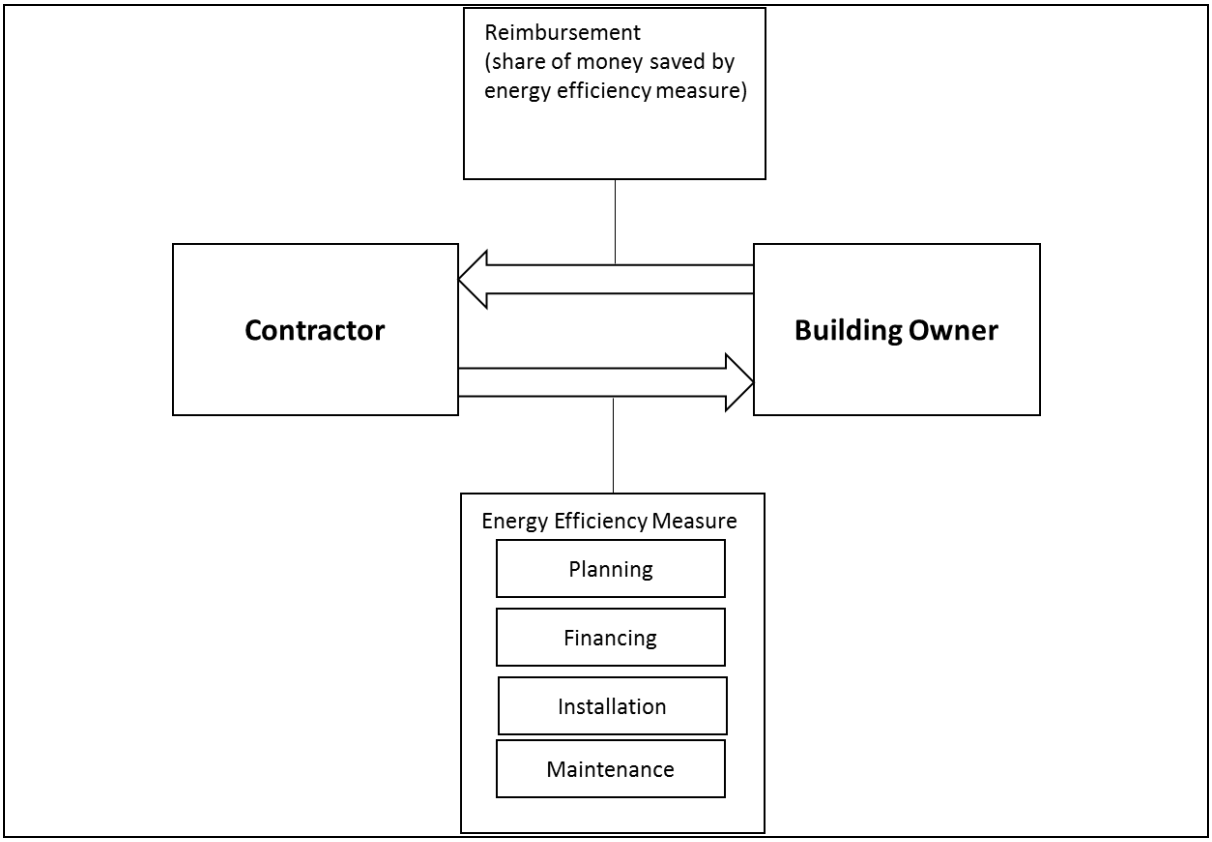
- *Shared savings*: the ESCO typically finances or receives financing by a third party in order to design and implement the project. Energy cost savings are then shared between the two parties.
- *Guaranteed savings*: In this model, the client carries the financing or gets financing by a third party. The ESCO guarantees that the value of energy saved will meet a certain threshold. Otherwise, the ESCO covers the gap. In these types of contracts, the ESCO is typically paid a fixed fee.

The fact that the ESCO is paid or provides guarantees according to the savings achieved obliges the two parties to agree on the way to measure and verify the outcome. As a result, considerable effort is put to determine on one hand energy consumption after the contract's implementation and on the other hand the baseline, i.e. an estimation of the client's consumption if the contract would not have been signed. The transaction costs linked to these measurements imply that these contracts are targeted towards high energy consumers (Bleyl (2011)).

In practice, the EPC models also differ in ownership of energy efficiency technologies and operating responsibilities:

- In the first case, the contractor has full ownership of the equipment and is responsible for maintenance and operation.
- In the second case, the contractor only takes measures to improve the performance of an existing building technology, while the building owner remains the owner and operator of the technology.

Figure 5 summarizes the basic principle of EPC, and more specifically shared-savings contracts.



Source: TEP Energy, based on Hinnen (2014)

Figure 5 Basic principle of shared-savings performance contracting (other, more complex and mixed forms of economic relationship may occur).

Other energy performance contract's schemes exist and can mix the characteristics of shared savings and guaranteed savings. For instance, the *forfaiting* scheme includes an additional actor: an investor. The investor finances partly or completely the installation and gets in return a corresponding predefined fixed amount of the expected savings (either directly from the client, or indirectly from the ESCO). As in the guaranteed-savings scheme, the client also pays a fixed fee to the ESCO which provides in return a guarantee on the energy savings achieved.

Moreover, the methods of financing are flexible and can involve a share of the actions financed by the ESCO while the rest is invested by the client. It is typically the case when some of the measures involve a longer return on investment (e.g. envelope enhancement).

2.2.3 Other contracting models

In practice, it is possible to see more comprehensive contracts that combine characteristics of both ESC and EPC. For instance, EPC can involve the financing of renewable energy technologies, such as solar photovoltaic systems, thermal collectors or heat pumps. Contracts with a full control of the contractor on the whole energy provision (total energy management) also exist. Recently, a new model of contracting that combines energy conservation and renewable has been presented in ESCOs conferences by

Bleyl (2011). The Integrated Energy Contracting (IEC) is an extension of the ESC model in two ways. First, the contract includes a quality assurance for energy efficiency measures that are agreed ex ante by the two parties. These measures can for instance include a one-time thermographic analysis, performance measurement or annual audit with improvement proposals. Second, as opposed to ESC, the ESCO has no incentive to supply more energy in IEC because the variable energy price paid by the client equals the marginal cost for energy faced by the ESCO. A few IEC projects have proven feasibility in Austria. This new business model will be discussed in more details in a subsequent section. IEC can be related to another form of contracting which is called Contract Energy Management and involves the supply of energy services, such as heating or lighting, at a fixed price (Marino et al. (2011)).

3 The interest of energy contracting

This section reviews the literature on the potentials of energy contracting as an instrument to overcome some of the barriers to investments in renewable energy at first, and then in energy efficiency.

3.1 Barriers to investment in renewable energy and the role of energy supply contracting

Investment in the development and production of small scale renewable technologies has been seen earlier in the literature as sub-optimal, due to barriers such as lack of access to capital, information and awareness, and restricted access to technology at a reasonable price (Painuly (2001)).

In particular, many small-scaled renewable technologies for heating and cooling are produced by SMEs that cannot reach the critical level to benefit from economies of scale (IEA-RETD (2013)). Moreover, the uncertainty concerning new technologies may bias consumers' decision towards status quo or may imply that it is rational for consumers to delay investments. In this case, the literature calls this phenomenon irreversibility (Pindyck (1991), Dixit and Pindyck (1994)).

Finally, any reasonable diffusion of renewable energy, let alone a mass-market development, depends also on the success of energy utilities to identify and exploit the potential market niches with a relatively high willingness to invest. However, the interested companies might be unable to identify and target the relevant potential customers. Indeed, although existing research shows positive willingness to pay for green energy (Borchers et al. (2007), among others), empirical evidence suggests that the estimates are highly heterogeneous across individuals and technologies (Borchers et al. (2007), Scarpa and Willis (2010)). As a result, while renewable technologies are significantly valued by the individuals, for the vast majority of them this value is not sufficiently large to cover the capital costs of micro-generation energy technologies without any kind of financial or regulatory support. Levine et al. (2007) estimate that 29% of the CO_2 emissions predicted for 2020 in the business-as-usual scenario could be reduced in a cost-effective manner in residential and commercial sectors.

As we saw in the contracts' classification section, energy supply contracting is typically used by customers to install new equipment that often involves renewable and/or innovative technologies such as co-generation systems (Bleyl (2011)). However, there has been no attempt in the literature to empirically prove that energy supply contracting promotes investments in renewable technologies. Nevertheless, Klinke (2016) compares the structure of heating systems in Switzerland with the heating technologies proposed within these contracts and suggests that such a promotion exist.

The impact of energy performance contracting, on the other hand, has been explored by Okay and Akman (2010) and Fang and Miller (2013), who analyse its influence on CO_2

emissions[12]. First, Okay and Akman (2010) use the ESCO markets' study of Vine (2005) on 38 countries to analyse pairwise correlations between ESCO indicators, such as the age of EPC market, the number of ESCOs and the total value of ESCO projects, and country indicators, such as GDP per capita, CO_2 emissions and energy consumption. They find positive correlations between ESCO indicators and CO_2 emissions and conclude that this suggests that ESCO projects are either not necessarily targeted to emission-reduction or that the market is unsaturated in most countries observed. Then, Fang and Miller (2013) reach an opposite conclusion using a panel of 129 countries from 1980 to 2007. Using a GMM estimation method, they find a negative impact of the existence of ESCO activities on CO_2 emissions that increase over time. The results presented in Fang and Miller (2013) are robust to several control variables, such as GDP per capita, energy intensity, share of industry or population living in urban areas, and thus may be interpreted as more reliable than the results found by Okay and Akman (2010). However, these results may still suffer from endogeneity problems and unobserved heterogeneity across countries.

As a result, there is no reliable empirical proof in the existing literature that energy contracting has a causal negative impact on CO_2 emissions and more precisely, that energy contracting promotes investment in renewable energy. Moreover, if this impact would be found, existing research does not allow to assess empirically through which channels energy contracting may induce investment and what are the relative importance of these mechanisms. This is the case even if many authors have argued that investments in renewable technologies are promoted because energy contracting, and especially ESC, can reduce some of the barriers aforementioned.

For instance, Sorrell (2005) argues that ESC allows the client to transfer some risk to the ESCO, thus reducing uncertainty linked for instance to the technical aspects of new technologies. Also, the customer can concentrate on core activities while finding a way to reduce his lack of technical knowledge or access to capital (Sorrell (2005), Painuly (2001), IEA-RETD (2013)). Indeed, the ESCO which has specialized in the field of renewable technologies has acquired an important know-how concerning the incentive schemes and financial opportunities available, the technologies as well as their characteristics and suppliers (IEA-RETD (2013)). Moreover, the long-term contract and the incentive it creates for the ESCO to maintain equipment performance during the contract implies that ESC is an "instrument to minimize life-or project cycle cost, including the operation phase of the building" (Bleyl (2011), p. 185). As a result, the limited access to innovative and renewable technology at a reasonable price, as stated by Painuly (2001), may actually be overcome by ESC. This opinion is supported by Eikmeier et al. (2009) who explore the advantage of ESC over in-house energy provision, once an old heating system is replaced. Using query of contracting companies and telephone inter-

[12] Vine (2005), Okay and Akman (2010), Fang and Miller (2013) use the general term of ESCOs to refer to companies that are engaged in performance-based projects. Even if they also account for projects involving renewable energy, it is plausible to consider that they refer to EPC rather than ESC in their research.

views with selected market participants, they assume that "contracting enables to counter successive declines of the annual use efficiency over the heater lifetime roughly 4% better on average than in-house solutions". Klinke (2016) shows empirically that the advantages of risk sharing and economies of scale brought by ESC are determining in the client's decision to opt for ESC. Sorrell (2007) and Globerman and Vining (1996) argue also that ESC can reduce significantly technologies' prices since competitive bidding induces the ESCO to minimize production costs. Conversely, when the energy supply is managed in-house, incentives of market competition are not present, unless such incentives are provided by an internal management mechanism (Irrek et al. (2005), Capelo (2011)). As a result, except if an incentive instrument is used in-house to implement energy renewables and maintain performance of equipment over time, ESC is a more efficient tool to guarantee low prices and efficient maintenance. Then, Sorrell (2007) and Globerman and Vining (1996) assert that access to expensive, promising or new technologies can be achievable at reasonable price thanks to the economies of scale that ESCOs experience. Indeed, while they observe that organizations usually lack the scale to implement large energy projects, the ESCOs, through specialization and contracting with multiple clients, can reach significant economies of scale. An example of new technologies implemented via ESC is co-generation systems in France. Indeed, Bertoldi et al. (2006) notice that "CHP and renewable energy projects only got off the ground in France when they were presented within the framework of a full energy service provided by ESCOs".

While citing all these apparent advantages provided by ESC, one has to keep in mind that contract also incurs transaction costs. Indeed, while contracting is expected to reduce overall productions costs as compared to in-house procurement, the overall transaction costs are also expected to increase (Capelo (2011)). Even if this argument has been used by Capelo (2011) about EPC, this also applies to ESC where the client must gather information about the ESCO and the implications of the contract, which comes at a cost (Sorrell (2007)). Klinke (2016) shows that the number of interlocutors in the contract, inducing higher expected adaptation costs, indeed has a negative effect on ESC adoption. Using empirical analysis, she also finds that less specific energy supply contracts, for instance involving residential or new buildings are more likely to be signed. As a result, it is important to note here that the extent to which contracting can effectively induce investment will depend on the trade-off between transaction costs incurred by the contract and decreased production costs. But this statement will be further discussed in section 5.1.

Finally, no author has argued that ESCOs are more effective than conventional energy providers to target and reach customers with high willingness to pay for renewable energy. However, the apparent success of the ESC markets in Europe to supply cost-effective projects with innovative and renewable technologies (see for instance Bleyl (2011), Klinke (2016) and literature on current market in next section) suggests that the ESCOs attracted a significant part of the individual interested in investing in these technologies, offering them a way to reduce transaction costs related to these invest-

ments. Sorrell (2005) emphasizes however that the contribution of contracting to low-carbon economy may be limited by the inappropriateness of ESC in some cases, such as small sites or process-specific energy uses.

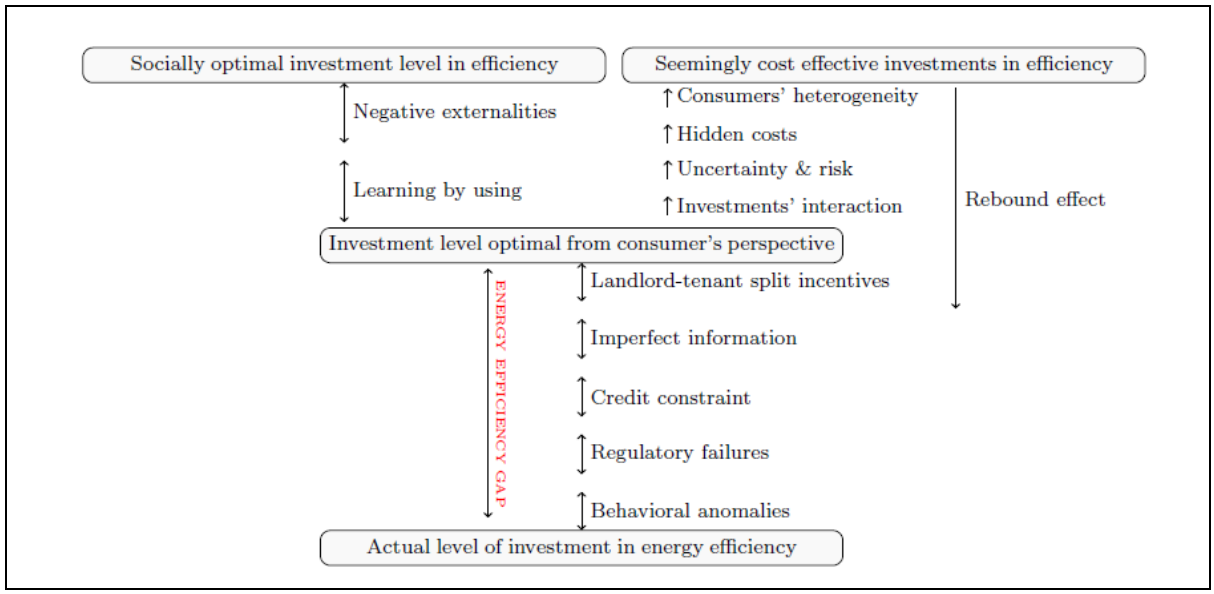
To summarize, even if existing literature suggests that there may be several channels through which energy contracting may support and induce investment in innovative and renewable technologies, there is hardly any empirical attempt to support these conjectures. Then, if we could empirically explore the relative importance of the mechanisms through which investment is induced, if any, then it would permit to propose contracting options that focus primarily on these important features, and develop further the ESC market and attracting more customers who invest in promising technologies. Finally, it is important to note that even if the ESC market may have developed renewable equipment, it does not focus on useful energy saving measures (Helle (1997)). Yet, the potential role of energy contracting would be importantly diminished by focusing only on supply without considering its potential impact to reduce energy demand. Indeed, without involving energy demand mitigation, ESC does not fully exploit the potential for energy efficiency improvement and CO_2 emissions abatement (IEA-RETD (2013)). This is the reason why it is important to review the potential role of EPC in contracting the energy efficiency gap.

3.2 The energy efficiency gap

In order to understand how EPC may have a role to play in contracting the energy efficiency gap, it is important to review the literature and the concepts underlying this paradox. Experts' interest in energy efficiency investments started with Hausman (1979) who explored the trade-off between capital costs for energy-using durables and their expected operating costs and found an implied discount rate of about 20%. The fact that this result is well above the rates at which most individuals borrowed or invested money suggests that consumers fail to make seemingly positive net present value energy saving investments. This observation has given rise to an important literature (See Gillingham and Palmer (2013)). The causes and the size of the energy efficiency gap have been highly debated in the literature and the difficulty to explain this phenomenon has led the authors to label it the energy efficiency paradox (Jaffe and Stavins (1994)). The primary difficulty lies in the fact that the gap may take different definitions across studies. Engineering studies typically compare the amount of energy efficiency investments presenting positive net present values with the current level of investments (See for instance EPRI (2009), McKinsey and Company (2009)). On the other hand, economists define the gap as the difference between what is optimal from the consumer's perspective and what is actually invested (Gillingham and Palmer (2013)). It is important to note that, even if the consumer's optimal level of investment may still be

lower than the socially optimal outcome (mainly due to externalities), this divergence is usually not taken into account when assessing the energy efficiency gap[13].

Figure 6 provides an illustration of the concepts that are reviewed in Gillingham and Palmer (2013).



Source: S. Klinke, based on the concepts in Gillingham and Palmer (2013)

Figure 6 The causes of the energy efficiency gap

A synthesis of the different causes explaining the gap will be provided first and then a review on how existing research attempted to measure its size will be presented.

The market failures that explain the energy efficiency gap can be organized in 5 categories visible on the figure.

- First, the level of investment may be suboptimal because the person who owns the building and the energy appliances and the person who uses them and pays for the energy use are not the same. **Split incentives** may arise from this situation because the up-front costs are not paid by the same person who benefits from lower energy costs (IEA-RETD (2013)). Both theoretical models and empirical evidence show that this can result in under-investment in energy efficiency[14]. Split incentives can occur between landlords and tenants and within firms. The land-

[13] Gillingham and Palmer (2013) and Jaffe and Stavins (1994) include into the energy efficiency gap the concept of "learning by using", i.e. the positive externality created by the adoption of a new technology that informs other potential investors. However, here it has not been included to keep consistency of the definition of the energy efficiency gap, i.e. the difference between the actual investment and the optimal level of investment from the consumer's perspective. And this is the case, even though negative externalities represent market failures that call for government action.

[14] See Murtishaw and Sathaye (2006) and Davis (2010) for empirical evidence and the appendix of Gillingham et al. (2012) for a formal explanation.

lord-tenants split incentives may be of particular importance in the Swiss context where only 36.8% of the dwellings were inhabited by their owners in 2010 (OFS (2013)). Within firms, split incentives may arise when the department which is in charge of investing in building technologies and the department who has to pay for the energy costs are separated and also have separate financial accounting. This leads to a similar situation and may hinder investment in energy efficiency.

- Second, **asymmetric information** between the sellers of energy efficient equipment and the energy consumers concerning the potential energy savings has been recognized as an important barrier to invest in energy efficiency (Tietenberg (2009), Gillingham and Palmer (2013)). And this is particularly true for innovative equipment where the investor cannot observe the performance. Also, energy consumers may be unaware of the potential investments or perhaps getting informed about the differences in quality of these investments may be too costly or time consuming (Allcott and Greenstone (2012), Sorrell et al. (2004)).
- Gillingham and Palmer (2013) also cite limited **access to capital** as another market failure characterizing investments in energy efficiency, where high up-front costs may discourage potential investors. This barrier, as well as asymmetric information, is also present in the case of investments in renewable technology. However, the extent to which it binds the investor may be larger in the case of energy efficiency. Indeed, while the renewable technology installation can represent a capital guarantee for the debt incurred, in the case of an energy efficiency investment the guarantees can only rely upon uncertain future energy cost savings (Hansen (2006)). This can result in higher interest rates hampering consumers to invest. Moreover, investors may be insufficiently informed about the financing options or subsidies available when making their decisions (IEA-RETD (2013)).
- **Regulatory failures** may not be an important contributor to the energy efficiency gap, but it is still important to mention it. Divergences between electricity prices and marginal costs, resulting from economic regulation of electricity markets, may distort incentives to invest in energy efficiency and increase the gap when the price falls below marginal cost (Gillingham and Palmer (2013)). However, this effect may be only temporary since prices can also rise above the marginal cost, creating positive incentives to invest. Jaffe and Stavins (1994) argue that these potential distortions do not relate to the paradox, since regulatory failures do not help explain non-adoption at current prices.
- Finally, **behavioural anomalies**, where consumers do not act according to the standard assumptions underlying the neoclassical economic theory, have inspired a new and interesting body of literature to explain the energy efficiency gap[15]. Gillingham and Palmer (2013) categorize these anomalies as follows: nonstandard preferences, nonstandard beliefs and nonstandard decision-making.

[15] See for instance Tietenberg (2009), Gillingham et al. (2009), Allcott and Wozny (2012).

Nonstandard preferences refer to self-control problems, where individuals can decide to act differently when the outcome is in the distant future but change their decision once the future nears. Individuals may take the decision to invest in energy efficiency, but never fully accomplish it. Another kind of nonstandard preferences that may play a role in the energy efficiency gap is the loss aversion (Kahneman et al. (1991)) and refers to the fact that the utility of an individual may decline relatively more when experiencing a loss than its increase when facing an equivalent gain. In this case, consumers who are uncertain about future energy savings, might give relatively more importance to the bad outcomes when deciding to opt for energy efficient technologies. This argument has been used by Greene et al. (2009) in the context of energy efficient vehicles adoption, though they do not provide empirical evidence of this phenomenon. The extent to which these nonstandard preferences should be included in the energy efficiency gap may however be discussed. If we use the definition of the gap from Gillingham and Palmer (2013), i.e. the difference between the level of investment that is optimal from the consumer's perspective and the current amount of investments, nonstandard preferences do not explain the paradox. Indeed, even if these preferences may lead to non-adoption, these individuals are still optimizing their nonstandard utility function and thus act as rational consumers. In other words, this does not represent a market failure. On the other hand, the two other kinds of behavioural anomalies that are non-standard beliefs and nonstandard decision making may represent market failures, and can be important explanations of the gap. Nonstandard beliefs refer to the fact that there may be a systematic bias in the beliefs of the individuals about future energy cost savings. That is, they tend to systematically undervalue discounted future energy costs as compared to the purchase price they face in the present. Allcott and Wozny (2012) use a dataset of vehicle transactions and find that the purchase prices reveal a consumers' indifference between one dollar in discounted future fuel costs and 76 cents in vehicle purchase. These results are sensitive to changes in discount rates and thus fail to conclude to a systematic bias. They nevertheless provide interesting insights by showing that this distortion may exist and play a role in the energy efficiency gap, though the size of its impact would need further research, especially when applied to other equipment such as lighting, cooling or heating systems.

Finally, nonstandard decision-making invokes limited attention that pushes individuals to simplify the decision by focusing only on certain attributes when making a choice or to stick to familiar or salient options (Hossain and Morgan (2006)). Sensitivity to the framing of choices, whereby the presentation of choices can affect significantly the decision (Duflo et al. (2005)), are also cited as important drivers (Gillingham and Palmer (2013)). Knowing the existence of these behavioural anomalies in the case of energy efficiency may be of particular importance because it can explain why policy instruments such as information campaigns may be insufficient to induce investment (Tietenberg (2009)).

While it has been argued in the literature that all these preceding causes are playing a significant role in the energy efficiency gap, there has been hardly any attempt to compare the sizes of their impact on the sub-optimal investment. Concerning split incentives issues, the comparison of the situation of rented buildings with the first best, i.e. those

where the owners lives and pays the bill, allowed to estimate quite easily their magnitude (Murtishaw and Sathaye (2006), Davis (2010)). Murtishaw and Sathaye (2006) attempted to quantify the size of the split incentives by comparing the average amount of energy used in households potentially affected by split incentives with those where the owner lives and pays the energy bill. They provide measures for refrigerators, water heaters, space heating and lighting. Their measures also include the cases where principal agent problems may arise due to the fact that the bill is not directly linked to the energy used (fixed price for energy or meter serving multiple housing units sharing the costs of the total energy consumed in the building). Although these principal agent issues may lead to higher energy consumption, these are not directly linked to investment in energy efficient equipment. While providing interesting insights about the size of this market failure, one has to keep in mind that these measures represent rough estimates since they are based on averages where individual characteristics were not controlled for. Indeed, even if tenants could choose their energy appliances, possible differences in preferences could lead them to invest less (respectively more) in energy efficiency than owners.

Because empirically assessing the impact's magnitude of lack of information and credit or behavioural anomalies is difficult or even impossible to do, the size of the gap remains unclear and the relative importance of its causes is unknown.

This is the case even if engineering and observational studies have attempted to measure this gap by typically comparing the present discounted value of future energy savings with the upfront costs entailed by the investment in energy efficient durables. For instance, EPRI (2009) and McKinsey and Company (2009) find a gap between the amount of investments that would be seemingly cost effective and the level of investments that are actually undertaken. WBCSD (2009) estimate a total potential of US$ 150 billion energy efficiency investments in buildings in the US, Japan, Europe, Brazil, China and India, with five-year discounted paybacks and which would decrease the carbon footprint by 40%. Nevertheless, the estimates of the gap's size found in engineering studies may be overestimated because they fail to account for the relevant costs underlying individuals' decision-making (Allcott and Greenstone (2012)). In other words, the amount of investments that is seemingly cost effective does not necessarily correspond to the optimal level of investments from the consumers' perspective (see Figure 6). The difference between engineering measures and the gap considered by the economists is explained by the following reasons:

- First, the **heterogeneity across energy consumers** may imply that the net present value of an investment may be positive for the average consumer, but negative for a majority of individuals (Jaffe and Stavins (1994), Allcott and Greenstone (2012)).
- Second, the mentioned studies fail to account for **hidden costs**, such as the discomfort linked to some technologies or the opportunity costs, which represent the return of any alternative investment that the consumer forgo when investing in energy efficiency. These opportunity costs may be particularly important for firms

where the part of energy in production costs often represents a small share of 2-5%, implying that investments on the production process are well more interesting than energy efficiency (Hansen (2006)). Uncertainty about future energy prices and risk due to the irreversibility of the investment may also imply that it is rational for consumers to delay their investments in energy efficiency (Dixit and Pindyck (1994)) and thus lead to an overestimation of the energy efficiency gap in engineering studies.

- Finally, the estimations do not account for possible **interactions between technologies** if implemented together and often "assume perfect installation and maintenance" (Gillingham and Palmer (2013)). But we saw in the last section that maintenance can have a significant impact since contracting, by improving maintenance, can increase the energy use efficiency of an installation of about 4% (Eikmeier et al. (2009)). Moreover, the coordination of the different actors involved in energy efficiency projects, such as architects, construction workers and installers, project developer, is very important as well to guarantee an optimization of the system as a whole (Levine et al. (2007), WBCSD (2009)) and may imply significant transaction costs that are not included in these estimates.

In conclusion, all these elements that are not accounted for in engineering research may lead to an overestimation of the energy efficiency gap. Hence, the extent to which engineering estimates of the gap are misleading depend on the size of these aforementioned elements. On the other hand, the gap may also be somehow underestimated, because these studies usually do not account for possible rebound effects either, where wealth effects following the implementation of energy-efficient installations lead the individuals to consume more, thus reducing expected energy savings[16].

3.3 Energy performance contracting and the energy efficiency gap

What are the market failures that are most likely to be reduced through EPC? As in the case of renewable energy, authors have argued that contracting can be a promising tool to reduce the energy efficiency gap because the client can share some of the risks, reduce his lack of technical knowledge or access to capital, benefit from economies of scale, market competition and incentives from the ESCO to maintain performance through time (Globerman and Vining (1996), Painuly (2001), Sorrell (2005), Sorrell (2007), Capelo (2011), IEA-RETD (2013)). However, these studies usually rely solely on the observation of contracts' design to support these arguments and do not use empirics to prove their conjectures. The following sections review the causes of the energy efficiency gap and the potential role of EPC to reduce them. Regulatory failures, such as divergences between the price and the marginal cost are not considered here since its presence as a cause of the gap is disputed (Jaffe and Stavins (1994)).

[16] See for instance Sorrell and Dimitropoulos (2008) for more details on the rebound effect.

3.3.1 Credit constraint

It can easily be argued that EPC schemes where the ESCO finances the efficiency measures implemented, in the case of shared savings contracts for instance, can significantly facilitate access to capital for building owners or managers willing to implement energy efficiency actions. Nevertheless, the problem may not be solved as easily since ESCOs may also have trouble to finance the projects, especially in emerging ESCO markets where financial institutions are not aware of this type of business and stay cautious because the expected return is entirely based on uncertain future energy savings (Hansen (2006), Kostka and Shin (2011)). Access to capital has also proven to be limited for ESCOs even in mature contracting markets during the last economic crisis. In fact, Marino et al. (2011) show that the economic downturn has restricted access of European ESCOs to loans, or at higher interest rates and that financial institutions are still prudent with credits based on future streams of cash-flows (vs. based on asset). After the crisis, financing ESCO market still remains as a barrier in both emerging and developed ESCO markets (Nolden and Sorrell (2016), Panev et al. (2014)). As a result, the argument that EPC reduces credit constraints may be challenged if the problem is simply transferred to the ESCO. Yet, IEA-RETD (2013) argues that even if ESCOs may also be constrained in terms of access to capital, they may still take the role of facilitator to help the investor to find third party financing solutions. This is the case in the "forfaiting" EPC scheme, in which the ESCO sells the debt claim to a bank or an investor and therefore does not need internal financing (swissesco (2016)).

Finally, a recent study by Li et al. (2014), empirically explores the impact of various factors on the contract terms and the resulted energy savings, based on a sample of 140 EPC projects implemented in China. This is the first study, to our knowledge, that uses micro-econometrics to analyse energy contracting. Their most important finding is that ESCO's and clients' registered capitals have significant positive impact on total investment and hence, on energy savings. They explain this by the fact that "larger registered capital size implies lower risk-adjusted capital cost" and thus their finding is empirical evidence that lower cost of capital is an important determinant for the success of EPC projects. They also find that ESCOs typically relieve partly the clients from their financing need. Indeed, they find that "client's registered capital has a slightly smaller impact than ESCO" because the ESCOs usually bear 100% of the investment costs. While providing useful insights, these results do not permit to determine whether the ESCOs have a facilitated access to capital as compared to individual investors and hence, whether it induces investment through mitigating credit constraint. Further research is thus needed in this context and the answer probably depends largely on the financial and institutional context of the market as well as the characteristics of the client.

3.3.2 Imperfect information

EPC is designed to give both the ESCO and the customer the incentive to reduce energy costs. Because the client shares the risk about future energy savings with the ESCO,

information asymmetry is expected to be reduced. However, it may still be present since the client does ex ante observe neither the technical knowledge of the ESCO nor the technical specificities of the measures implemented. The complexity brought by the contract as well as the measures and verifications of the savings achieved also increases asymmetry of information since the client may get less advice than the ESCO. These arguments are supported by Limaye and Limaye (2011), Kostka and Shin (2011) who use ESCOs interviews and Backlund and Eidenskog (2013) who relies on clients' interviews, to show that trust has an important role to play in ESCO markets. Klinke (2016) also shows in the context of energy supply contracting that trust in both technology and the ESCOs are important determinants to sign a contract. Nevertheless, it is also important to note that asymmetry of information could also go in the opposite direction because the ESCO is not fully aware of the consumption behaviour of the client. This is why the ESCOs typically measures with precision the consumer's behaviour before and after the contract's implementation using a standardized method called the International Performance Measurement and Verification Protocol (IPMVP) in order to evaluate energy savings[17].

Despite the standardization that makes these measurements simpler for the ESCO and credible for the clients, these measurements and verifications may increase significantly transaction costs (Bleyl (2011)) as well as reticence from the client to share information (especially in the case of firms with confidential production processes). The ESCO actors, aware of these remaining information asymmetry issues, have tried to involve a third party in the bidding processes of EPC which is called a facilitator and serves as an intermediary between the client and the ESCO and consult on behalf of the client. Bleyl et al. (2012) argues that this new actor has been proven to play a significant role to foster projects implementations, as well as ESCOs competition. The recent publication of Nolden et al (2016) shows similar findings and concludes that the use of intermediaries is a viable and attractive approach to mitigate asymmetry of information and therefore unlock cost-effective energy efficiency improvements through various channels. For instance, intermediates:

- Benefit from legal, contractual and technical expertise to act in the client's interest
- Can facilitate the comparisons of the ESCOs offers which may be presented differently and include technical jargon
- Advise the client on the quality of the contractors, which they know

Interestingly, Polzin et al. (2016) show that having such an intermediary decrease the willingness to consider EPC and increase the clients' confidence resulting in self-investments in energy efficiency. It therefore suggests that facilitators may actually work as a substitute to EPC in fostering energy efficiency investments.

[17] See EVO (2012) for more details on this and Hui-Jiun (2010) for specific examples and application of this method.

While these studies provide interesting insights about the role of facilitators, further research needs to be done in order to assess whether asymmetry of information can be sufficiently reduced via EPC in order to contract the energy efficiency gap. Recent research from Polzin et al. (2016) show econometrically that municipalities underestimate risks associated with street lighting LEDs retrofits and therefore do not value the risk-sharing advantage of EPC. While this result may be specific to the LED technology which may not be perceived as risky, studies in this field of research should be expected in the following years and hopefully provide more evidence on the matter.

3.3.3 Split incentives

There has been no attempt in the literature to determine whether and how EPC could reduce split incentives. Nevertheless, Klinke (2016) shows that having tenants is an important barrier to ESC adoption, and suggests that the legal framework should be clarified. In the case of EPC as well, it seems that rental legislation must be clarified on the extent to which owners can transfer the costs onto the tenants, and that the ESCOs cannot alone overcome the split incentive barrier (IEA-RETD (2013)). One could however argue that the ESCO, or even the facilitator, may help the tenants or the departments within a firm to coordinate in the case they were interested in investing in energy efficiency. The ESCO can also assist potentially interested owners in the legal process to redirect the costs of energy efficiency investments onto the tenants. The reality shows however that ESCOs are also struggling to break into the rented buildings market. In the UK (Nolden and Sorrell (2016)) as well as in the mature US and Canadian ESCO markets (Panev et al. (2014)), commercial centres and commercial office centres represent untapped potentials because of the tenants they involve. While standard EPC therefore does not seem to solve split incentives issues, EPC with slightly different payment schemes may be more useful. Nolden and Sorrell (2016) provide a list of these schemes, such as on-bill financing, where repayments are typically tight to the property and not the owner or the tenant. However, because these schemes always involve to repay the capital via electricity bill or increased rent, they may not be suitable in the Swiss legal framework[18].

3.3.4 Behavioural anomalies

Finally, since behavioural anomalies have been cited only recently in the energy efficiency gap literature, to my knowledge no research has yet explored the impact of EPC in this area. However, the market actors seem aware about these: "We want to acknowledge the fact and raise awareness among Facilitators and other stakeholders, that the identified needs for change require approaches beyond economic rationale based on a *homo oeconomicus* concept or environmental awareness. Instead psycholog-

[18] The law explicitly mentions that the variable charges paid by a tenant cannot include retrofits capital costs repayment (except in the case of district heating). Moreover, transferring 100% of the capital costs of a retrofit onto the payment via an increased rent is in practice not possible.

ical and organizational change processes need to be put on the agenda, even though this may be new territory for most energy efficiency professionals." (Bleyl et al. (2012)).

3.3.5 Other empirical evidence on the role of EPC to reduce the gap

Soroye and Nilsson (2010) attempted to explore empirically the extent to which EPC can address the energy efficiency gap with the aim to "understand the managerial and other challenges for ESCOs in transforming this efficiency gap into a viable business" (Soroye and Nilsson (2010), p. 237). In order to do so, they interviewed Swedish ESCOs to assess the firms' business strategies, business characteristics and service functions in Sweden. However, the authors rapidly notice that access to information about projects and energy savings, in Sweden and abroad, are very limited. This issue has also been raised by Mathew et al. (2005) who observe that data collection is a specific issue in both ESC and EPC markets.

- First, ESCOs not always document their project and have no standardization in the way they archive them so data collection becomes complicated and time consuming.
- Second, and this is the main problem, many ESCOs do not share the data from their projects for competitive reasons.

Yet, Soroye and Nilsson (2010) managed to collect some data on EPC projects implemented in the public sector in Sweden since 2000 and find that these contracts have led to 22% energy saving for heating and hot water. Moreover, they observe that ESCOs helped to increase the awareness of firms about the usefulness of energy efficiency although this could not be precisely measured.

A few other studies explored and tried to measure the impact of EPC on energy consumption:

- First, we can cite again Okay and Akman (2010) who explore pairwise correlations between ESCO and country indicators in 38 countries and find that the volume and maturity of the EPC market is positively related with energy consumption. They conclude that this can come either from ineffectiveness or non-saturation of the EPC market. But one could also interpret this result by the fact that countries with higher energy use have a greater need for EPC solutions.
- Fang et al. (2012) reach an opposite conclusion by using a GMM method in a panel data of 94 countries over the period 1981 to 2007, and find that the existence of the EPC market has a negative impact on energy use and that this effect increases over time. However, these results may suffer from endogeneity and/or unobserved heterogeneity across countries.
- Goldman et al. (2012) provide interesting insights about the estimated amount of energy saved in the US thanks to energy performance contracting. Based on a sample of 2484 projects implemented in US from 1990-2008, which they assume to be a representative 20% of overall US EPC activity during this period of time,

they evaluate that EPC generated a net direct economic benefit to their clients of $23 billion[19].

While these studies provide a comprehensive understanding about the potential size of energy savings induced by EPC, these do not inform about the mechanisms through which these savings were achieved. Indeed, it is possible that EPC simply facilitated the tasks of customers who would have invested anyway and as such, cannot be considered as a complete solution for the energy efficiency gap. In fact, as we will see in the next chapter, in the EU as in the US, EPC is practically limited to the public sector[20] and energy efficiency investments in this sector could be due to regulations forcing public entities to implement energy policy goals (Bleyl (2011)). Moreover, Goldman et al. (2012) find that many public institutions use EPC to recover their delay in terms of building maintenance or retrofit needs, such as Asbestos removal, where the measures generate little or no energy-related savings. Finally, the fact that EPC projects must be repaid in totality by future energy cost savings limits their implementation to buildings with substantial energy savings potentials. This could exclude many small but numerous energy consumers thus challenging the perception of EPC as an efficient instrument to reduce the gap (Bleyl (2011)).

To conclude, further empirical research is needed to determine whether energy contracting, being ESC or EPC, can induce private investments and if so through which channels. While many authors have argued that these business models are in fact promising tools to mitigate barriers to renewable technologies and to reduce the energy efficiency gap, the question now is whether these potentials are exploited in the current ESCO markets. This point will be discussed in the next chapter.

[19] A total of $4 billion direct benefit has been measured for the projects from the sample.

[20] Surprisingly, this may not be true in the emerging Swiss EPC market.

4 The current state of energy contracting markets

In order to determine whether the potential role of energy contracting is exploited in reducing barriers to both renewable and energy efficiency, it is important to review the situation of the ESCO markets in different countries. A summary will be drawn, concerning foreign and Swiss markets. The common trends will then be reviewed and based on these findings the ideas of the authors evoking an energy service gap will be developed.

4.1 Foreign ESCO markets[21]

An important part of the relevant literature consists in assessing the evolution and the size of the ESCO markets around the world (see for instance Vine (2005), Goldman et al. (2005), ICF (2007), Painuly et al. (2003), Lee et al. (2003), Bertoldi et al. (2006), Marino et al. (2010), Marino et al. (2011), Xu et al. (2011), Goldman et al. (2012), Fang et al. (2012), Panev et al. (2014), Stuart et al. (2016), Nolden and Sorrell (2016)).

According to Fang et al. (2012) and Panev et al. (2014), the US holds nowadays the most mature EPC market. The US private industry has been developing since the 1970s as a response to the oil shocks and was mostly based on the shared-savings model (Langlois and Hansen (2012)). In the mid-1980s, the beginnings of the market activities were perturbed by decreases in energy prices which extended the payback beyond contracts' duration and put the shared-savings model together with the ESCOs in financial trouble. At the same time, the reputation of Time Energy, one of the US ESCO pioneers, was damaged in the press by the accusation of being interested in the market primarily to benefit from tax credits. However, the remaining ESCOs managed to revive the market thanks to the guaranteed-savings scheme (Hansen (2006)). As a result, the market experienced a strong growth during the 1990s, with revenues growing at an annual rate of 25 % on average (Singer and Lockhart (2002), Langlois and Hansen (2012)). In the 90s, the evolution of the market in the US was going along with an increased confidence of the consumers in the performance of ESCOs to guarantee energy savings thanks to their growing positive reputation (Goldman et al. (2005)). Based on a survey of firms and an analysis of approximately 1500 EPC projects conducted in the ends of the 1990s, Goldman et al. (2005) predicted a growing evolution of the ESCO market in the US, mainly due to an increase in concerns about energy supply security, energy prices and environmental problems, as well as a "trend toward outsourcing non-core business activities" (Goldman et al. (2005), p. 32). However, these more long-term trend develop-

[21] This entire body of literature cited in this subsection uses the term of ESCO to refer to the companies offering specifically Energy Performance Contracting. They all define an ESCO as a company providing performance and savings guarantees through a contract with a payment scheme that depends on the energy savings achieved. In that sense, they use a restricted definition of ESCO than the one used by Sorrell (2005) and in this report.

ments were slowed down between 2002 and 2004 by the following factors, described by ICF (2007):

- Firstly, the collapse of Enron Energy Services, which used to be a major energy company, affected once again the trust of customers in ESCOs.
- Secondly, the deregulation of the electric utility industry has been implemented with hesitations which induced a lot of uncertainty for the ESCOs. This went against the general expectation that deregulation would actually boost the ESCO market (Marino et al. (2011)). Actually, the Californian electricity sector experienced a crisis following its deregulation in 2000-2001, which made the other states reconsidering the implementation of electricity market restructuring. This induced the energy service companies to reconsider partly or completely their business strategy.

But the slowdown from 2002 to 2004 was only brief and the ESCO market recovered by a growth rate of 20 % per year in 2007 (ICF (2007)). It is interesting to note that the deregulation implied a change in the type of ESCOs, moving from utility companies towards manufacturers. Then, the economic downturn weakened once again the growth of the US ESCO market, which was estimated at 7 % per year from 2006 to 2008 (Goldman et al. (2012)). As in other countries, this slow-down was mostly due to tightened access to loans, higher interest rates and the needs for stronger guarantees (Marino et al. (2011)). Finally, US ESCOs' aggregate revenues are estimated around $4.1billion in 2008, and Goldman et al. (2012) estimates an annual growth rate of 26 % for the 2009-2011 period to reach around $5 billion in 2011 (Gilligan (2011)). In a more recent report, Stuart et al. (2016) shows that the US ESCO industry revenues have been stagnating between 2011 and 2014. Interestingly, Stuart et al. (2016) also demonstrate that US ESCOs have tried to diversify and are now often proposing non-energy benefits within EPC. These benefits, such as water conservation, tradeable emission credits, avoided operation and maintenance, avoided capital costs, are transformed in dollar value and incorporated into the guaranteed or the shared savings schemes.

Even though the US ESCO market is the largest around the world, the initial Energy Contracting concept started in Western Europe more than 100 years ago (Hansen (2006), Bertoldi et al. (2006), Adnot et al. (2002)). However, it only re-emerged significantly in the European Union in the 1980s. In 2000, the estimation of the EPC market size in Western Europe was around 150 million Euros per annum (Bertoldi et al. (2003)). Bertoldi et al. (2006) present the results of a survey conducted in the EU-25 countries and Romania and Bulgaria in the period 2003 to 2004 and show that there were important differences among the situation and evolution of the markets across countries.

With 250 ESCOs and an estimated turnover of 1.2 billion Euros in 2009, Germany is the leading market in Europe (Eikmeier et al. (2009)). In 2000, Austria, the UK, Spain and Hungary were also holding EPC markets of considerable size (Bertoldi et al. (2006)), although precise numbers about the market size are not provided in the literature. These countries were then followed by France, which had a rather well developed mar-

ket but largely dominated by a few companies (Bertoldi et al. (2006)). Sweden, Czech Republic and Italy were following this ranking, with ESCO activities also developed. This ranking, provided by Bertoldi et al. (2006) was also supported by Sidler (2004) and Vine (2005). In a more recent review of the EU ESCO market, Marino et al. (2010) showed a slightly different picture where Germany was followed by Italy and France in 2010. In 2013, a similar ranking is drawn in Bertoldi et al. (2014). This is due to a strong market growth between 2007 and 2010 in Italy, France, Denmark, Sweden, Romania and Spain while Austria, the UK and Norway were experiencing a decreasing growth rate. The general trend in European countries shows a stagnation or a slow growth for the 2010-2013 period (Bertoldi et al. (2014)), despite an increasing awareness towards energy efficiency measures and favourable legislative framework (Fang et al. (2012)). Exceptions are France, Spain, Denmark and Ireland which experienced a strong growth in the same period. In 2013, the ESCO markets are still emerging or inexistent in a majority of countries[22] (Bertoldi et al. (2014)), suggesting that the situation may significantly evolve in the EU in the next years (Bertoldi and Boza-Kiss (2007)). In all these countries, ESC accounts for a major share of the revenues as compared to EPC (Bertoldi et al. (2014), Nolden and Sorrell (2016)).

In the 1990s, the ESCOs have also spread to developing countries, where the largest ESCO industry in terms of total investment is established in China (Fang et al. (2012), Ellis (2010)). In the latter energy performance contracting investments increased by more than 25 % from 2005 to 2010 (Langlois and Hansen (2012)). In 2015, China is estimated to account for 55% of worldwide ESCO revenues (IEA (2016)). Qin et al. (2017) note: "the EPC industry is now travelling on a virtual express way in China and is likely to continue its growth momentum in the foreseeable future".

Other interesting studies provide information about the development of ESCO markets in other countries, such as Turkey (Akman et al. (2013)), Russia (Efremov (2004), Garbuzova and Madlener (2012)), Korea (Lee et al. (2003)), Ukraine and Czech Republic (Evans (2000)) and other non-European countries (Panev et al. (2013)).

4.2 The Swiss energy contracting market

In Switzerland, detailed statistics on the energy contracting market are not available. The available data suggest a slow growth, due to lacking in-house expertise, limited flexibility for the industry, and financing barriers for small contractors (Marino et al. (2010), Bertoldi et al. (2014)). In 1999, the Swiss Federal Office of Energy (SFOE) estimated the Energy Supply Contracting (ESC) market at 170 million Euros/year (Bun-

[22] Exceptions are Germany, France, Austria, Czech Republic, Denmark, Finland, Italy and UK, which show either moderate or good development of the ESCO market.

desamt für Energie (1999)). This number has reached 350 million Euros in 2009, according to Swiss Contracting[23].

Since 2000, interest for ESC increased, especially in central and North-western Switzerland. ESC has been experiencing a boom since 2002 which is partly due to the liberalization of electricity provision that has been in effect since 2009 for large energy consumers, and planned for all energy consumers[24] (Brunner (2009)). This change in legislation forced electricity suppliers to become ESCOs as well and more actors are planning to enter the market soon. For instance, BKW plans to invest CHF 1 billion in the next five to six years towards energy services[25]. Alpiq considers supplying energy services in order to get closer to its clients and to provide decentralized energy provisions[26] and finally other actors, such as Repower and Hotelleriesuisse are jointly developing energy services[27]. However, these observations concern only the ESC market, because Swiss energy contracting companies are mostly active in ESC. The energy performance contracting market, on the other hand, is still small and undeveloped with only a few ESCOs active and consequently only a few contracts per year signed. These projects encompass improvement of heating ventilation and air-conditioning (HVAC), lighting, pumps, automation, motors and inverters, with a relative dominance for industrial and non-residential buildings (Bertoldi et al. (2014)). Interestingly, as opposed to other markets, EPC in Switzerland so far has been rather implemented with private clients.

Although interest from the supply-side for EPC exists, the concept is rather unknown among consumers[28]. The first call for tender applied to EPC has been published in 2016. The apparent delay of the Swiss EPC market as compared to other European ESCO market is not explained in the literature.

[23]Association that listed 76 energy contractors in 2010 which include local energy producers and distributors with some of them providing ESC. An estimation is that around 7-10 companies (mainly local energy utilities) have carried out energy contracting projects (Bertoldi et al. 2014).

[24] Since 2009, the largest energy consumers, with a consumption exceeding 100'000 kWh per year, have the possibility to choose their electricity supplier. The electricity-market liberalization is planned to be extended to small energy consumers in 2018 (BFE 2014).

[25] "Die BKW hat sich entschieden, ihre Zukunft selbst in die Hand zu nehmen und richtet sich aufgrund des fundamentalen Wandels in der Energiebranche neu aus. Ziel sei es, in fünf bis sechs Jahren 1 Mrd. Fr. Umsatz durch Dienstleistungen zu generieren.", Suzanne Thoma, BKW Chief, at the "Bilanzmedienkonferenz" on 03.26.14, awp

[26] "Wir bewegen uns näher hin zum Kunden und werden Energiedienstleistungen und Energiemanagement anbieten -etwa, um die zunehmend dezentrale Energieproduktion zu optimieren", Jasmin Staiblin, Alpiq Chief, in an interview in "Sonntagszeitung" on 02.16.14

[27] "Repower und Hotelleriesuisse Graubünden entwickeln gemeinsam Energiedienstleistungen", Newsticker NZZ, 01.28.2014

[28] According to Jean-Marc Zgraggen, EPC-expert of SIG, one of the few ESCOs offering EPC in Switzerland.

4.3 General trends in the ESCO markets

As aforementioned, literature on the evolution of ESCO markets is abundant. But reliable numbers about the size of national or European market data are not available (Bleyl (2011)), including the case in Switzerland. However, the literature is reliable enough to determine some general trends and conclusions that are common to most ESCO markets:

- Evidence shows that **ESC projects dominate significantly the markets, as compared to EPC**. In Germany, a comprehensive market study provided by Prognos AG found that two thirds of the ESCOs were making more than 80% of their turnover with ESC (Eikmeier et al. (2009), Bleyl (2011)). In Italy, the market is dominated as well by ESC (Bertoldi et al. (2006)). In Europe, the market share of EPC is estimated between 10 to 14% (Bleyl (2011), IEA-RETD (2013)). Recent numbers about these shares in the US market are not provided since ESCO market study usually focus only on EPC (Satchwell et al. (2010), Gilligan (2011)). In 2010, Satchwell et al. report an increasing growth of 14% for renewable and on-site technologies coupled with EPC projects.
- The **advantages of energy contracting are most relevant beyond a certain scale,** mainly due to the transaction costs involved in the contracting process.

  For ESC, a Swiss ESCO uses typically bottom threshold of 50kW[29], i.e. more than ten household units, while in Germany, Eikmeier et al. (2009) cites a thermal load of 100kW, i.e. around 20 000 € annual energy costs (Bleyl (2011)), as a minimum project size to cover all the transaction costs, based on empirical results from a market study.

  In EPC, the contracting process is even more complex and hence, increases significantly the transaction costs incurred. Indeed, the price that the client will pay, in an EPC project, depends on the intangible concept of "negawatthours", which implies two important shortcomings.

  - First, measurements and verification of the savings achieved are costly and imply that both contracting parties agree on the computation of an "hypothetical" baseline, i.e. the consumption of the client would he not have implemented any energy efficiency measures. This baseline is difficult to measure and sometimes misunderstood by potential clients, because it is neither directly observed nor constant since it depends on several factors such as the client's behaviour, climate conditions or energy prices.
  - Second, because the payment of the ESCO is based on uncertain energy savings, the risks associated with them can lead to important safety surcharges.

  As a result, the critical size for a viable project is even larger than under ESC. This has been showed by Goldman et al. (2005) who observed a median project cost of

[29] For projects typically involving heat supply and hot water, sometimes coupled with passive cooling, cooling, ventilation, etc.

US$1 million for EPC compared to US$0.5 million for non-performance-based contracting projects. And this lower size threshold still applies, although some measures have already been taken to reduce the transaction costs, such as standardized and worldwide recognized procedures of measure and verification (cf. International Performance Monitoring and Verification Protocol (IPMVP) in EVO (2012) or Meyers and Kromer (2008)). Today in Germany, the minimum energy cost for an EPC project is estimated at 100'000 euros per year (Bleyl (2011)). Swissesco (2016) also targets only large buildings or pools of buildings with high energy savings potentials. Hence, even though small clients may be interested in EPC, they might face difficulties to get an offer from an ESCO. In the US for instance, Rufo et al. (2002) report that only 12.5% of small commercial consumers received offers over a period of 2 years, while 64% of large consumers with loads greater than 2MW got a proposition within the same period of time.

- **Project financing varies across countries** and typically depend on the financial institutions environment. In Europe, financing can come from bank loans to the client or to the ESCO, or ESCOs' and clients' own internal funds. In Eastern Europe, it is quite rare that the investment come from the client's own funds (Marino et al. (2011)). In Switzerland, the ESCOs, which are in majority big utility companies, can use their own funds to finance their contracting project when the client wants to outsource the up-front investment. On the other hand, while the US ESCOs used to finance sometimes with their own funds the projects in the premises of contracting activities, this has drastically changed and projects are now financed with long-term debt or leases. This is mainly due to the collapse of a few ESCOs after the 1980s energy prices fall because they were bearing the financial risk. Nowadays, US ESCOs prefer to serve as vehicle or facilitator to provide financing rather than directly finance themselves, in order to balance the risks (ICF (2007), IEA-RETD (2013)). This can as well explain the differences between the types of EPC schemes used in Europe as compared with those in the US. Indeed, shared savings is the dominant model used in Europe, while 90% of the contracts in the US are rather using guaranteed savings schemes. Since the European ESCO is a younger market, clients are likely to be less confident and aware about this new business model, and usually let the ESCO finance the investment and bear the financial risk as it is the case in the shared savings model (Hansen (2006), Marino et al. (2011)). In the US, on the other hand, confidence of the consumer leads them to invest in EPC projects, through guaranteed savings schemes (Goldman et al. (2005)).
- Another important point to mention is an observed **decrease in the cost-effectiveness of EPC projects over time**, at least in the US. In fact, Goldman et al. (2005) find that 90% of the 1500 projects observed in his sample were presenting a benefit/cost ratio larger than one when implemented before 1996, while only 68% were cost-effective since then. They also find evidence that the proportion of lighting-only project decreased from 30% in 1996 to 23% since then.
- Finally, while in practice **ESC is used in various market segments, such as housing, commerce industry or public buildings** (IEA-RETD (2013)), **EPC is**

practically limited to the public sector and buildings with special purpose, such as hospitals, swimming facilities or schools (Bleyl (2011), Marino et al. (2011)). It is also the buildings targeted by Swissesco (2016). In Germany and Austria, the main customers are the federal building administrations, municipalities and a few large cities such as Graz or Salzburg, while private commercial buildings are not typical consumers (Bertoldi et al. (2006), Seefeldt (2003)). Observations on the US market go in the same direction, where the initial focus of the ESCOs doing EPC was on public infrastructures (Langlois and Hansen (2012)), which represent currently 84% of the ESCOs' revenues (Satchwell et al. (2010), ICF (2007)). The actors call it the "MUSH" market (municipal and state government, universities and colleges, schools and hospitals) (Satchwell et al. (2010)). The abundance of public EPC projects in spite of private investments may be explained by several causes:

- First, public institutions often need third party financing and the ESCOs are not reluctant to provide the financing in such cases because public clients are credit worthy (Bleyl (2011)).
- Second, public sector usually asks for generic technologies (Backlund and Thollander (2011)), which implies that in practice only very few projects include improvements in the building envelope (Bleyl (2011), Nolden and Sorrell (2016), Nolden et al. (2016)).
- Then, the size, the use and the age of public infrastructures typically represent high savings potentials that are attractive for the ESCOs (Bleyl (2011)). Germany is an interesting example, where EPC represented an efficient tool to retrofit and modernize all the building in the eastern part of the country after the fall of the Berlin Wall.
- Moreover, regulations have forced public entities to implement energy policy goals, to their own buildings. For instance, US federal government facilities are expected to reduce their energy use by 30% until 2015 while their construction budgets have not been increased (Langlois and Hansen (2012)). This means that EPC applied to public sector is expected to continue to grow significantly in the upcoming years in the US.
- We can also cite procurement laws as an important driver of the success of the "MUSH" market in the US. Indeed, state and local governments, which need to retrofit old public infrastructure must enter in a complex process if the construction project costs more than US$25 000. In this process, each stage of the investment must be precisely designed for bidding by governmental agencies, which often lack technical expertise. Conversely, projects using EPC are exempted from these traditional procurement rules. The ESCO can itself design the whole project and the government agency must select the best EPC project based on the expected and guaranteed savings by the ESCO, which must cover debt obligations (Langlois and Hansen (2012)).

- Finally, low penetration in the private sector may also be explained by the shorter payback time in this market segment. Indeed, based on a sample of approximately 1 500 EPC projects, Goldman et al. (2005) find a median payback time of 10 years for public infrastructure as compared to 3 years for private projects.

4.4 Conclusion and the energy service gap

Despite the success of energy contracting in some countries, some authors have argued that the potential of this business model was not fully exploited (Marino et al. (2010), Bleyl (2011), Langlois and Hansen (2012)), which lead Backlund and Thollander (2011) to refer to this problem as the *energy service gap*. The main reason for the existence of the energy service gap, evoked by Backlund and Thollander (2011), relies on transaction costs that prevent the market to further develop.

This observation builds on the analysis of the general trends on the ESCO markets that have been over-viewed in the last subsections. To summarize, we observed first a slow-down in both US and some European ESCO markets that cannot be solely explained by the economic downturn since the deceleration remains after the crisis (Langlois and Hansen (2012), Bertoldi et al. (2014), Nolden and Sorrell (2016), Stuart et al. (2016)). Then, the markets are dominated by ESC, especially in Europe, with projects that can apply to diverse market segments with a minimal project size of 20 000 euros per year. EPC, on the other hand, are mainly limited to public infrastructure projects of much larger span (100 000 euros per year) with decreasing contract duration and cost-effectiveness and where small consumers and SMEs are generally excluded (Pätäri et al. (2016)).

However, the energy service gap is not the only diagnostic brought by the literature to explain this apparent slow-down.

First, Goldman et al. (2005) suggest that the deceleration in the market comes from the fact that most cost-effective projects, i.e. the "low hanging fruits", have already been harvested in most countries. These attractive projects are typically represented by public buildings and simple technologies that reduce easily energy consumption, such as LED, HVAC, voltage optimization and building controls and rarely apply more comprehensive retrofits such as envelope enhancement (Bleyl (2011), Nolden et al. (2016), Nolden and Sorrell (2016)). This, in some sense, can be interpreted as an opposite view to the claim of the existence of an energy service gap. Indeed, this could mean that the ESCOs have already exploited all their potentials and that other instruments than contracting must be found to cover other market segments or technologies. Another explanation for the decrease in cost-effectiveness of EPC projects in the US is proposed by Goldman et al. (2005), who state that customers in the US are no longer interested in cost/benefit ratios only, but are also increasingly valuing other indirect benefits, such as mitigating facility security or electric reliability of on-site generation projects that are usually not taken into account in cost-benefit analyses. In this case, there may still be a

potential untapped by the ESCOs, i.e. an energy service gap. While Backlund and Thollander (2011) argue that the energy service gap prevents the ESCO to target the important market segment of SMEs, other authors observed that there is also a potential untapped of energy efficiency improvements in the public sector, even in the mature US "MUSH" market (Satchwell et al. (2010)) as well as in the existing residential buildings (IEA-RETD (2013)).

Whether the energy service gap exists or not calls for a further investigation on the potential developments that remain for energy contracting. If these possibilities to grow further and target new market segments exist but are not exploited, then one should review the barriers that are hampering such an expansion. If these barriers happen to be non-existing or unbinding, then this could mean that ESCOs have already exploited the existing market niches, at least in mature markets such as the US. In this case, this would imply that other instruments, or other types of energy services than ESC or EPC should be used to promote the deployment of renewable technologies and energy efficiency. This is the reason why the next chapter is devoted to review the literature on the barriers to the development of energy contracting. Drivers will also be reported, since they allow the emerging markets, such as the Swiss market, to draw upon the success and experience of more mature markets in order to grow.

5 Barriers and drivers to energy contracting

5.1 Theoretical analyses of barriers and drivers

Only a few studies attempted to develop a theoretical framework applied to energy contracting. Yik and Lee (2004) and Li et al. (2014) provide a model for energy performance contracting viability and design based on net present values of future savings. Sorrell (2007) relies on economic theory, and more specifically on transaction cost economics (TCE), to assess contracts' viability, applicable for both energy performance and energy supply contracting. He argues that energy contracting represents a shift from a hierarchical form of organization (vertical integration) to a more market-based form and thus can reasonably be related to the economic theory of the firm, i.e. the so-called "make-or-buy" decision.

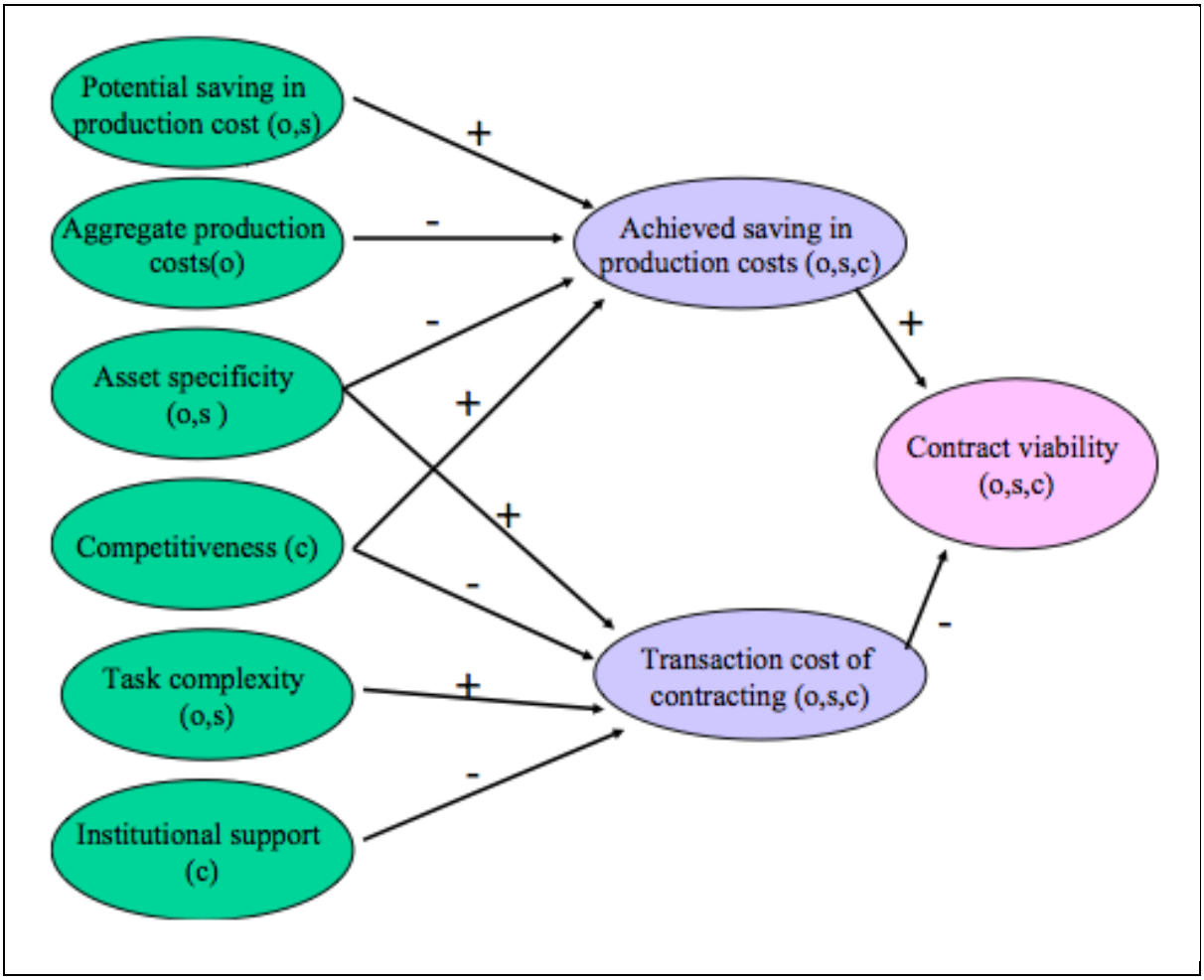


Figure 7 Sorrell's model of contracting decision (Sorrell (2007), p. 519). (o) refer to factors determining the contracting decision, (s) to determinants explaining why particular services are in or out of the contract, (c) for elements that clarify why contract's viability varies between comparable organizations in different contexts

Sorrell's model on the choice to invest in energy contracting rather than self- invest is summarized by Figure 7. The decision to opt for contracting draws upon the comparison of anticipated production costs (i.e. financing, distribution, control, maintenance, etc.) and transaction costs (i.e. consulting and legal costs, negotiations, risk sharing, costs associated with risk of opportunistic behaviour, etc.). Potential savings in production costs and aggregate production costs are key determinants in Sorrell's model to explain contracts' viability. Two other factors inspired from the TCE are added, namely asset specificity and task complexity. Finally, he also incorporates two external variables specific to the context, i.e. competitiveness of the energy service market and institutional context (e.g. information, procurement, accreditation, consultancy, etc.). While these conjectures are available for empirical tests, the attempts have been scarce to determine econometrically whether the determinants of contract's viability suggested by Sorrell (2007) were relevant. A few exceptions are Polzin et al. (2016) and Klinke (2016). This lack of empirical research is due to the aforementioned problem of limited availability of data on contracts (Mathew et al. (2005)). Klinke (2016) follows Sorrell's idea to ground the determinant of ESC adoption into vertical integration theories. She explores the mechanisms of adoption by combining predictions from transaction cost economics, risk-sharing (from incentive system theory) and economies of scale considerations.

One important implication of Sorrel's model is that energy contracting may not be suitable for small clients, whose savings are likely to be offset by consequent transaction costs, although their large number would imply important overall savings. Sorrell (2007) (p. 521) concludes:

> *The model suggests that, while energy service contracting may have an important role to play in a low carbon economy, a wholesale shift from commodity to service supply is unlikely to be either feasible or desirable. Contracting may only be appropriate for a subset of energy services within a subset of organizations, and is particularly unsuitable for final energy services at small sites and process-specific energy uses at large sites.*

This conclusion suggests that the slow-down in mature ESCO markets may simply come from the fact that energy contracting is not appropriate to target small size clients or specific technologies. With this conclusion, the potentials deployment of energy contracting, evoked by Backlund and Thollander (2011), may be significantly reduced and the energy service gap may actually not exist. In order to understand better Sorrell's conclusion, the literature on the economic theories that relates to energy contracting's viability has to be reviewed in the next section.

5.1.1 Asset specificity and contract's incompleteness: Theoretical predictions from the Theory of the firm

As already mentioned, Sorrell (2007) relates the decision to opt for energy contracting or not, to a choice to outsource a service instead of producing it in-house, i.e. vertically

integrating this service in the production process of energy. As a result, this choice can be easily related to the question of vertical integration in a firm's decision. Three main theories have emerged from this question: transaction cost economics, property rights theory and incentive system theory.

Transaction cost economics (TCE)

TCE has been the first informal theory developed within the theory of the firm, beginning with Williamson (1971) (Lyons (1996), Gibbons (2005)). This theory emphasizes that vertical integration is explained by the interaction of two factors.

First, there is an asset specific investment within the transaction. This asset specific investment is defined as a durable investment, whose opportunity cost is much lower in best alternative use (Riordan and Williamson (1985)). This can be explained by the fact that once an asset has been installed, it may be too costly to remove or too specialized to be sold to another client. Asset specificity exposes the parties to hazard where potential opportunism, also known as the "hold-up" problem, may appear if circumstances change.

However, this would not be a problem without the interaction with a second factor explaining vertical integration that is, contracts incompleteness (Shelanski and Klein (1995)). Indeed, if contracts were complete by specifying every possible contingency, asset specificity would not be an issue. In practice however, complete contracts are impossible because agents have bounded rationality, certain states may not be observed by all contracts parties, and even if they were observed, they may not be verifiable in court law simply because it is too long and costly to write down every possible eventuality in the contract (Lyons (1996)). Hence, contract's incompleteness results from a mix between uncertainty and task complexity, i.e. "the degree of difficulty in specifying and monitoring the terms and conditions of a contract" (Globerman and Vining (1996)).

This theory predicts that the more specific is an asset, coupled with contract's incompleteness, the higher the probability to choose vertical integration, i.e. in our case the higher the likelihood to keep energy service in-house, since opting for contracting would require safeguard clauses against opportunistic behaviour that may be either too costly or complex to state and enforce. These predictions have been widely studied empirically in the context of firms outsourcing different services, but rarely for energy contracting. In these studies, evidence mostly supports TCE's conjectures, although some of them suffer from econometric issues, such as endogeneity bias (Shelanski and Klein (1995)). Moreover, most of the studies consider each factor separately, despite the fact that the model predicts that it is the interaction between incompleteness and specificity that matters (Lafontaine and Slade (2007), Shelanski and Klein (1995)).

In the context of energy contracting, asset specificity can take various forms:

- First, it can be site specific, as it would be the case if the physical equipment is installed at the client's site or close to it (Sorrell (2007)).

- Second, audits, engineering calculations and feasibility assessments made before the first offer by the ESCO are typically specific to the client and cannot be transferred to another (Mathew et al. (2005), Sorrell (2007)).
- Third, human asset specificity relies on the fact that certain projects need specific knowledge or human capital (Shelanski and Klein (1995), Sorrell (2007)).
- Finally, customers may ask for very specific technologies, especially when complex energy-intensive production processes are involved. Shelanski and Klein (1995) call these investments "general purpose investments".

A fifth type of asset specificity, temporal specificity, has been cited by Lafontaine and Slade (2007) and relies on the fact that certain assets must be used in a certain order or at a certain point in time. However, this last example does not seem to apply in the case of energy contracting.

While the empirical investigation from Klinke (2016) does not show that asset specificity is an important barrier to energy contracting adoption, further research are needed in this domain. One can observe that contract duration, compensation for contract termination or the way the payment schemes are adapted to changes in energy prices are in fact safeguard clauses to cover the ESCO from a potential "hold-up" problem (Sorrell (2007)). One could however argue that if these clauses are sufficiently detailed in the contract, they do not allow the client to renegotiate the contract, once the technology is installed. As a result, it is questionable whether there really exists a risk of "hold-up" once the contract is signed. Of course, and this is the point of the TCE theory, asset specificity is a problem only in the case of contract's incompleteness. In other words, the "hold-up" problem may still occur if uncertainty and task complexity are sufficient to prevent the contract from being complete. This problem is likely to be more present in EPC projects than in ESC. Indeed, under EPC, uncertainty about energy savings results from the unobserved client's behaviour, as well as external reasons such as weather conditions (Yik and Lee (2004)). Task complexity may lie in the fact that it is difficult to specify and monitor the service quality provided. Again, EPC may be more affected: "The complexity associated with supplying a useful energy stream (supply contracting) should be less than that associated with supplying a final energy service (performance contracting)" (Sorrell (2007)). This is due to the fact that the number of factors influencing equipment performance and under the user's control is significantly larger in EPC than in ESC (Helle (1997)). However, ESCOs have already implemented an efficient tool to overcome this problem in EPC projects: The IPMVP standardized procedure (EVO (2012), Meyers and Kromer (2008)). This procedure represents an important safeguard clause against ex post renegotiations of the contracts, since the client and the ESCO agree on a detailed way of computing energy savings, which depend on weather conditions as well as occupancy patterns of the client.

As a result, even in the case of EPC, the "hold-up" problem may be avoided. But this may come at the cost of negotiations on the way measures and verifications are lead, which may increase considerably the transaction costs. One has also to keep in mind that the more complex the contract, the more reluctant it may be to the client to be

interested in it. And this is especially the case in emerging ESCO markets, where contracting concepts are rather unknown. Moreover, Hansen (2006) notes that a contract that is too complete may actually benefit only the lawyers.

Backlund and Thollander (2011) points towards another important implication of the transaction costs economics. Asset specificity that are represented by engineering audits and calculations, feasibility studies, as well as the transaction-specific knowledge are usually financed by the ESCO before the contract is signed, since the offer of the ESCO will depend on these studies. In the case of EPC, these audits are very complex and usually consist in Investment Grade Audits (IGA), which include specific risk appraisal[30] and whose price can be 50% larger than a "conventional" energy audit (Hansen (2006)). Therefore, these audits represent a "very specific knowledge [that can] become a sunk cost [if the client refuses the contract] and makes the consultant vulnerable to the clients' demands. The ESCO then risks to become a price taker" (Backlund and Thollander (2011)). This point may have two important implications for the ESCOs.

First, this may actually incite the ESCO to choose generic technologies in order to minimize the investment made before the client signs the contract. This can also be related to ESCOs minimizing the uncertainty by choosing "relatively certain (but relatively shallow) energy savings opportunities (...) [to the detriment of] more promising but more complex and uncertain measures" (Mills et al. (2006)). And this may be an important reason explaining the apparent abundance of "low hanging fruits" technologies implemented, especially in EPC, that we have observed in the last chapter, in place of more comprehensive refurbishment projects (e.g. Nolden and Sorrell (2016)). Of course, it happens that clients ask for "cutting edge" technologies, proving that there is a willingness to pay for them. In these cases, ESCOs typically accept to implement them, but without any guarantee on the savings (Hansen (2006)). Second, the ESCOs may introduce safeguard clauses before the contract is signed, using a process of negotiations. This is the strategy used by swissesco (2016). First, a very basic analysis of feasibility is provided for free by the ESCO, which informs the client about the amount of investment, the contract duration and payment schemes. Then, the client can choose to sign a first agreement to proceed to the second step, which consists in a comprehensive energy audit, measurements, financing options, IPMVP elaboration, etc. In this first agreement, the client guarantees that he will reimburse the costs of these studies in the case he will not sign the EPC contract. Finally, once the client has studied the offer proposed by the ESCO, which is based on this comprehensive energy audit, he decides to sign or not the EPC contract. If he refuses, he must pay the costs of the audit. While this permits to avoid the implementation of generic technologies only, the transaction costs are once again considerably increased.

To conclude on TCE, two important implications stand out from the preceding discussion.

[30] These audits even account for the level of commitment of the management to the project, a measure on how the occupants are informed and the abilities of the staff for operation and maintenance.

- First, the combination of asset specificity and task complexity, in the context of energy contracting, allows understanding, why there is an obvious tendency to opt for generic technologies, especially in the case of EPC, to the detriment of more comprehensive refurbishment projects.
- Furthermore, trying to avoid the potential "hold-up" problem, before or after the contract is signed, implies a significant increase in transaction costs. In this case, energy savings must be sufficient to offset these costs, otherwise the contract is not viable, as was arguing Sorrell (2007) who concludes that smaller size clients should not be targeted by the ESCOs. However, the extent to which energy contracting can also be exploited for smaller size energy customer depends on the potentials of either simplifying the energy service contracts, introducing facilitators to help the clients reduce transaction costs, or finding new efficient tools to increase energy savings potentials for small consumers. This point needs further research and will be discussed in the last chapter.
- Finally, the apparent effect of the "hold-up" problem on the technologies adopted in energy contracting must be reset in its initial context. That is, these technologies should be compared with those that the client would have eventually implemented would he not have opted for energy contracting. The second framework within the theory of the firm, i.e. the property-rights theory, might help to investigate this further.

Property-rights theory

Together with the growing literature on transaction cost, a second more formal model appeared, beginning with Grossman and Hart (1985): the property-rights theory. It is closely related to transaction costs economics since it also relies on contracts incompleteness and asset specificity. However, rather than focusing on ex-post haggling (Gibbons (2005)), property-rights theory determines how ex-ante decisions on investment incentives are determined by the allocation of assets ownership. Whinston (2003) argues that since transaction costs economics and property-rights theories are closely related, empirical studies have often concluded that their results were supporting both models. However, he argues that the impact of asset specificity on vertical integration is much more complex in the property rights framework than in the transaction cost theory. Indeed, the former theory introduces a trade-off between integration and market. But vertical integration might not be the solution to mitigate the risk associated with asset specificity as it also reduces investment incentives (Lafontaine and Slade (2007)). According to the property-rights model, changes in asset specificity will only have an impact on the make-or-buy decision if it affects the marginal returns on investments (Whinston (2003)). Unfortunately, while property-rights theory provides more rigorous and formal predictions, the complexity of the model makes it very hard to prove empirically. As a result, there are very few empirical studies that directly deal with property-rights predictions (Whinston (2003)).

This alternative way to consider asset specificity brings an interesting insight in the context of energy contracting. While TCE leads to the conclusion that the risk associated with asset specificity may reduce the incentives for the ESCOs to implement innovative and specific technologies, the property-rights theory suggests that investment incentives may even be smaller in the case energy production is kept in-house. In this context, IEA-RETD (2013) argue that the guarantees provided by the ESCO on the functional performance and the savings, as well as the economic and technical risks shared with the ESCO is also an added value that the client should take into account in her decision-making. The advantage of energy contracting over in-house investment in renewable technologies or energy efficiency can be justified by competition among ESCOs. But this assumes a sufficient competition on the contracting market, which is not necessarily the case, especially in emerging markets.

Empirical evidence on a comparison of investments between in-house vs. contracting options does not exist. However, Iimi (2016) empirically proves the importance of competition to get better EPC projects in public procurement. The next subsections on empirical evidence will review what has been showed in the energy contracting literature.

Incentive system theory

The last theory of the firm under focus is the incentive-system theory, which is used to explain a manufacturer's choice between forward integration and outsourcing retail activities. In this case, moral-hazard theory is used to explain firm boundaries, where the principal, in the contracting case the client, does not observe the effort of the agent, which is represented by the ESCO. The trade-off occurs between risk insurance monitored in-house and effort incentives provided by the market. The main determinants of vertical integration, i.e. keeping the investment in-house, are thus lower importance of the agent's effort, higher importance of the principal's effort, higher risk and higher risk aversion of the agent (Lafontaine and Slade (2007)).

Li et al. (2014) propose a theoretical bargain model based on moral hazard theory to analyse the impact of capital cost on EPC shared-savings contract terms (length of contract period, total investment, share of investment and share of energy savings) and the resulted energy bill savings. Their model is interesting as they adapt the famous "share cropping" problem of landlord-worker to EPC. As opposed to the classical model, in EPC the "landlord" who is the client, does not get his main source of revenue from the contract. In other words, the energy bill savings is not the main source of revenue for the consumer, whose core activity is elsewhere. As a result, the client's objective function does not maximize the residual gain from the energy savings, but rather guarantees that the residual gain reaches a minimum requirement. While this article is very interesting since it is the first one, to my knowledge, to apply a formal theoretical framework to energy contracting, it does not directly explore the factors inducing the client to opt for energy contracting.

Even if empirical evidence based on the incentive-system theory and applied to contracting are rare (exceptions are Li et al. (2014) and Klinke (2016)), one can however

observe that EPC payment schemes are directly targeted to reduce the problems of moral-hazard. This is the case when energy savings are either shared between the two parties (Eto et al. (1998)), guaranteed by the ESCOs, or both. Measure and verification protocol, such as the IPMVP permits probably to mitigate the effect of unobserved efforts. The contractual duration is also a guarantee of performance, even in the ESC case. Although the problem of moral-hazard may be important in the context of energy contracting, no econometric analysis exists on the extent to which some contractual payment schemes are mitigating these and how they may influence the clients' choice to opt for energy contracting instead of investing themselves.

In the context of other markets, a majority of empirical studies have found evidence supporting incentive system theory, except for risk aversion that is usually not measured, and risk which seems to show the opposite impact. This is also the result found in Klinke (2016) in the context of ESC. Lafontaine and Slade (2007) suggest endogeneity or selection bias on risk aversion as possible answers for this counter-intuitive result. Another explanation can be given by property-rights theory and thus suggests that empirical studies combining the different theories are likely to be needed in future research.

5.2 Barriers and drivers from the client's point of view: empirical review

The empirical literature of the factors affecting the clients' decisions mostly consists of qualitative studies using a descriptive approach based on interviews and perception of various impacts. More recent papers use quantitative analyses to explore these barriers and drivers:

1. Iimi (2016) examine winning bids of ESCOs project in Japan and determine how the number of competitors, the experience of the ESCOs and the information disclosed in the public tender affects the score of the winning bidder and through which channels: savings, payment and duration proposed in the bid.
2. Polzin et al. (2016) use stated preferences of German municipalities to explore their willingness to consider EPC for LED retrofits. They analyse empirically how stated barriers, drivers and the municipality characteristics can affect this willingness to adopt EPC.
3. Klinke (2016) assesses the determinants of ESC adoption in Switzerland based on a dataset of more than 2000 energy supply contracts signed and rejected from 1996 to 2011.

Here is a summary of the trends observed across the markets.

One of the most important barrier described in the literature is low awareness, lack of information and scepticism of the clients towards contracting options (Soroye and Nilsson (2010), Vine (2005), Xu et al. (2011), Marino et al. (2011), Hansen (2006), Jensen et al. (2010), Capelo (2011), Nguene (2008), Pätäri et al. (2016)). Xu et al. (2011) interviewed engineering managers from hotels who opted for EPC and found that trust was one of the five most important driving factors. Then, Capelo (2011) used a survey of firms and policy makers to determine the five most important determinants of the Portuguese EPC market. He found that "low awareness and scepticism towards the potential benefits of EPC was one of the most commonly reported barriers to deployment of EPC projects. Most potential clients are ignorant of the concept or are reluctant to adopt EPC." In Switzerland as well, the pioneer ESCOs on the EPC market tend to observe that they have to first sell the business model before trying to negotiate with the client on the conditions of the contract. The importance of trust, towards both the ESCO and the technology, has been shown to be an important factor of adoption (Klinke (2016)). As a result, the reputation of the firm is an important factor. The importance of trust can also be illustrated by the fact that many large customers prefer a phased approach when working with ESCOs (Goldman et al. (2005)). That is, a first, small project -usually involving lighting retrofit- is implemented so that the customer can assess the ESCO performance on this initial project. Then, if the ESCO performs well, the client gets involved with the ESCO for a more complex investment project.

A formal step-by-step procedure is known as the method "à la française", which consists in four steps (Hansen (2006)). First, low cost energy efficient operation and maintenance are implemented and the savings achieved through this first step serves to fi-

nance the second step, which involve small energy efficiency investment. Then the benefits from the second step finance more comprehensive investment in the third step, etc. While this method allows the client to build trust, to reduce uncertainties and at the same time to overcome credit constraints, large investments are only implemented after a long period and potential savings are lost in the meantime. In addition, the projects are usually smaller since the savings appear later in the process (Hansen (2006)). This implies that a priority in this context relies on the dissemination of information about EPC options (Capelo (2011)). However, Marino et al. (2011) observed an increase in the understanding of the ESCO market in Norway and United Kingdom, while project implementations or market volume did not rise. This suggests that awareness and trust towards EPC is not the only driver from the consumer's point of view.

A second important barrier relies on the lack of commitment from firm's top management (Thollander et al. (2013), Vine (2005)). Indeed, Hansen (2006) observes that EPC is hard to be implemented in business, especially industries, because "the horrible truth is that top management is not interested in energy". This is explained by the fact that the part of energy costs in the overall costs represents usually only up to 2-5% in industries. While these numbers can increase significantly for energy-intensive industries, up to 30% in chemical production (Hansen (2006)), clients may still be reluctant to outsource energy management to an ESCO, especially if in-house technical expertise exists (Marino et al. (2011)). This reticence may be particularly important against EPC, when the production involves trade secrets, because the implementation of energy efficiency measures as well as the measures and verification, for example made via the IPMVP, asks for a certain knowledge and control of the processes. Moreover, from the firms' point of view, transaction costs and financial risks incurred by projects that are not related to their core business activities are regarded with caution. These projects need to bring high profitability in a limited period of time to be considered by the managers (Helle (1997)). As a result, Thollander et al. (2013) observe that only firms where the top managers have real ambitions for a long-term energy strategy tend to be interested in energy contracting. 50% of the firms surveyed in their study claim to have these ambitions. They also observe, together with Capelo (2011), that competition can increase the need to improve cash flows and subsequently increases the interest for EPC. But the lack of interest from firm's top management remains an important barrier (IEA-RETD (2013)).

Then, Klinke (2016) found that the number of interlocutors, and more specifically the presence of tenants, increase considerably the expected adaptation costs which induce lower willingness to opt for energy supply contracting. She concludes that this is also likely to be the case, even possibly to a larger extent, for EPC, involving existing buildings and retrofits actions.

Finally, private clients (including firms) usually ask for small payback time periods (Goldman et al. (2005)), which is sometimes hard or impossible to reach for the ESCOs. This is due to the fact that these clients want to limit the duration of the contract as much as possible (Hansen (2006), Soroye and Nilsson (2010), Lee et al. (2015)). An

interesting theoretical model for the decision of the contract duration is provided by Deng et al. (2014) and can serve as a decision tool for the ESCOs. Iimi (2016) shows that competition and the experience of the ESCO affects positively the score of the winning ESCO to public auctions. More specifically, having more competition and/or more experienced ESCOs make EPC more attractive through shorter payment periods. This suggests that a potential solution is to foster the supply side of the ESCO markets. Guidelines on this are provided in the next subsection. Iimi (2016) also interestingly demonstrates that the information disclosed in public calls for tenders affect the quality of the bids: by pre-announcing energy savings target, the collectivity is more likely to get attractive bids with shorter contract duration. Moreover, if the collectivity announces that it will bear the regulatory and institutional risks, the ESCOs "propose better investment plans with greater savings at lower costs". These results show that the design of public auctions may be crucial to make EPC projects more attractive.

Other barriers related to the contracts, such as administrative hurdles (Jensen et al. (2010)), project complexity, repayment inability due to ESCOs default (Lee et al. (2015)), complex procurement procedures (Nolden and Sorrell (2016)) or complex measure and verification processes (Xu et al. (2011)) have been observed. Qin et al. (2017) provide interesting insights to simplify the client's choice of EPC business model. Based on the criteria of the project, the energy user, the ESCO and the external environment they propose a methodology presenting the most appropriate and adapted EPC business model in this context. Based on the transaction costs economics and on interviews with representatives of the UK ESCO market, Nolden et al. (2016) show how intermediaries can lower transaction costs and work as drivers for the clients. More specifically, the note that these intermediaries provide the client with specialization economies, scale economies and learning economies that reduce search costs, bargaining and opportunism costs. They can also pool small projects to reach a viable size and open EPC to smaller-size energy consumers.

It is finally worth noting that barriers hindering investments in energy efficiency may also apply in the decision to opt for EPC. Table 7 provides a summary of the barriers from the client's point of view.

Table 7: Overview of important barrier's from the client's point of view

Category	Barrier
Information	Lack of knowledge, awareness or trust
	Scepticism
	Non-availability of examples to proof concept of EPC
Commitment	Lack of commitment
	No interest due to a small share of energy costs in overall costs
	Willingness to keep in-house
	Fear of giving up control or decision power
	Reluctance due to confidentiality
	Unattractive long-term partnership which might affect flexibility of the facility management or building usage.
Risk	Financial risk linked to future and uncertain energy savings
	Energy performance contractor could become insolvent.
Hidden costs	Cumbersome and complex process to set up EPC contract (hidden transaction costs)
	Search costs to identify suitable contractor
	Complex measure and verification processes
Barriers to investments in energy efficiency	Split incentives between Landlord-tenants (building owner does not pay energy bill and therefore lacks incentive to promote energy efficiency measures)
	Behavioural anomalies (low priority, limited time and attention available for a sound decision, status quo bias)

5.3 Barriers and drivers from the ESCO's point of view: empirical review

The barriers and drivers observed in the literature, which are reviewed in this section, are based on descriptive statistics and ESCO interviews.

The decision for companies to enter the ESCO market can be driven by several factors. Based on interviews of energy companies in Europe and mainly in Switzerland, Nguene (2008) found that the interest of energy companies for energy efficiency and renewable technologies was driven mainly by the willingness to be close to their customers, to foster economic success, to enhance their reputation and market position. This is in line with the results found in Kindström et al. (2017). Other factors that can be cited are the need to reduce import dependency, the diversification of resources, the price risk mitigation and the economic flexibility. However, when entering the ESCO market, companies may face important barriers.

The most important barrier raised in the literature for the ESCO is the risk, which can take various forms. While the client's solvency and technological risk apply to both ESC and EPC, the latter is likely to be more subject to risks since there are more elements under the client's control. It is also the case for the risk related to the capacity utilization from the client, where changes in use or installation of additional energy appliances

can affect importantly the achieved savings if the ESCO does not account for these variations (Hansen (2006)). The more control over final energy demand the client has, the higher the risk. Indeed, a study cited by Hansen (2006) shows that up to 80% of the energy savings achieved are due to efficient operation and maintenance and not to hardware installations. However, Helle (1997) argues that both technical risk and risk related to the client's behaviour can be mitigated using an appropriate "tariff structure as well as by competent planning and professional project management." Comprehensive measures and verifications procedures can also be cited to mitigate the risk related to the client's behaviour.

Mills et al. (2006) observe nevertheless that these safeguards are not sufficient in the US to incite the energy performance contractors to provide 100% savings guarantees. And the clients, on the other hand, do not necessarily understand the associated risk and thus are sometimes unwilling to pay the premium requested by the ESCO. This may result in a lack of available financial resources, because lenders increase interest rates when they perceive high risk, which in turn reduces the intrinsic cost-effectiveness of energy efficiency projects (Mills et al. (2006)).

The solvency risk is often seen in the literature as the most important obstacle in this context (Helle (1997), Nguene (2008), Lee et al. (2015)). In fact, Helle (1997) argues that this risk is important for the ESCO in the case of specific investment. For instance, in the case of an industry, where energy efficiency measures involve very specific technologies applied to the production process of the firm, it may be difficult to find a new customer using the facility if this industry goes bankrupt. On the other hand, residential or office buildings might easily be redeemed by a new investor, so that the risk is significantly reduced in this case. Klinke (2016) indeed finds a higher propensity to sign ESC in residential and new buildings. Still, in Belgium, the ESCOs often outsource the management of this risk to solvency insurance (Helle (1997)). In ESC as in EPC, the ESCO typically bears also the risk of unexpected installation or maintenance costs. This has also been perceived as an important barrier (Lee et al. (2015)).

One has to keep in mind that the ESCO presents the key advantage to be able to diversify its risks among all the projects it implements. This is not the case of the individual owner who is interested to invest in renewable technologies or energy efficiency. In fact, based on a sample of 24 public housing retrofit projects in the US, Mills et al. (2006) show that individually these projects were presenting important savings variability over time (from -12% to 52%) while the average portfolio volatility ranged from +16% to +25%.

A few other external factors are significantly affecting the deployment of ESCOs in a country. First, as aforementioned, financial institutions can play an important role by providing access to credit (Vine (2005), Fang et al. (2012), Marino et al. (2011), Lee et al. (2015), Pätäri et al. (2016)). Access to credit for energy efficiency projects is difficult in many countries, even when financial institutions are strong as in developed countries.

This is due to a problem of disaggregation of the projects as Nolden and Sorrell (2016) cite Michael Eckhart[31]:

Energy efficiency projects do not yet meet the requirement of capital markets. The industry is too disaggregated. No two projects or contracts are alike. Securisation is not practical or possible under these circumstances. Say you have 1000 energy efficiency projects. Standard and Poor would have to read 1000 documents to assess the risk. Few won't pay for that level of review.

Then, energy prices are likely to be an important driver of the EPC market (Marino et al. (2011), Soroye and Nilsson (2010)). Moreover, as we will see in the next chapter, energy market liberalization has been cited as an important driver (Marino et al. (2011), Vine (2005)).

More recently, Kindström et al. (2017) explore the interests, the challenges and the drivers that local and regional Swedish energy providers can face when willing to enter the ESCO market. The main challenges are intern to the organizations such as lack of strategic direction and of a resources commitment towards energy services.

Finally, it has been shown that the creation of national ESCO associations allows important activities to be implemented and foster the market in a country, such as transfer of knowledge, standardization and joint efforts to disseminate information (Marino et al. (2011)). The European Association of Energy Service Companies, for instance, disseminate best practices and case studies of EPC projects. They also organize each year an ESCO Europe Conference, where actors from the supply side, as well as consultants, government, municipalities, researchers and bankers discuss about EPC (EU-ESCO (2015)). In the United States, there is also an association called the US National Association of Energy Service Companies which purpose is to promote EPC through information dissemination and accreditation program (NAESCO (2015)). The Swissesco association has been founded in the end of 2015 with practical results such as a first public tender for EPC launched by the end of 2016.

Other institutions exist to promote the expansion of Energy Contracting. Table 8 provides an overview of the different international associations and organizations seeking to promote energy contracting.

The International energy agency (IEA) is an independent organization which has been founded in the 1970s in response to the oil crisis. Its main goal is to provide reliable, affordable and clean energy for its 29 member countries worldwide, including Switzerland. They have implemented a demand-side management (DSM) programme in which, one of the tasks is to promote Competitive Energy Services (IEA-DSM Task XVI (2015)). In order to do that, they are creating a platform where experts can share their competences. They also design, elaborate and test new financing and business models, such as the new Integrated Energy-Contracting model (Bleyl (2011)). They also support and

[31] Managing Director and global Head of Finance and Sustainability (UK).

follow national activities to develop the ESCO market. One of their main publications concerns the role of facilitators in ESCO markets (Bleyl et al. (2012)).

Then, The *Transparense* project, financed by the Intelligent Energy Europe (IEE) Programme of the European Commission and co-funding ESCO partners, aims at addressing one of the most important barriers to EPC, i.e. information. They are currently implementing a European Code of Conduct for EPC, which describes the principles underlying successful implementation of EPC projects. The ESCOs which will satisfy this code will be recognized as providing a harmonized European quality standard, which can act as a form of signalling for the client. The project also presents an overview of the European EPC markets based on a survey, and also provides the ESCOs with training programmes and materials.

Table 8: Description's summary of international organizations promoting ESCO markets (state in 2015)

Name	History	Part of	Participants	Main contribution(s)
European Association of Energy Service Companies	Founded in 2009	European Building Automation and Controls Associations (eu.bac)	Firms providing home and building automation, 27 members of eu.bac	Annual ESCO Europe Conference
US National Association of Energy Service Companies			Members: 37 ESCO companies, 3 public sector members, other companies	Accreditation Program, Industry reports, Project case studies, Conferences
International Energy Agency – Demand Side Management, Task 16	Founded in 1973		Participating countries to the task: Belgium, Korea, Netherlands, Sweden, Switzerland	Expert platform, Design & Test of new business models
Transparense Project	April 2013 - September 2015	Intelligent Energy Europe Programme of the European Commission (EU 2020 Targets)	21 European Countries	European Code of Conduct for EPC, ESCOs training programmes, database on European EPC markets
European Energy Service Initiative			ESCO companies present in 9 European cities: Antwerp, Barcelona, Berlin, Dublin, Graz, Prague, Oslo, Sofia and Zagreb.	European Energy Service Award Eurocontract Platform
Joint Research Center		European commission		Regular European Esco markets reports, List of active ESCOs in Europe

Another institution, the European Energy Service Initiative (EESI2020, (2015)), aims at addressing the European energy strategy 2020, and especially the 20% energy saving objective by developing the use of EPC in 9 major European cities. It also prizes each year European Energy Service Awards, which also works as a guarantee of quality for the winning ESCOs. Finally, it developed the EUROCONTRACT platform, which provides best practice examples, model contracts and country specific information for many European countries.
Finally, the Joint Research Center (JRC (2015)) provides the European Commission policy-makers with independent and evidence-based scientific and technical support. The JRC provides regular European ESCO markets reports and a list of European ESCOs.

To conclude based on surveys and observation of the markets, the literature emphasizes that clients and ESCOs are facing various barriers that may prevent them, in some cases, to implement energy contracting options. Nevertheless, empirical evidence on the decision choice to opt for energy contracting, based on a sound theoretical framework, tends to be lacking in this field. One explanation could be the fact that no information has ever been gathered about energy contracting projects that have not been signed by the clients. Such information is needed to comprehensively test theory-based hypothesis. Still, the general consensus that goes out from this literature review is that there are still untapped potentials for market developments. Hence, this puts in question the need to mitigate the barriers that are perceived on these markets. In other words, should the government step in, and if so, by which means?

6 Should the government step in?

6.1 Involvement of governments to support energy contracting markets

In 2006, a directive of the European Parliament and of the Council on energy end use and energy services declared that the "use of financial instruments for energy savings, including EPC" was one of the possible requirements that the member state's public sector shall apply (Parliament and Council (2006)). This directive illustrates that public authorities in Europe are active in supporting the ESCO markets (Marino et al. (2011)). In fact, this comes from the fact that the European Commission sees the ESCOs' deployment as "catalysts for the renovation" in buildings (EEP (2011)) which is one of their priority, since "40% of final consumption comes from houses, offices, shops or other buildings". The different measures undertaken to promote the ESCOs in Europe are preparing standardized ESCO model contracts, facilitating the legal procedures for calls for tender to implement contracting in public buildings and working with public banks to facilitate access to financing (Marino et al. (2011)).

In the US, government support has also been important, in terms of marketing efforts to promote the awareness and information about contracting projects and contract models, as well as reducing administrative obstacles in public procurement laws and providing state guarantees (Helle (1997)).

In developing countries, where the ESCO development is rather slow even for public buildings, Limaye and Limaye (2011) propose a new ESCO business model, called a Super ESCO, which works as a Public Private Partnership (PPP) where the government capitalizes sufficient funds to implement EPC projects in the public sector and leverages commercial financing. Limaye and Limaye (2011) argue that this could bring significant economies of scale and thus attract large energy service providers on the market.

International agencies, such as the World Bank, the Asian Development Bank and the US Agency for international development got involved in the ESCO development as well (Fang et al. (2012)). For instance, the World Bank worked actively to develop the Chinese ESCO market, by implementing the first three ESCOs, by providing risk guarantees to facilitate the ESCO access to financing, by implementing an ESCO association and providing dedicated credit lines (WB (2013)).

In Switzerland, the government has financially supported the swissesco association and has recently worked on information campaigns (information days, flyers). The Swiss Federal Office of Energy (SFOE) is considering various other measures targeted to the deployment of the EPC market in Switzerland. For instance, the possibility to implement a pilot EPC project on a public building is explored to be shown as an example. Further information dissemination, support to a unified method of measurement and valuation methods, staff training, facilitated access to financing and hosting the next ESCO Europe Conference are also under consideration (Bundesamt für Energie (2014)).

To conclude, according to the elements reviewed in the last section, there seems to be a general consensus about the importance of the involvement of public authorities to foster the development of the ESCO market. However, the extent to which the government must step in, and the instruments it should use do not seem to be the same in all countries. This is why there is a need to review the empirical literature on the evidence on the role that government played in the ESCO markets around the world.

6.2 Evidence on the role of government

The literature in this section is also based on interviews and observations of differences among the ESCO markets' situation. One has to note that differences in government intervention levels among European countries seem to be an important explanation of the major differences in the development of the ESCO markets[32] (Bertoldi et al. (2006)).

First, the implication of public sector in implementing ESCO projects for their own building is often cited as an important way to trigger the market (Lee et al. (2015) for instance), especially in those countries where contracting is only emerging. In fact, Fang et al. (2012) argue that this can provide a credible example of "success story" for potential interested investors as well as attract or develop the competences of ESCOs on the market. This evidence is concluded from an observation of the mature US and European markets where the public sector was the most important client. In France, the action plan "La Grenelle de l'environnement" fostered the creation of the ESCO market by involving the public sector in Public Private Partnerships with ESCOs (Marino et al. (2011)). In the developed German and Austrian ESCO markets, public buildings have also opened the market: in the city of Berlin only, 750 public buildings have been retrofitted within 11 EPC contracts which represent annual total guaranteed savings of about 6 million Euros (Seefeldt (2003)). Public infrastructures represent in fact a considerable potential for ESCOs, because public buildings represent about 12% of the entire building area (Ecofys et al. (2010)). However, Gilligan (2011) argues that public mandates are necessary but not sufficient to insure the success of the ESCO market.

Second, subsidies, and especially temporary subsidy programs, have been seen as favourable policy schemes for ESCOs. Indeed, because of the deadlines presented involved, a sense of urgency induced investment and EPC adoption (Capelo (2011)). Using interviews of ESCOs, Soroye and Nilsson (2010) also observe the interest of deadlines in subsidy programs. Marino et al. (2011) describe that subsidies, together with a set of market instruments such as CO_2 taxes and green certificates have developed the market in Sweden. Panev et al. (2014) also argue that the steady growth in the US up to 2010 is due to the fact that most of the ESCO projects have been financed through federal funds. Stuart et al. (2016) estimate that more than half of the US ESCOs benefit from using local, state or federal tax benefits. Panev et al (2014) also suggest that the

[32] Again, the references in this section refer to EPC markets when using the term ESCO markets.

growth in several countries, such as China, India, Thailand and South Korea are due to government investment programmes on energy efficiency. They also argue that international financial institution and donor organizations have been the triggers of the high growth in the ESCO markets of Chile, Brazil and Uruguay. On the other hand, Li et al. (2014), based on an econometric analysis of around 100 EPC Chinese projects, found no impact of government subsidy on investments in EPC or energy savings. They explain this by the fact that subsidies in China are eventually approved only once a project has already reached a certain stage and thus cannot be used to induce or finance early stages of the projects. Moreover, these subsidies are paid directly to the ESCOs in China, so that the client may consider that unfair. The positive impact of subsidies is also refuted by Iimi (2016) who shows econometrically using winning bids in Japan, that subsidies do not lead the ESCOs to offer better propositions.

On the other hand, the econometric analysis provided by Li et al. (2014) shows that access to financing at a low cost has a significant impact on the amount of investment within an EPC projects, and thus allow to reach a higher level of energy savings. The importance of the government facilitating access to capital, has also been raised by IEA-RETD (2013), Lee et al. (2015). Based on 1 500 US ESCO projects, Goldman et al. (2005) also consider financial incentives, such as tax credits for investments in energy efficiency, as necessary to trigger an ESCO market.

However, Goldman et al. (2005) also argues that once the market is settled, the ESCO market can be developed further without necessary involving financial incentives to customers. Other non-financial policy mechanisms are nevertheless cited as necessary to maintain the market growth. These instruments include "enabling legislation, regulation that modifies government procurement practices and information/education on energy efficiency, ESCOs, and performance contracting" (Goldman et al. (2005)). Facchinetti and Sulzer (2016) also highlight the importance of suitable regulatory frameworks for the deployment of high quality comprehensive energy services. This point of view is also supported by Lee et al. (2015). Other measures include the support of third party organizations, such as energy agencies which act as market facilitators, as in the case of Germany and Austria (Bertoldi et al. (2006)), model of standard contracts approved by the authorities which can raise the trust and credibility for the clients (IEA-RETD (2013)) and accreditation, which can act as a form of signalling (Sorrell (2007)). Nolden et al. (2016) show that UK has followed the recommendations of the EU Energy Efficiency Directive to foster EPC markets using model contracts, guidelines and dissemination of best practices. They however argue that these top-down approaches have been ineffective in UK, probably due to their top-down characteristics that do not provide the flexibility needed to be useful for individual clients. They argue that intermediates are more effective to foster EPC markets and therefore suggest to encourage such bottom-up approaches using subsidies for their start-up costs.

Authors have also emphasized the important role of two other non-financial mechanisms which fostered the ESCO development. First, the system of white certificates, which has been applied in several countries (see for instance Bertoldi and Rezessy (2009)), has

been shown to have a significant impact on the energy service market. For instance, white certificate scheme has developed the market and more particularly energy performance contracting in Italy, while in France, it has considerably changed the contracts currently proposed, going from selling energy to selling energy services (Bertoldi and Rezessy (2009), Marino et al. (2011)). In Denmark, the role of ESCOs has also increased because the white certificates have been introduced in such a way that energy suppliers cannot directly implement energy saving obligations themselves. They have to find third parties, which are usually ESCOs (IEA-RETD (2013)). Then, energy market liberalization has been often cited as an important driver of the ESCO market. For instance, Marino et al. (2011) found that competition induces the actors on the energy market to become more creative in increasing the added value of energy provision, and energy contracting is one of the ways to do it. In France, Adnot et al. (2002) also observe that EDF turned towards a more customer-oriented policy because it was entering into competition. Delmas et al. (2007) notice that under market competition, the freedom conferred to energy companies and the competitive threats lead them to conduct differentiation strategies, in particular by the mean of environmental measures. Out of the 20 ESCOs interviewed by Nguene (2008), which included 10 Swiss companies, 3 French companies, 2 Spanish companies and one company from Netherlands, Ireland, Austria, Belgium and Sweden, a little bit less than 25% of them claimed that they would adapt their strategy towards energy service markets in order to face the ongoing process of liberalization. He also found that the potential interest of energy suppliers to become ESCOs was likely to be driven by the liberalization process, because 35% of them consider service suppliers as potential competitors on the energy market. However, while it is argued that market competition induces the ESCOs to be interested in providing energy services, the effect of the liberalization on energy efficiency is still under discussion (Bertoldi et al. (2006)). Indeed, other factors, such as falling and volatile prices, might result from competition and this may have a negative impact on ESCOs providing EPC, via reduced and/or uncertain energy savings. Further research needs to be done in this field in order to know the real impact of liberalization on energy contracting.

To conclude, while many authors argue that policy support is necessary for the ESCO market to grow, or even to exist, this point has been nevertheless questioned by Sarkar and Singh (2010) who found that despite many supporting governmental programs towards energy contracting, many developing countries could not copy the success of the US or European mature ESCO markets (with the exception of China). Moreover, Goldman et al. (2005) argues that energy contracting is suitable to overcome barriers to energy efficiency only in specific market segments that is large institutional, commercial or industrial customers. Together with Sorrell (2007), Goldman et al. (2005) claim that governments must find other instruments than contracting to target investment at smaller size energy consumers. Thus, there may not seem to be a consensus in the literature about the success of governments to enhance energy contracting growth in their markets and to target all energy customers via energy contracting. Finally, when assessing the role of government in the ESCO markets, one has to keep in mind the

initial goal of policy-makers that is inducing private investments in renewable technologies and energy efficiency. If government instruments can directly target the barriers to renewable energy and energy efficiency, then the rationale for government support in the ESCO market should be further investigated.

6.3 Rationale for government support

The rationale for government support has been emphasized in the literature by the observation, as explained earlier, that there exist an "energy service gap". However, while the terminology has been used to bring a parallel with the "energy-efficiency gap", one should note that it is not the same causes that are underlying these concepts. Indeed, as stated previously, the energy-efficiency gap eventually exists because of market failures that prevent energy customers to invest as it would be optimal. The energy service gap, on the other hand, is claimed to be due to high transaction costs, which represent a market barrier, but not necessary a failure. And as stated by Jaffe and Stavins (1994) "unlike market failures, if market barriers are not market failures, they don't call for policy responses". In fact, one could argue that ESCOs are supposed to be market-driven instruments to enhance investments in renewable technologies and energy efficiency. And as such, they do not directly depend on, or should not rely on governmental support.

In the energy contracting literature, no study claims directly that there is no need for government support, to my knowledge. Yet, there is no evidence that an ESCO market cannot emerge and grow without any help from the authorities. Some authors argue in fact that energy contracting is likely to gain in importance in the future because of factors that are not linked to any policy instruments. For instance, Goldman et al. (2005) state that several trends, such as the increase in environmental concern, the need for technical system supply security, high fuel prices, and trend towards outsourcing energy procurement will induce growth on the ESCOs markets. Switzerland provides an example where the government has stepped in only recently, but where contracting, yet only ESC, has been developed significantly. Even if ESC is also experiencing a slow growth, as compared to other countries, there already exists an ESCO association of contractors specialized in ESC, there is no proof either that without government support the main problem of ESCOs market will be overcome. Indeed, evidence seems to suggest that it is not possible for the ESCOs to target smaller customers if they do not get any policy support (Tietenberg (2009)). In order to overcome the market failures that characterize renewable and energy efficiency investments in all market segments, even for small energy consumers, the government has to step in. The appropriate question is now to determine whether it is more efficient for the authorities to help the ESCOs to supply these smaller consumers with contracting options or to implement other policy instruments that are directly targeted to this market segment.

The instruments that directly target the energy efficiency gap and investment in renewable technologies include, for instance, the implementation of obligations and strength-

ening of building codes, the change of legal frameworks to allow to redeem the costs of investments onto the tenants and various incentive programs, such as subsidies or taxes. However, experience has shown that voluntary measures, enhanced by incentive programs, were not sufficient to foster significantly the development of renewable energy and efficiency measures (IEA-RETD (2013)). As a result, it seems that obligations will be needed to reach EUs 2020 energy savings goals, if the government choose to directly target energy consumers. However, IEA-RETD (2013) argue that energy contracting could be well more flexible, since it is a market-based instrument. Moreover, while obligations force the consumer and thus may overcome some behavioural issues, they do not solve the barriers of limited access to capital or the lack of technical information. Hence, energy contracting could be seen as a promising complementary instrument to obligations in order to induce private investments in these market segments. One can then conclude that, not only energy contracting may need the support of the government, but the reverse could also be true. The extent to which energy contracting or obligations, together or alone, represent an appropriate policy tool, would need further research on what is really binding the potential private investors. Sorrell et al. (2004) argue that several limiting barriers are usually involved together in a single energy efficient investment. This implies that using one single instrument may appear to be insufficient, "since it could simply cause another barrier to become the binding constraint" (Tietenberg (2009)).

The preceding review lead us to conclude that a combination of policy instruments together with the support of energy contracting is probably needed to induce private investments in energy efficiency and renewable technologies in all market segments, yet further research is needed to assess which combination is the most efficient. However, before concluding, one could ask whether the contractual schemes currently used in the ESCO markets, i.e. ESC, EPC shared-savings, EPC guaranteed-savings, could not be adapted in a flexible manner in order to target smaller energy consumers.

6.4 Potentials for new contracting models

Current energy contracting models are not appropriate for small and medium-size energy consumers, because the energy consumption (for ESC) or the energy savings (for EPC) are not large enough to offset the incurred transaction costs. This section will thus review new mechanisms that could potentially reduce these transaction costs sufficiently to allow the ESCO market to cover all the energy end-users.

First, the new Integrated Energy-Contracting model (IEC) (see first chapter and Bleyl (2011)) has been proposed as a blend between ESC and EPC, with a fixed-price equalized to the marginal cost of energy supply and quality performance assurance. The author argues that this business model allows reducing significantly the measurement and verification costs and thus makes contracting with energy efficiency measures available for smaller energy consumers. IEC does not pretend to replace EPC, but rather comes as a complement to reach additional end-use markets.

One question that may arise when analysing this business model further is the extent to which the fixed-price will indeed equalize the marginal cost. While this is the condition for the ESCO not to have any incentives to supply more energy, it also implies a sufficient market competition, which is not necessarily the case in the ESCO emerging markets such as in Switzerland. In Austria, where the pilot projects of IEC have been implemented however, the "contract was awarded in a combined competition of prices and solutions in the course of a two-phase negotiation procedure" (IEA-RETD (2013)), suggesting a sufficient competition.

Furthermore, while the price equalizing the marginal cost is a guarantee that the ESCO will have no incentive to sell more energy, it is also a guarantee that he will not be willing to sell less energy. Thus, the projects implemented via IEC may be less promising in terms of energy efficiency measures, or percentage of energy savings, than under EPC. But this would need further investigations in order to compare both business models.

Finally, another limitation of IEC is pointed out by Bleyl (2011), who questions the extent to which the "savings incentives and control through quality assurance are sufficient to motivate the ESCO to continue efficient operations and optimizations". This system indeed questions the potential need of penalties in order to enforce the ESCO to provide sufficient effort (Bleyl (2011)). Moreover, the quality insurance proposed under these contracts involves for instance performance measurement or annual audit with improvement proposals. But this actually gives no incentive to the ESCO to implement these improvements. It is the role of the energy user to undertake the proposed measures and even if the lack of technical information is maybe decreased, other barriers, such as limited access to capital or behaviour anomalies may still persist.

Other simpler contracting models have been tested, such as the one implemented by Eneco in Netherlands. In these contractual agreements, the client finances the up-front cost and benefit from Eneco services in terms of financing, requesting government support or technical advices (IEA-RETD (2013)). These models could be interesting for single-family building owners at very low transaction costs, though they do not completely overcome market barriers, such as limited access to capital.

Finally, standardization has been seen as an efficient and simple way to reduce transaction costs in contracting (Sorrell (2007)). In this context, IPMVP and ready-to-use guidelines for tendering procedures have already been implemented to simplify the processes and reduce transaction costs (Marino et al. (2011)).

One could then think about further standardization in the choice of energy efficiency measures and the way to measure them. Actually, this is the challenge that took up Enron and which contributed to its collapse. The primary focus of Enron was to supply electricity and gas to consumers with annual energy consumption greater than $10 million. Because the price for energy was specified over the contract's duration, typically 10 years, a price increase represented a great risk for Enron. In order to diversify this risk, Enron decided to bundle these contracts with energy efficiency projects so that they could either invest to buy or save energy depending on the prices variations

(Mathew et al. (2005)). But Enron rapidly faced the same problem as with EPC, i.e. the expensive and time-consuming detailed site audits. To solve this issue, Enron standardized drastically the way audits were performed, and priced the projects and decided the efficiency measures to be implemented according to a few standard questions. As would proceed an insurance, Enron relied on the answers to these standard questions to develop a risk profile of the client and implemented energy efficiency projects without even going to the client's site. "In fact, plans were underway to develop standard products that could be sold with a 'low-touch, high-volume' sales process" (Mills et al. (2006)). However, this idea has proven to be a dramatic mistake since these simple audits failed to estimate correctly the potential savings and contributed to the collapse of Enron. This example illustrates the limits of the standardization for energy contracting.

Mathew et al. (2005) nevertheless conclude that such simplifications of the audits could be appropriate for homogeneous facilities, such as hotels lighting retrofits, and would considerably reduce the transaction costs for some market segments and technologies. One could however question the impact of this kind of standardization on the incentive for the ESCOs to try innovative and promising energy efficiency measures. Indeed, this could lead the ESCOs to focus, again, only on "low hanging fruits" that represent these generic technologies and in this case, energy contracting could fail to be a promising tool to enhance comprehensive energy efficiency and renewable technology projects.

7 Conclusions

The literature on energy contracting is wide, and has assembled experts of many fields, such as engineering, physics, law, finance or economics. The existing research provides interesting insights about the evolution of the ESCO markets around the world and the potential driving forces and barriers to the deployment of a sustainable contracting market. However, despite this abundance, three main sets of questions still ask for further research:

- Does energy contracting induce (additional) investment or operational energy efficiency measures and renewable technologies, and through which mechanisms?
- If the potentials to promote such projects are not fully exploited, what are the main barriers that prevent them from being reached and how they relate to individual characteristics?
- Should the government step in, and if so, by which means?

First, chapter 3 concluded that even though many authors have argued that energy contracting mitigates various barriers to investments in renewables and energy efficiency, the energy contracting literature lacks empirical proof, and especially in the assessment of the mechanisms through which it can be done. Further empirical investigations, via econometric analysis for instance, are needed in order to assess what are the most binding constraints preventing investments, how suitable is the contracting business model to contribute to induce them, and what are the most promising contractual mechanisms.

Second, energy contracting and especially EPC, has been applied in practice to specific market segments, i.e. large energy consumers (mainly public) that usually ask for generic technologies. This fact, together with the slow growth of energy contracting markets in most countries, conducted to the hypothesis, in chapter 4, of the existence of an energy service gap, where low hanging fruits have already been harvested. In order to test this hypothesis, one has to analyse whether market barriers prevent the ESCO markets to develop further, or whether energy contracting is simply not a suitable instrument for some market segments, such as small energy end-users.

This lead to review the market barriers and drivers in chapter 5. A general consensus has emerged about the fact that significant barriers are hampering the expansion of contracting market, from the client's point of view as well as from the ESCO's perspective. However, these conclusions were drawn by observations of the worldwide ESCO markets and descriptive analysis of interviews. Micro-econometric analyses that allow exploring precisely the decision to opt for energy contracting, controlling for individual and project characteristics as well as contractual schemes are scarce. As a result, it is currently not possible to assess what are the most important barriers that are preventing energy contracting to target all market segments.

Finally, chapter 6 reviewed the arguments for the need of government policy to support the ESCO markets. While a general consensus came out from the literature about the fact that financial and non-financial policy measures are needed to develop the market, we decided to rephrase the question to go back to the initial problematic. In order to do so, energy contracting must be put in its initial context: this is a market-based instrument which is expected to promote the deployment of renewable technologies and energy efficiency measures. If this instrument fails to target some market segments or to bring comprehensive improvement measures, as it seems to be the case, then the question that policymakers should explore is not how they have to get involved in the ESCO markets. They should instead analyse what are the most efficient instruments, to be used instead of, or in combination with energy contracting, to induce investments in the unexploited market segments. The ESCOs, on the other hand, could also explore the possibility to adapt their business models to reach new types of clients.

In this context, three main research projects that attempt to answer to the remaining questions are proposed here. These will be explored in the context of the Swiss ESCO market, where ESC is experiencing a slow growth, EPC is only emerging and where public policy makers have not yet concretely stepped in.

- First, since data is not yet available for the Swiss EPC market, the current situation will be analysed in Switzerland and compared to the context in neighbouring countries. Using expert interviews, this research will allow identifying important Swiss actors related to the EPC market and provide guidance for the following two sections.
- Second, in order to explore to what extent and through which mechanisms energy contracting allows to induce investments and thus to reduce barriers to energy efficiency and renewable technologies, a discrete choice experiment will be conducted. Using stated preferences where respondents have to choose between status quo and different energy contracts in a hypothetical choice setting, allows measuring the relative importance of each contractual agreement. Thus, it is permitted to assess indirectly what are the most binding constraints in the choice of investors and how contracting can mitigate them. The results will be analysed for different clients' groups, in order to understand the differences that characterize various market segments.
- Finally, a choice experiment will be conducted among the potential ESCOs in Switzerland. By analysing the business decisions of these companies in different legal and policy frameworks, the objective will be to assess which could be the instruments that induce the ESCOs to implement new contracting models, to target other types of clients with various technologies. Together with the results found in the first two articles, this research attempts to provide sound empirical evidence to guide politics towards successful energy strategies.

II. Analysis of framework conditions of energy performance contracting in Switzerland

1 Introduction

Switzerland's building sector satisfies *a priori* many of the prerequisites of a successful market for Energy Service Companies (ESCO) implementing energy performance contracting (EPC): strong financial institutions, a significant number of credit-worthy private and public companies with budgetary constraints, an increasing need for building renovation and finally, the policy context of ambitious energy efficiency and CO_2-reduction objectives.

However, the real situation seems to differ from this initial assumption. Although a limited but growing interest seems to exist on the supply side, the concept remains unknown to many potential clients, including public entities. The first Swiss EPC calls for tender has been launched in end of 2016 only. As a result, the Swiss EPC market is still in its infancy, lagging behind neighboring countries, such as Germany or Austria.

Despite this apparent paradox, the Swiss EPC sector has finally been initiated by a few recent contracts held by different ESCOs and some public calls for tender expected for 2016. Moreover, an association for EPC (*swissesco*) was founded by interested parties in 2015 with the main goal of developing the Swiss market. However, this has occurred with a certain delay after the first trials promoted by the 'Energie2000'[33] initiative in the 1990s.

The present chapter is a first attempt to explain the Swiss EPC market's delay, by analyzing in details the framework conditions, as well as the barriers and drivers of the EPC market, using expert interviews.

The chapter is organized as follows. The adopted methodology for analyzing the current situation is described in chapter 2. Chapter 3 provides the underlying value proposition based on the business model concepts developed by Teece (2010), and an analysis of the organizational structure for EPC. Chapter 4 presents an analysis of actors. The framework conditions, including market drivers and barriers with potential solutions are presented in chapters 5 and 6. The current involvement of the public sector and current or future regulations that could have an impact on the EPC market are presented in chapter 7, followed by concluding remarks in chapter 8.

2 Methodology

The analysis of the framework conditions for EPC in Switzerland includes a review of the legal and financial environment, the market conditions and, among others, a comparative analysis of EPC actors and stakeholders' active in similar businesses. The literature based analysis is complemented by observations and lessons from interviews with experts who are familiar with the Swiss boundary conditions and the market environment.

[33] Energie2000 is now called EnergieSchweiz/SuisseEnergie. More information on this initiative is provided in Table 12.

In section 2.1, the interviews' target groups used to gather the relevant information on the Swiss EPC market are specified, followed by a description of the interview structure (section 2.2).

2.1 Target Groups for interviews

The identification of target groups with a possible interest in EPC in Switzerland is based on an analysis of market players in foreign countries, as well as information provided in the initial interviews with active EPC suppliers and important stakeholders in the Swiss market.

Four different service sectors were identified for the interviews:

- technology suppliers and utilities, including those already active in EPC provision as well as those with no EPC activities
- financing institutions potentially interested in Swiss EPC projects
- cantonal public authorities
- legal experts specialized in specific legal issues related to EPC framework

A pre-defined set of questions has been assigned to each target group as described in section 2.2.

2.2 General structure of interviews

For each target group, a questionnaire was prepared focusing on specific aspects of EPC (see appendix 6.2 to 6.5). With technology suppliers and utilities, the following topics were discussed:

- available know how and current interest in EPC within the company
- potential business model set up for EPC within the company
- potential barriers hindering the deployment of EPC in Switzerland
- potentials for the development of EPC and perceived expected market volumes

After evaluating the general interest and possible activities related to EPC within the company, we investigated whether specific market research has been conducted to evaluate the expected market size and/or whether there were special events triggering the decision to develop the business further.

Based on the answers provided, the actual or potential business model was discussed with questions identifying the value proposition of the firm, its delivery mechanism and the way it captures the value through EPC (see for instance Teece (2010) for more on these concepts).

Subsequent questions focused on the industry competition and the business model environment to better understand the opportunities, risks, hurdles, and barriers of EPC. The

interviews were then concluded with questions related to the expected potentials and future developments of the market.

For companies which have not yet been active in EPC, the interviews were more structured towards the implementation of their business model and potential innovations in this domain, either towards EPC provision or other kind of energy services.

Finally, depending on their legal or regulatory grounds, the market barriers perceived by the actors were discussed with legal experts and public authorities.

3 Value proposition and organizational structure

In order to fully understand the position of companies willing to provide EPC in Switzerland, or of those interested to supply it in the near future, it is important to explore the business model they intend to implement. In the context of an emerging EPC market, these business models are likely to be based on the suppliers' own perception as well as preliminary experience they could gather, either in foreign markets or with the few contracts they implemented in Switzerland. Other companies have led market studies and comparative analyses with foreign markets in order to build their business model proposition.

In the following subsections, we first develop the interviewees' point of view regarding the value proposition they offer to their client. Then through an analysis of the organizational structure, we identify the delivery mechanism through which this value is optimally conveyed to the customer.

3.1 Value proposition

The value proposition provides an overview of the customer's needs which are satisfied through EPC. In other words, it makes sense for the supplier to define what is finally delivered to the customer and how it solves its client's problem (Osterwalder et al. (2015)). For active ESCOs in Switzerland and some who are interested in entering the market, the value proposition relies on the technical aspects brought through EPC. The answers ranged from selling technical knowledge towards optimizing technical parameters of equipment, or selling equipment with higher efficiency, complemented with a permanent monitoring system and performance measurement.

Therefore, the main value proposed to the client is an improved equipment and machinery efficiency combined with a reduced energy bill at the end of the year. However, there are other aspects of EPC which could interest the clients, but are promoted only by a few suppliers or rarely recognized as the principal component of their business model. These benefits include among others, a higher level of comfort or system reliability, performance guarantees, or additional financial services.

After determining how EPC is presented as a value added, we must explore the organizational structure the ESCOs implement for an appropriate structure of key activities,

resources and partners in order to capture this value. This is done in the following subsection.

3.2 Organizational structure

According to different interview partners and the general understanding of EPC, the organizational structure for EPC can be split into four main key activities:

1. Audit (collection of information)
2. Optimization proposal
3. Financing
4. Implementation of measures
5. Performance Guarantee (operation and maintenance, measurement and verification)

After a general agreement to investigate the EPC potentials in a project during an initial meeting between the supplier and a potential client, the next steps in the EPC organizational structure usually start with an energy performance audit. As part of this process, all available information is collected on the current state of the energy appliances and the energy consumption is measured for a specific period of time. The procedure ranges from reading energy bills and orders to installing sensors and meters to survey specific energy flows in sub-processes of the production process; from average values to 15 minute intervals. Based on the measurements, the overall energy demand is calculated and the demand flows are specified. The measurement period is usually accompanied by detailed exchanges between the EPC supplier and the operations manager of the energy appliances together with the owner. These inputs are important for the supplier to understand the usage profile of the appliances as well as the operation modes and specialties.

Based on the measured data, the supplier offers specific optimization steps to realize the full energy demand reduction potential. This can simply involve an improvement of the technical equipment and/or suggestions for process changes, but can also include building automation systems and occasionally, though less frequently, an improvement of the building envelope.

The implementation of the agreed optimization measures is carried out by the ESCO and potential sub-suppliers. More technical realization can include the installation of intelligent control instruments and sensors, heat exchangers, the replacement of pumps, boilers or other equipment needed to provide heating or cooling within the building.

The difference between the organizational structure of a normal renovation project and an EPC project lies in the prolongation of the value chain towards financing (activity 3) and performance guarantee (activity 5). The ESCO can therefore secure the financing of the project. In addition, the contract provides a guarantee for a pre-defined level of energy savings or remunerate the ESCO according to the energy savings achieved. To be able to guarantee the success of the project, the ESCO needs to control the operation

and maintenance of the equipment installed and run proper valuation and verification measurements during the contract period.

After having described the key activities of an EPC project, we asked the experts to determine which resources and partners have to be deployed for an appropriate implementation. It was of particular concern to determine which activities were important to keep in-house and which ones could be externalized.

Whilst there is no general consensus among the EPC experts on which activities can be externalized, two generalities can be identified using their responses. First, the only activity that cannot be completely outsourced is the audit. While some ESCOs externalize part of the analysis, they still have a control over it since they keep access to the information collected and verify the conclusions of the audit. Therefore, this first activity is crucial for the success of the EPC projects. Intuitively, the importance of this phase relies on the fact that the ESCO cannot provide any financing or performance guarantee, without controlling the *ex-ante* analysis of energy savings potentials. This in turn points toward an important difference between EPC and conventional renovation projects. In EPC, the optimization measures proposed are carefully analyzed in order to implement the most effective combination of energy efficiency measures in order to maximize the energy savings achieved.

Second, the only activity that the ESCOs would unanimously be ready to outsource is the financing part. However, finding appropriate partnerships with financial institutions seems to be difficult in some cases. It appears that financial institutions will be key partners for the deployment of the market. Facility managers have also been cited as very important both during the negotiation phase and during the operating phase, including operation, maintenance, measurement and verification.

Other firms, called facilitators, have a role to play in the future to support the clients, especially in the first two activities, i.e. audit and optimization proposal. A description of these key partners, together with other stakeholders of the EPC market, is provided in the next chapter.

4 Analysis of actors

In this chapter, we analyze the actors and their role in the suppliers' description of business model. We are exploring the interests of potential suppliers in providing EPC as well as their clients target groups. The role of other important stakeholders is also analyzed.

The demand-side point of view regarding EPC is developed in chapter III. However, the EPC benefits for the clients as perceived by suppliers are presented in section 5 of the present chapter.

4.1 ESCOs

As seen in foreign markets as well as with potential or active ESCOs in Switzerland, a large panel of firms can be active in the EPC market. They can be investors, technical equipment builders or installers, energy suppliers and utilities, engineering consulting firms, builders or entrepreneurs. In Switzerland today, to our knowledge, 5 ESCOs have implemented EPC projects, with a total of around 20-25 contracts signed. There are however, a much larger number of companies in the set of potentially interested actors including those willing to become ESCOs, facilitators, ESCO suppliers, investors or other stakeholders. Chapter IV provides estimates of interested firms.

4.1.1 Reasoning for ESCOs to provide EPC

When new business models are introduced, one is always interested in their viability. Companies would invest in new business models only if there are valuable arguments such as financial gains or an improved client base. From the conducted interviews, we can observe that EPC is provided for the following reasons:

- Increasing market volume for equipment and maintenance portfolio
- Binding clients in the long term
- Stabilizing and planning cash flow on annual basis
- Covering client's needs
- Keeping control on business processes, resources, inventions
- Preserving competitive advantage

As can be seen from the answers, there are two approaches in arguing for the new business model.

The first one focuses on the supplier's side, striving for increased market shares in the business of the firm, or trying to secure market shares by long-term contracts. A successful company can increase the revenues in general and stabilize the cash flow by accounting for predictable annual revenues over a long period.

Other suppliers are taking the client's point of view and try to identify their needs which can be covered by EPC services. Although this approach seems to be promising, only few insights could be gained during the interviews on the effective value proposition. Further insights are provided on this perspective in chapter III.

Section 7.4 describes whether and how current or future policy measures influence the decision as to provide EPC or not.

4.1.2 Reasoning for ESCOs favoring no participation in EPC markets

Some of the interviewees did not show a concrete interest in providing EPC for the following reasons:

- Legal hurdles too high
- Small market volume

- Large up-front investment for the ESCO willing to provide EPC in terms of technical knowledge and risk appraisal expertise
- Financial and reputational risks if guarantees cannot be met

One of the most important reasons not to provide EPC seems to be the perception of the legal framework in which those contracts need to be handled (see also chapter 6 and more specifically 6.3). Depending on the company culture and experience with such framework conditions, the risk perception will vary and with it, the strategic decision on how to proceed with the EPC business model.

From a strategic point of view, the unclear market potential is an important issue for the firm's decision-maker. As far as we have seen, no reliable estimates exist on the potential EPC market size in Switzerland. Therefore, business development specialists have to argue on weak grounds to convince the board members to agree on the likely business plan. Furthermore, the number of pilot projects is negligible thus failing to provide a sufficient experience to support the business decision.

4.2 Client target groups

The clients typically targeted by suppliers or potential suppliers are characterized by the following aspects:

- Centralized, large energy consumption
- Refurbishment or optimization needs for existing infrastructure and operations (either because of legal requirements, inefficient operations or desuetude)
- Limited financial resources for non-core-activity investments
- Professional risk perception and technical handling
- Interest in (or no reluctance towards) long term partnerships
- Defined utilization of the building in the next years
- Clear and preferably not changing ownership/tenant of the building in the next years
- Building older than 3 to 5 years or new buildings with bad monitoring

Currently, EPC is not a standard product widely known in the market. Moreover, it probably entails high transaction costs. Therefore, the client target groups are large energy consumers with a centralized office or production site. The building is also preferably old with high energy savings potentials. EPC can also focus on industrial processes or street lighting (swissesco (2016)). With those potential clients, the transaction costs are reasonably low compared with the overall investment allowing a positive return on investment for both parties.

swissesco (2016) also insists on the need to have a clear plan concerning the usage and the ownership of the building, at least in horizon time as long as the contract's duration. If the building is rented, the client should be the main tenant and should not be expected to move out in the next years. This avoids unexpected adaptation costs due to changes in energy use or resulting from the transfer of the contract to another owner/tenant.

Large enterprises are interesting targets since they are usually more experienced in terms of risk assessment and operation of technical structures. This allows reduced transaction costs by keeping the negotiation process short. Public owners, though usually less familiar with technical specification and management, are still an interesting EPC target. This is because they are usually of significant size with large energy savings potentials and often lack the access to credit required for energy efficiency investments. Furthermore, they represent creditworthy entities, which can accept relatively long payback time.

On the clients' side, it is also important to understand the timeline of EPC from the beginning. Currently, with low energy prices the payback time is long. Therefore, one has to accept that EPC contracts will last for approximately 3 to 15 years (swissesco (2016)). Therefore, a profound understanding of the clients on the market situation seems crucial.

EPC is unlikely to be an economically viable solution for small energy consumers. Indeed, there is currently a consensus among suppliers that audit and negotiation costs are incompressible due to the risks borne by the ESCO during the contractual period. As a result, energy saving potentials in small consumers' buildings are not sufficient to offset the incurred transaction costs hence, compromising the viability of EPC in this market segment. However, potential adaptations of EPC to small consumers have been mentioned, such as solutions where only one technology is used. An example of this is in lighting, where standard contracts and small audits are sufficient. But this would come at the cost of foregoing potentially interesting comprehensive refurbishments, only because the client is of small size. Another solution brought by swissesco (2016) is to pool several buildings closely located in a single project.

There might be other ways to work around costly audits for small energy customers by accepting standardized evaluation methods. Since the financial volume is smaller, the risk perception could be appeased and therefore more general audits might be accepted by both parties. However, this needs a common understanding and certain trust in the partnership. ESCOs might also be reluctant to standardize the evaluation methods such as audits without reducing at the same time the performance guarantees.

When discussing smaller consumers with cantonal energy authorities, it also appeared to them that instruments other than contracting would be necessary to induce investments in energy efficiency in that market segment. For instance, the idea of cheap and simple automatisms has been raised, such as annual visits by an energy expert for advice and monitoring, as in the chimney-sweeping model. Instruments such as credits at zero interest rates could also be a potential solution.

4.3 Facility managers

Facility managers already employed by the client could play a crucial role in the EPC business model. Their daily work on site in close contact with the building's technical equipment brings a valuable understanding of the technical conditions of the infrastruc-

ture. In addition, they are familiar with the daily operation including special situations under which the energy demand might deviate significantly from the normal conditions.

On the other hand, it is also recognized that facility managers may be reluctant to the fact that external actors (i.e. ESCOs) intervene on the facility and manage the operation during the contractual period. This explains why a close collaboration with these actors is crucial for ESCOs. This has been recognized by the respondents which are active in EPC, who clearly see facility managers as key actors for the success of these projects, not only in the operation phase of the contract but also in the preliminary steps of negotiation, audit and design.

4.4 Facilitators

In the current environment, facilitators can help to spread the word and recommend EPC to potential clients. Facilitators can be engineering firms or consulting firms that work as a third party in the negotiations between the client and the ESCO[34]. Since the business model is not yet known to the customers they need an independent partner to explain the opportunities and risks entailed in EPC projects. They can also help in the elaboration of the project and public tendering procedures. Their consultancy can even be extended after the signature of the contract, to support the client in the control of installation, operation, maintenance, measure and verification lead by the ESCO. Facilitators usually have a good understanding of both parties. On one side, they are in close contact with potential clients and are familiar with their needs and intentions. On the other side, they know the suppliers and can bring expert advice on the equipment and technical solutions.

4.5 Engineering consulting firms

Engineering consulting firms and large energy customers are already working closely together in the field of energy efficiency. These firms have gained a lot of experience regarding the planning and implementation of such measures. Therefore, it would be a small step to expand the consulting services in the direction of EPC where guarantees and long-term contracts are involved. These firms could either work as ESCOs or as facilitators. In the latter case, by having engineering consulting firms as EPC promoters, barriers relating to lack of information or legal requirements during the selection process (see chapter 7) could be reduced.

[34] See Bleyl et al. (2013) and Nolden et al. (2016) for more on the definition and role of facilitators.

4.6 Public authorities

Public authorities have a role in the EPC market as potential clients, energy agencies and also appear as regulators, defining the boundary conditions of the market. This is described in more detail in chapter 7.

4.7 Financial institutions

In the Swiss EPC market, financial institutions may have a smaller role to play than in other foreign markets, at least in the preliminary steps of the market deployment. As put forward by some interviewees, many potential Swiss clients already have sufficient access to financial resources to invest in energy efficiency projects. On the other hand, when the client is not willing to finance the installation, as in the shared-savings EPC scheme[35], almost all of the active ESCOs are currently financing the projects internally. Of course, this may no longer be the case for new entrants, such as small local entrepreneurs or when the EPC market will be more mature, bringing large ESCOs to their financing constraints. Therefore, seeking investment funds for EPC projects or bank partnerships will probably be an important step in the further development of the market.

Several investment funds, from Credit Suisse, UBS or SUSI partners, can be cited as solutions to finance some of the EPC projects (BFE (2014a)). This, however, does not guarantee that all EPC projects will be readily financed. Indeed, the financial institutions we contacted are ready to invest only in large EPC projects with a minimum of 10 years horizon. This decision is probably due to the cost of assessing the risk of all projects individually. As in other ESCO markets such as in the UK, the lack of standardization of documentation, evaluation and implementation of these projects make them costly to consider (Nolden and Sorrell (2016)). As a result, most of the ongoing EPC projects in Switzerland are too small to satisfy these criteria. Potential solutions to a lack of financing, from contractual and organizational mechanisms to public institutions' support are developed in section 6.2.1 of the present chapter.

4.8 swissesco

swissesco is an association promoting the EPC market in Switzerland. ESCO associations have been proved to be important drivers of EPC markets abroad (Panev et al. (2014)). Founded in autumn 2015, swissesco is supported by the SFOE and other active players in the EPC market. The main goal of the association is to disseminate information about EPC as well as references and standards for an efficient application of the model. This includes a manual on how to collaborate within- and how to design an EPC project available on its website. The members are represented by stakeholders, such as ESCOs, util-

[35] See Klinke et al. (2015) for a description of the different EPC schemes

ities, engineering and consulting firms, academic research institutes or facilitators. The 2016 agenda of the association focuses primarily on guidelines for public entities to implement EPC. Active players are indeed convinced that the deployment of the business is crucially determined by the implication of public owners as clients, in order to show examples of the viability of the model. These guidelines will include references about appropriate public tendering processes applied to EPC, for projects submitted to the law on public markets, as well as public accounting advice. The 2017 agenda includes the finalization of standardized contracts, information and EPC training courses and dissemination of the work elaborated in 2016.

4.9 Research institutes

swissesco also intends to constitute a comprehensive database of courses, research, and project information related to the Swiss EPC market. At its instigation, several groups of research, which were either already active in research dedicated to EPC or interested in it, could meet and share their knowledge. They include, for instance, the universities of Geneva and Neuchâtel, the HES-SO Valais, and TEP Energy. These research groups can play an active role in the EPC market deployment. They can investigate different theoretical and practical aspects of the business model and project implementations. This leads to a better understanding of the framework conditions, helping to overcome certain market barriers (see chapter 6).

Some courses related to energy management or buildings management are also offered at the University of Geneva and at the ZHAW, which can teach future ESCOs employees the practical and technical skills necessary for the implementation of successful EPC projects. A certificate of advanced studies (CAS) will also be possibly implemented jointly between HES-SO Valais and ZHAW.

5 Driving factors – benefits for the clients

Several ESCOs have emphasized that an important driving factor for the client to opt for EPC has been the financing solution brought by this model. However, this driver has mainly been observed abroad and to a lesser extent in Switzerland. In general, these clients have available resources to invest, but only on their core business, while energy represents only a small business part with low priority. However, the fact that EPC is attractive due to the investors' credit constraints on energy is not a consensus among the market players. As already mentioned, several actors have even explained the apparent delay of the Swiss ESCO market by the sufficient availability of financing for investments into energy efficiency measures. This would imply that the credit constraint is not a sufficient explanation to the *energy efficiency gap*[36] in Switzerland. This point needs further research and chapter III, dedicated to the point of view of the EPC demand-side, is intended to provide some answers.

[36] For a review on the energy efficiency gap, see chapter I, section 3.3.

The second important advantage of EPC is that it is offered as a turnkey solution for large energy consumers that are subject to legal obligations. In most Swiss cantons, a cantonal law forces large energy consumers[37] to choose between 3 options of energy efficiency improvement plans. In most cases, a company can either contract a universal convention of objectives, a cantonal convention of objectives, or conduct an analysis of energy consumption. In each case, the consumer must reach specific objectives of energy savings in a pre-determined period of time. For consumers who want an attestation of reduction of CO_2 emissions to reduce their CO_2 tax levy, or those who can apply for a CO_2 tax exemption[38] and/or who can apply to a reimbursement of the supplement on electricity network transmission costs[39], they can do so only if they opt for the universal convention of objectives. In this context, energy performance contracting may be seen as an outsourced solution to meet the legal requirements. This, however, requires that the ESCO be accredited by one of the two Swiss organizations (EnAW or ACT) in order to supply solutions in the context of the universal conventions of objectives. However, as we will see in section 6.4.2, accreditation is sometimes not so easily obtained.

In the case of public buildings, even when they do not reach the size of large energy consumers submitted to the aforementioned legal obligations, EPC can be seen as an interesting instrument to fulfill their duty of exemplarity in terms of energy efficiency and CO_2 emissions.

A further advantage of EPC, for both public and private clients, is to have a single interlocutor taking all the responsibility during both realization and exploitation phases. Lack of human resources has also appeared to be an important driving factor. And finally, trust and provider-client relationship seems to be a *sine qua non* condition for EPC to be successful.

In all these cases, experience has shown that energy savings do not represent the only important driving factor for the client. Indeed, energy costs often represent only a small share of the overall cost structure. In order to convince the client, ESCOs should present other advantages, such as production system reliability, comfort or turnkey solutions. As a result, energy savings should only be presented as the "icing on the cake". The challenge for the ESCO is then to discover *ex ante*, what the client values the most.

[37] With more than 0.5 GWh electricity consumption per year and/or more than 5 GWh heating consumption per year

[38] Exemption applies if CO_2 emissions are greater than 100 tons in a preceding year or if at least 60% of CO_2 emissions come from one of the activities listed in appendix 7 of CO_2 order ("ordonnance"). Condition: the consumer engages in a universal convention of objectives. (OFEV 2013)

[39] Total reimbursement applies if electric costs are at least equal to 10% of the gross value added (partial reimbursement if electric costs are between 5-10%). Conditions: reimbursement is at least 20'000CHF per year and that the consumer engages in a universal convention of objectives. (OFEN 2015)

6 Market Barriers

In addition to a review of the legal and financial environment for EPC in Switzerland, the interviews allowed us to identify several barriers on the markets mentioned by suppliers, potential suppliers, authorities and other stakeholders (see Figure 8). These barriers concern private large consumers, public large consumers, or both. They will be explained and detailed in the following sections, which include also potential solutions.

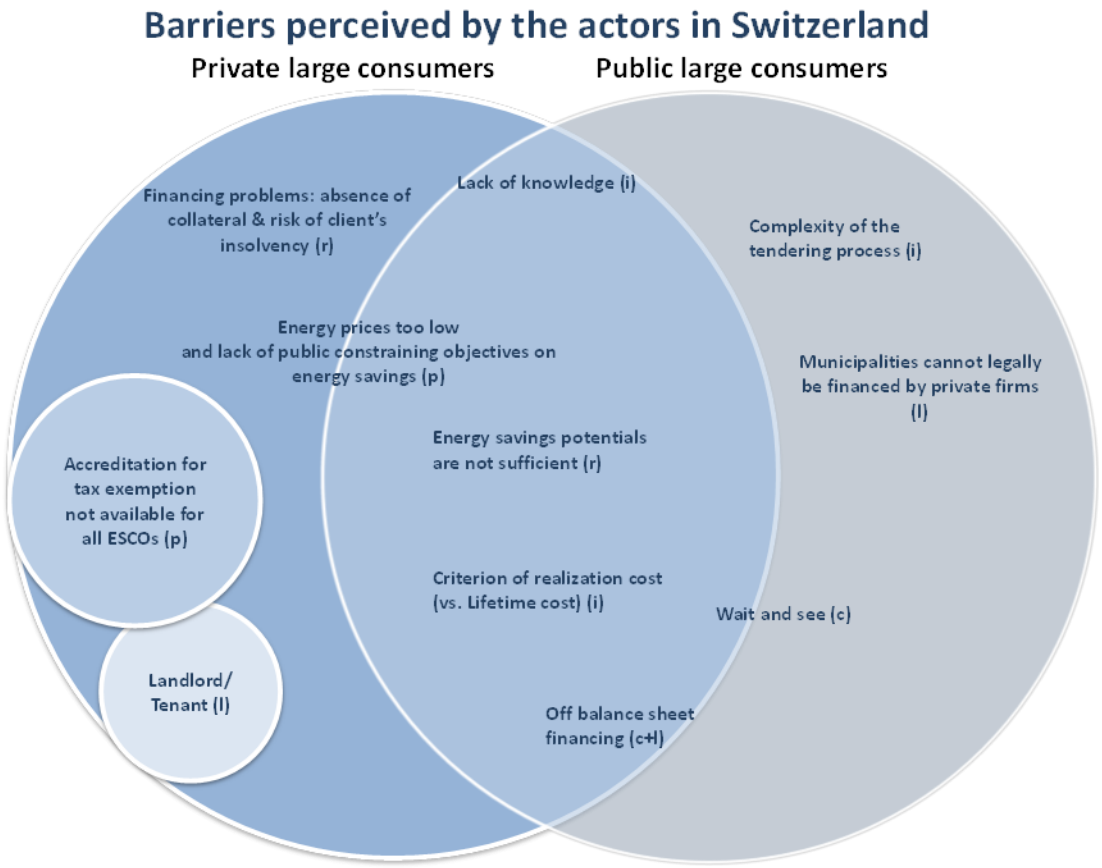


Figure 8 Summary of perceived barriers: information barriers (i), barriers related to risks for the ESCO (r), political barriers (p), legal barriers (l), cultural and behavioral barriers (c).

6.1 Information barriers

6.1.1 Lack of knowledge

Lack of knowledge was the problem that has been mentioned the most by the potential suppliers and current actors in the EPC market. *"The problem with the energy performance contracting market in Switzerland is that we first need to explain the business model, before even trying to sell it."* This sentence stressed by J.-M. Zgraggen, EPC expert from an active Swiss ESCO, summarizes well the situation.

How to improve the situation:

Not only the business model needs to be explained but also the terms and conditions of the contracts need to be specified in general terms (model contracts), so potential private and public clients get a better understanding of their role and contribution.

Additionally, a neutral organization that can inform about advantages and shortcomings of EPC would help to overcome this information barrier and reduce the current information asymmetry between suppliers and potential clients.

The situation may improve in the near future since the Swiss Federal Office of Energy (SFOE) has organized some information meetings for public entities about EPC, which can, in turn, inform smaller public institutions or large energy consumers in their region. The association swissesco is also likely to play a central role in the dissemination of information and model contracts.

6.1.2 Complexity of tendering processes

A second important constraint is the lack of knowledge of potential public clients on how to perform a proper tendering process for EPC. This concerns any public entity or any institution in charge of public tasks willing to sign an energy performance contract with a private entity, involving a significant amount of investment[40]. These contracts are indeed subject to the law on public markets since they involve a pecuniary nature, through which the public entity acquires the services of a private entity, providing the means to execute its public tasks, in return for a payment of a price or any other kind of remuneration. As such, it corresponds entirely to the definition[41] set by the law on public markets (Poltier (2014)).

This implies that specific public tendering procedures open to national or even international competition must be implemented depending on the scope of application the public entity is submitted to.

Table 9 provides an overview of the procedures of public tendering that can be applied for each type of market and each public entity level. For instance, a municipality willing to acquire a service from a private firm is allowed to use a simple direct agreement ("gré à gré"), that is, without going through a public tendering process, if the total investment is below 150'000 CHF. However, if the latter lies between 150'000-250'000

[40] see Table 9 for the investments thresholds

[41] The definition of a public market is not set in the legal texts (cf. federal law on public market or intercantonal agreement on public market). However, this absence of definition had to be very rapidly filled by the Swiss Federal Court, which set a first definition: "We are in the situation of a public market when a public collectivity, who intervenes on the free market as a "demander" ("Nachfrager"), acquires from a private firm, on payment of a price, the necessary means it needs in order to execute its public tasks." (ATF 125 I 209 (212)). The international agreements on public markets (Swiss-European Commission), allows also identifying the essential elements of a public market, i.e. a contract, with a pecuniary nature.

CHF, it will have to proceed at least on "invitation". In this kind of procedure, the municipality invites bidders (if possible at least 3) to present an offer. This procedure does not require a publication of a call for tender. If the size of the investment reaches an amount higher than 250'000 CHF, the municipality can choose between an open procedure, i.e. a standard public tendering process or a selective procedure, where the municipality publishes a call for tender where candidates apply to participate to the bid. The adjudicator then selects ex ante the candidates who can present a quote. Finally, if the investment is above 350'000 CHF, open or selective procedures must even be open to international competition[42].

Table 9 is a simplification of the legal framework. Indeed, while the inter-cantonal agreement has been signed by all cantons, they are free to set smaller threshold values than the one defined in this agreement. The details regarding each procedure may also vary depending on the canton[43]. These cantonal and even municipal specificities may explain some of the difficulties for EPC to break through the public market in Switzerland. However, public tenders are commonly used in Switzerland at all authority levels.

Subsections 'a' and 'b' describe why EPC is more complicated to define than any standard public market. Section 'c' will highlight some guidelines to overcome certain shortcomings in the tendering procedure.

a) EPC, a combination of service, construction and supply

The first difficulty related to a public tender for an EPC project, as opposed to any other kind of public market, exists because it involves a combination of construction, service and even possibly supply ("furniture")[44]. So, it is unclear under which scope of application the contract falls. In such a case, the market type with the highest value of investment should prevail in the determination of threshold values. The problem is that the size of the project in each market type, i.e. the total amount the public entity will pay to the ESCO respectively for service, construction or supply, can be difficult to estimate ex ante, especially in the case of shared-savings performance contracts where the payments are not fixed[45].

[42] This call for tenders will therefore be open to the firms in foreign countries having similar commitments than Switzerland at the World Trade Organization.

[43] For instance, a procedure by invitation in canton Vaud requires an invitation to at least one offer external to the municipality.

[44] This could be the case for instance in comprehensive contracts, at the frontier between energy supply contracting and energy performance contracting, as is the case in integrated energy contracts (IEC) (see Bleyl (2011)), which include the provision of energy services, and thus include supply (furniture).

[45] See Poltier (2014), pp. 138-142, for more information on the way the value of public markets should be estimated.

Table 9: Public tendering procedures (I=must be submitted to competition on international public market)[46]

	Supply						Service					Construction						
												Structural work				Finishing work		
Threshold values (excl. VAT)	<100 K	100 K-230 K	230 K-250 K	250 K-350 K	350 K-700 K	>700K	<150K	150 K-230 K	230 K-250 K	250 K-350 K	350 K-700 K	>700K	<300K	300 K-500 K	500 K-8.7 M	>8.7M	<150K	150K-250K	250K-8.7M	>8.7M
Cantonal & municipal levels (based on Inter-cantonal Agreement on Public Markets 1994)																				
Direct agreement																				
By invitation																				
Open					I	I					I	I				I				I
Selective					I	I					I	I				I				I
Federal Level (based on International Agreement on Public Markets of the World Trade Organization 1994, rev. 2014)																				
Direct agreement	47						47							47				47		
By invitation	48						48							48				48		
Open		I	I	I	I			I	I	I	I					I				I
Selective		I	I	I	I			I	I	I	I					I				I
Sectors of water, energy, transports, postal (e.g. CFF/SBB, Post, Swisscom for service deliveries related with public tasks) (based on Federal Law on Public Markets 1994)																				
Direct agreement				47						47				47				47		
By invitation				48						48				48				48		
Open					I						I					I				I
Selective					I						I					I				I

[46] Summary table based on information gathered in Poltier (2014). Some exceptions can exist depending on which scope of application the contracting authority is submitted (can depend on inter-cantonal, cantonal or municipal laws for decentralized public entities at cantonal/municipal levels). (cf. Poltier (2014), pp. 143-144)
[47] The federal council can extend the requirement to use by invitation, open or selective procedures below these thresholds (cf. Art. 2 III International Agreement on Public Markets of the WTO)
[48] The federal council can extend the requirement to use open or selective procedures below these thresholds (cf. Art. 2 III International Agreement on Public Markets of the WTO)

b) EPC public market definition: The problem of the "pre-implication"

A second dimension lies in the description and definition of the public market before the public tendering is published. The scope of the project and the requirement specifications represent a crucial phase in the success of an energy performance contract. Without any public tendering process, each potential supplier of a client would lead a preliminary audit in order to detect the energy efficiency potentials in the building and base its offer on this analysis. In a tendering procedure, however, the preliminary audit, its results and recommendations must be published with the call for tender in order to satisfy the transparency principle (Poltier (2014)). In most cases, however, the public authority is unlikely to have the technical knowledge to lead itself this preliminary analysis. Therefore, it will likely have recourse to an external private firm, which could typically be a facilitator or an ESCO.

But, in the latter case, the question is to know whether the ESCO leading the preliminary audit is authorized to take part of the following bidding procedure, or whether this "pre-implication" gives to it a competitive advantage which justifies its exclusion from the bidding process. Unfortunately, the answer may be slightly different depending on the law the public market is subject to, and again some cantonal specificities may appear. In general, however, the advantaged firm is allowed to participate under certain conditions (Poltier (2014)). It often implies that the analysis of the firm, as well as all the data and information it had in its possession to lead the analysis, must be transparently transmitted to the other bidders. The deadline for the submission of bids must also be adapted so that the other competitors can catch up. More critically, the adjudicator should also verify that the requirement specifications are not defined in a manner that provides the pre-implicated firm with an advantage, by requiring for instance some technical expertise or equipment that only this firm has, excluding ex ante, any other competitor.

Another problem, related to the necessity of externalizing the first phase of the tendering procedure, exists in the case of big public markets, involving buildings of very large structures. In these cases, this preliminary study can imply a consequent and expensive work which could reach the threshold values, requiring another public tender for this phase as well. As a result, the transaction costs increased considerably.

This phase is nevertheless crucial. The importance of the information disclosed in the call for proposal is also highlighted by Iimi (2016), who shows that it can have a major impact on the quality of the bids proposed by the ESCOs. Moreover the law on public market does not permit major modification of the project once the public tendering has been implemented and the adjudication submitted. As a result, if it appears *ex post* that the needs of the public entity have changed or have been incorrectly evaluated so that an important modification would be needed in the contract, the adjudication must be revoked. Moreover, if new competitors would participate after the project is changed the whole tendering process would need to be reinitiated.

A potential solution to this issue is other selection procedures, which are based on the solution (as opposed to the "prestation" as in the process described above). These in-

clude the functional public tender ("Appel d'offres fonctionnel") and the mandate of parallel study ("Mandat d'études parallèles")[49]. These procedures induce a higher flexibility for the ESCOs in the actions they are proposing, and an advantage for the client who does not always know precisely the technical requirements at the time of the public tender[50].

In other markets such as in the US, the ESCOs benefit from an exception and a more flexible regulatory framework for public tenders than other public markets. This modification has been changed to facilitate the deployment of the ESCO market (Lee et al. (2015)). While such an exception is unlikely to occur in Switzerland, selection procedures based on the solution may provide interesting alternatives to simplify EPC public procurements.

c) Guidelines

In response to the complexity public authorities are facing when envisaging an EPC, *swissesco* association provided the potential public clients with guidelines (Swissesco (2016)) and examples of public tendering procedure documents. It also plans to document comprehensively the first Swiss public tender implemented in 2016 and still running currently. While providing useful insights for potential clients and possibly reduced transaction costs, it is important that these documents shall not be too rigid and allow the client to keep a degree of flexibility, allowing the implementation of innovative solutions as well as to simplify the procedure when the client is allowed to do so.

Indeed, the threshold values determining the required procedures have been chosen by the legislator in order to account for the entailed transaction costs. In the case of small investment amounts, it would be very constraining and inappropriate for public entities to enter into an expensive and complicated tendering procedure. For large investments, however, the importance of competition and its potential benefits in terms of reducing prices and increasing quality of bids are more likely to outweigh the transaction costs of a public tendering procedure. As illustrated in Table 9, a public entity can always decide to choose a procedure open to competition even if the size of the market would not require it. But in this case, the authority must be aware that it must satisfy the legal standards of this procedure, and as such, may be subject to potential appeals.

This is why the choice of tendering procedure, its entailed transaction costs and legal requirements, must be properly evaluated on a case-by-case basis and the example documents should not be too rigid. The guidelines should also permit to account for cantonal and even municipal specificities as aforementioned.

In this context, facilitators may even be more important and valuable than guidelines, in order to advise the client and set up tailor-made tendering procedures, satisfying corre-

[49] See Swissesco (2016) for a precise description of these procedures. The mandate of parallel study is available at the cantonal level but not at the federal level.

[50] Nevertheless, the first Swiss public tender for EPC launched in 2016 did not select these solutions but retained a standard public tendering procedure.

sponding legal requirements. They can also play an important role in the definition and design of the public market. This implies that the facilitator must have the technical expertise to do so, as well as the knowledge of specific legal frameworks. Not only engineers should step in, but jurists are needed.

The argument that intermediates may be more important than standardized procedures is cited by Nolden et al. (2016). They indeed show that such top-down approaches have been quite ineffective in the ESCO market of the UK and that subsidizing the intermediates and their bottom-up development may be more appropriate.

At the end, the central issue for the public entities interested in EPC is to implement a tendering process which is irreproachable enough to sufficiently reduce the risk of appeal. First, the smallest consequence of an appeal can be a delay of the project implementation through a suspensive effect. Second, if the appeal is accepted and the contract has already been signed, the appellant may go through a second lawsuit. If the latter is accepted, it can lead the public entity to pay indemnities to the aggrieved bidder[51]. Finally, if the contract is not yet signed, an accepted appeal can lead to revoking the adjudication and force the public entity to restart, at least, the phase of the procedure where the infringement has been committed. This means that if at the very beginning of a tendering process, a wrong procedure has been chosen due to a misspecification of the value of the market it would lead to reinitiate the complete tendering process.

How to improve the situation:

In order to deal with the specificity of a tendering process applied to EPC, public entities need some guidelines that should be sufficiently flexible to be adapted in a case-by-case basis. In addition, we argue that the involvement of facilitators will be indispensable in order to overcome this problem. Selection procedures based on the solution may be interesting in the context of EPC. Good practices in this domain would be worth it in the upcoming years.

6.1.3 Risk of legal dispute

Another information barrier lies in the risk of legal dispute. This relates to the lack of knowledge and understanding of energy savings measurement and verification processes. It is less a problem for the client to accept the precise measurement of energy consumption after the energy efficiency measures have been installed, but rather to understand how the baseline energy consumption is computed, i.e. what would be the consumption if the contract would not have been signed. To do so, there exists a unified and internationally recognized protocol, i.e. the International Performance Measurement

[51] These indemnities are however capped at the amount corresponding to the costs of elaborating the offer and the appeal. The revocation of the contract invoking its nullity due to its violation of the law on public markets has not yet been used in the jurisprudence.

and Verification protocol (IPMVP), used by many ESCOs. However, the protocol is not yet known by the Swiss potential clients. Currently this results in a risk of legal dispute in the contract's exploitation phase.

How to improve the situation:

The risk of a legal dispute will be mitigated in the future when a more mature market has established and sufficient explanation is provided by the ESCOs on measure and verification procedures.

The measures and verification procedure also needs to be validated with the client before the contract is signed. This procedure must also be included within the contract

Additionally, clauses of renegotiations of the measurement protocol can also be included in the contract to increase flexibility *ex post*.

6.1.4 Criterion of realization cost

The last information barrier mentioned is linked to the clients' decision criteria that can be misleading in the sense that they do not properly account for the costs and savings incurred during the entire lifetime of the installation. For clients, up-front realization cost is often more decisive than overall costs including operation and energy costs during the installation's lifetime. This problem relates not only to EPC, but to energy efficiency investments in general. Indeed, the underestimation of future energy cost savings can be an explanation to what is termed the *energy efficiency gap*[52].

How to improve the situation:

In this context, EPC may even be seen as a solution to this problem, especially when the ESCO finances the installation, because it allows significantly reduced realization costs, and at the same time decreased credit constraints, by spreading the payment of the installation during its entire lifetime. Turning this barrier into an advantage for clients opting for EPC will be a matter of information dissemination.

6.2 Barriers related to risk for the ESCO

While the information barriers concern potential clients, barriers concerning the ESCO's are described in the following.

6.2.1 Financial risks

The present section describes the difficulties linked to credit access or financing risks for EPC projects. Because these projects include energy efficiency improvements, their return is mainly determined by their ability to bring energy savings, which comes with a

[52] For more on this, read Klinke et al. (2016), section 3.3.

significant risk, as described in this section. It is important to note however that these three financial risks can hardly explain the delay of the Swiss EPC market development since they also exist abroad.

Another financing barrier, which concerns only public potential clients, lies in the fact that it might be legally problematic for a private firm to finance a retrofit project in a public building. This barrier, related to the legal framework, will be described in section 6.3.1.

When the ESCO or a third-party investor finances a performance contract, it bears a significant risk for three main reasons:

1. Any energy efficiency investment provides energy savings that are difficult to capture and communicate as well as uncertain *ex ante*. This includes any technological risks as well as the risk linked to a change in the final user's behavior, in the building occupation or in the processes. The expected profit of the investor can therefore be subject to a substantial risk. Without a comprehensive risk appraisal of each project, third party investors may be reluctant to invest in EPC.

Khoury et al. (2016) emphasize the importance of a proper follow-up on users' behaviors and necessary adjustments of the technical settings during the operation phase in order to reduce the gap between expected and realized energy savings. With regard to this, EPC presents a clear advantage as opposed to standard energy efficiency investments since the ESCO has the incentive and the mean to undertake this follow-up and an appropriate control after the implementation of the equipment.

The advantage of EPC to mitigate this risk has also been emphasized by some of the interviewed financial institutions. The fact that an ESCO is guaranteeing the savings, provided it is a big and experienced ESCO, was sufficient for them to reduce the perceived performance risk. Yet, this does not guarantee that all EPC projects will be financed easily. This is due to a possible mismatch between financial institutions requirements and currently implemented EPC projects (see section 4.7)

How to improve the situation:

the "forfaiting" EPC scheme can be seen as an interesting solution for third party investors, who provides the ESCO with financing and gets paid with a fixed proportion of the expected energy savings (see also swissesco (2016)). In this case, the investor bears none of the performance risk since the ESCO provides a fixed guarantee on the savings.

Another solution would be for the ESCOs to provide the financial institutions with comprehensive tools which compute the technical and economic risk related to each project allowing them to lead a proper evaluation. This has been done for instance through the Investor Confidence Project (ICP), which aims at standardizing the documentation, the evaluation and implementation of energy efficiency projects (Nolden and Sorrell (2016)).

Finally, all financial risks in this section could be mitigated via diversification. This can be done for instance by pooling several projects, such as in a "Super ESCO" organization, as has been done in several developing countries, such as China or India, in order to leverage enough public and commercial financing (Limaye & Limaye (2011)). However, this mechanism may not be the most appropriate approach in the Swiss context, characterized by very heterogeneous EPC suppliers in terms of financial needs. Indeed, it may be difficult for small ESCOs to convince larger ones with sufficient financial resources that aggregating the projects is necessary[43].

More simply, an EPC project can also constitutes a pool of energy efficiency measures in which the underachievement of one action can be offset by the savings generated by other measures.

[53] As a matter of fact, this kind of solution had been raised 20 years ago in Switzerland in order to develop the energy supply contracting market. This finally failed because large energy companies did not need any financial support and could develop the market without having any coordinated organization across all energy contracting providers. As a result, several small firms who were interested in providing energy supply contracting finally left the market as they were lacking financial resources.

2. The ESCO also typically bears the risk of unexpected costs in a project. Indeed, because the upfront cost is defined in the contract according to the estimations from the detailed audit, any additional unexpected costs are borne by the ESCO. These include the unexpected costs at the construction phase or at the operation phase.

How to improve the situation:

A contractual clause should be added to clearly define the responsibilities of each party. As described in the economic theory, optimality would require that the risk should be borne by the agent which is the most able to mitigate it. This strategy permits to reduce both the risk *ex ante* and minimize the costs once they occur. Therefore in theory, the ESCO should be responsible for additional charges resulting from errors of estimations or technical issues and the client should be responsible for unexpected costs that are resulting from drastic changes in its behavior, malpractice from its employees, etc. Iimi (2016) also shows that public clients should bear institutional risks related to changes in regulations framework. This allows the ESCOs to provide their client "better investment plans with greater energy savings at lower costs".

In order to limit the risk of unexpected costs, the ESCO can also add to the contract that any additional costs resulting from external factors independent from the ESCO's immediate control should be imputed to the client.

3. Further, financial risks are related to the credit rating of the client and the future prospects of its business development. The investor carries the risk of losses in case the client becomes insolvent during the operation phase or if the client decides to move and the new building owner is not ready to take over the contract. This is due to the fact that performance contracts often involve installations or measures of energy efficiency, whose property cannot be transferred to the investor in case of insolvency. A significant part of the work provided by the ESCO is also in the form of services, such as detailed audits, monitoring, measure and verification. As a result, a large part of the investment cannot be covered by collaterals owned by the investor.

How to improve the situation:

In order to mitigate the risks of client's default or relocation, contractual clauses may be included in order to protect the investor. For instance, a contractual clause can require from the client to pay an indemnity to the ESCO, in the case he moves out of the building during the operation phase and cannot convince the new building owner to take over the contract with the ESCO. Alternatively, ESCOs could build together a guarantee fund in order to mitigate the risk of clients' defaults.

Other solutions to induce energy efficiency investments are currently explored to receive facilitated access to credit as foreseen in some cantons (e.g. canton Fribourg). Under such a scheme, the cantonal bank proposes credit at a low interest rate for large energy consumers' energy efficiency projects and the canton guarantees to reimburse the bank in case the client goes bankrupt. This kind of mechanism, still under consultation, could be a promising instrument to promote the ESCO market and more generally energy efficiency investments.

Finally, the financing institution has the option to opt for real estate liens which are described in more detail in section 6.2.1a)

a) Real estate liens for risk mitigation (excursion)

Regarding the risk of the client becoming insolvent or relocates, risk mitigation strategies exist in the law such as the registration of mortgage notes or mortgages. Table 10 summarizes advantages and shortcomings for ESCOs or other creditors to opt for one of these two kinds of real estate liens when financing EPC, as compared to having no such security. Real estate liens allow the ESCO or the investor to guarantee the receivable by the building's value. The lien gives the right to the creditor to make the debtor sell the building, in order to get the payment of the guaranteed receivable (Steinauer (2012)). However, the building may already be encumbered with one or several mortgages. And the reimbursement priority in case of the debtor's bankruptcy depends on the rank of the lien, which will probably get a lower priority than existing liens, unless the ESCO or the investor can benefit from an empty case with higher priority[54]. As a result, the real estate lien security is not absolute and the degree of coverage will depend on the rank the creditor can negotiate on and, finally, on the building's value at the time of sale.

[54] Unless it is specified otherwise in the contract, the reimbursement priority system used by default in Switzerland is called the fixed cases system. The building's value is divided in shares. The rank of each share defines the reimbursement's priority. The rank is determined by the contract, and once a lien is deregistered, its corresponding case stays empty. The debtor can use it as she so wish. The liens' contracts may however define another reimbursement's priority system as well as agree that the creditor can benefit from future empty cases with higher reimbursement's priority. In case several liens benefit from the latter agreement, the date of the lien's registration determines the priority to benefit from empty cases. It is also worth mentioning that some specific legal direct real estate liens may legally benefit from the highest priority ranks, regardless of their registration date (Steinauer (2012)).

Nevertheless, it is worth mentioning that even if the guarantee through a real estate lien is not absolute, a creditor with a lien will always be reimbursed in priority over other creditors. As a result, contracting a lien is always safer for the creditor in case the client gets bankrupt.

Table 10: Creditor's advantages and shortcomings of real estate liens

	Advantages	Shortcomings
Real estate liens (mortgage note or mortgage)	• Receivable guaranteed by the building's value • Creditors with liens have priority of reimbursement over other creditors • In case of relocation of the client, additional incentive for the new owner to take over the contract	• Still some risk: degree of coverage depend on building's value and on priority rank of the lien • Inscription to land registry • Increases transaction costs • Reluctance of the client • May be complicated to implement for an existing building with condominium ownership (e.g. floor ownership)

Real estate liens may also present an advantage in case the clients relocate and a new owner takes over the building. When the client sells the building, it affects neither the debt, nor the liens affected to the building (Steinauer (2012)). As a result, if the initial client leaves without reimbursing the debt, either the new owner takes over the debt or the building will still guarantee the debt of the initial client. Thus, if the new owner does not want her building to guarantee someone else's debt, she will have an incentive to take over the debt and probably the energy performance contract with it.

However, real estate liens also come associated with some costs. We mentioned in chapter I that a reason why energy performance contracting was not suitable for all energy consumers is that transaction costs for these contracts are subsequent. Requiring a real estate lien may increase them even more significantly. The client may also be reluctant to contract an additional mortgage, especially for energy efficiency measures in the building. Indeed, a company may prefer to keep empty cases for core business future credit needs.

Real estate liens may also appear to be inappropriate for existing buildings with condominium ownership, i.e. for instance commercial, residential or office buildings with co-ownership. In these cases, an energy performance contract, and its potential real estate lien, would certainly encompass the whole building. However, if one or several shares of co-ownerships are already encumbered with liens, in principle the building's basis can no longer be mortgaged ex post. The only exception to this would be that the new mortgage on the building's basis can get a priority rank over all liens on co-ownership shares. But such a priority would require the agreement of all existing creditors guaranteed by a lien on a co-ownership share (Steinauer (2012)). This requirement could further increase transaction costs.

Finally, it is worth noting that in principle public buildings, i.e. that serve a goal of public services, cannot be encumbered with real estate liens (art. 10 LPcom (1947)[55]). This also concerns all administrative buildings of the confederation. In general, it is also the case of cantonal and municipal administrative buildings, unless the cantonal law emitted some authorizations.

If the ESCO or the investor decides that the advantages of real estate liens outweigh the shortcomings, he must then decide which kind of lien he will propose to the client, i.e. either a mortgage note or a mortgage, any other kind of real estate liens being prohibited in Switzerland (Steinauer (2012)). Advantages and shortcomings of the mortgage note over the mortgage are presented in Table 11. The main difference between the two concepts resides in the fact that a mortgage implies a real estate lien which is distinct from the guaranteed receivable. This means that the mortgage can for instance be created for a future or even an eventual receivable. In the latter case, the mortgage will materialize only when the guaranteed receivable appears.

Table 11: Mortgage note vs. mortgage.

	Advantages over mortgage	Shortcomings with respect to mortgage
Mortgage note	• Can mobilize the soil value	• Inappropriate to guarantee receivables with an amount that can vary

The mortgage note, on the other hand, includes at the same time the receivable and the real estate in an inseparable manner. This inseparability presents the advantage of mobilizing the soil value in a note. That is, the investor or the ESCO could sell both the receivable and the lien to a third party relatively simply, i.e. to another investor for instance.

However, the mortgage note can include neither condition nor counter performance ("contre-prestation"). As a consequence, this kind of lien is rather inappropriate when the amount of receivable can vary (Steinauer (2012)). In the energy performance contracting context, such an amount can vary for instance when a contractual clause specifies that some additional costs can be imputed to the client under certain conditions (e.g. if the client reduces its business activity or if these additional costs are a consequence of bad management from the client). This would also happen if once the amortization of the capital financed by the ESCO is completed, the parties agreed to share the energy savings during the remaining contractual period. In these two examples, it would be impossible to specify ex ante the precise amount the client will owe the ESCO. When it is the case, a mortgage would be more appropriate. Indeed, a mortgage can be registered for an undetermined receivable. The two parties must then agree on the fixed

[55] LPcom, 1947. Loi fédérale du 4 décembre 1947 réglant la poursuite pour dettes contre les communes et autres collectivités de droit public cantonal (RS 282.11)

amount representing the maximum of the real estate guarantee. This is called the maximal mortgage.

6.2.2 Lack of energy savings potentials

The second risk concerns potential new entrant ESCOs. Even for engineering firms or utilities which already possess a profound technical knowledge on audits, new technologies, and measures of energy efficiency, they need reasonable investment in terms of multidisciplinary knowledge, especially in the domain of contractual arrangements and legal prescriptions and measure and verification processes before entering the EPC market. As a result, a firm considering an entry into the market must be certain of the economic potentials of the market, and for EPC, these are equal to the energy savings potentials. Several potential actors claimed, however, that assets and machinery parks in Switzerland are in most cases in good condition due to existing legislation. Consequently, energy savings would rather be limited compared to the investment size and potentials for EPC market would not be as promising as they initially seemed.

How to improve the situation:

There is a lack of consensus among actors or potential actors over the claim of insufficient energy savings potentials among large private and public energy consumers in Switzerland. This would need further research.

On the other side, training programs on energy and building management, such as those proposed at the University of Geneva and at the ZHAW can provide assistance to help interested companies to enter the ESCO market at reasonable costs.

6.3 Legal barriers against EPC

In the following, the most important legal regulations are discussed which are closely related to financial and accounting aspects limiting the deployment of EPC in Switzerland.

6.3.1 Private financing on public buildings

A first barrier that appears in the Swiss legal context lies in the fact that it is not always clear whether and under which conditions a private firm can legally finance a retrofit project in a public building. This was the case for instance in canton Geneva, where a municipality was interested in EPC, but the entire project was halted in an initial negotiation phase because of this potential legal issue. After the agreement from the canton, the project is now continuing. In most cases, financing energy efficiency projects through private funds are possible, but must be approved by legislative or executive municipal instances. In certain large municipalities, such as cities, financing options should additionally be approved by cantonal executive councils. These requirements

depend on the cantonal laws on municipalities, which can differ considerably from one canton to another.

How to improve the situation:

Facilitators with appropriate legal experience can be important actors in assisting the municipalities which are not familiar with the details and various possibilities of private financing.

6.3.2 Off-balance sheet financing

Several actors have emphasized that an important driving factor of EPC abroad is the accounting benefit it can bring when the ESCO finances the project, for instance in case of "shared-savings" contracts. Indeed, because this kind of contract implies that the investment is financed through the energy savings achieved, it should be possible to account for it into the books as an operational expenditure (opex), as opposed to a capital expenditure (capex) and thus use off-balance sheet financing.

This has been presented as a clear advantage particularly for public entities, because it allows them to avoid impact on the public degree of debt or public expenditure, provided that no credit is indeed accounted ("10 Argumente" (2010), Berger et. al (2012)). Off-balance sheet accounting can also be an advantage for private clients from an income tax perspective, as well as to keep debt to equity (D/E) and leverage ratios low.

However, it is not perfectly clear whether this kind of accounting procedure is legally allowed in Switzerland. This should be explored in further research in order to determine whether it can really be used as a driving factor for the Swiss EPC market.

In the following two subsections, we introduce the conditions under which private clients (subsection a) and public clients (subsection b) can use off-balance sheet financing.

a) Accounting EPC for private clients

From the perspective of private clients, accounting procedures depend on the accounting standard the firm is submitted to (e.g. International Financial reporting Standards (IFRS), IFRS for SMEs, SWISS GAAP FER, etc.) and on the financing scheme. Figure 9 presents an overview of the accounting possibilities depending on these elements.

Off-balance sheet financing cannot be used if the client finances herself the installation. In this case, because the installation represents a tangible asset owned by the client, it must be accounted for in her balance sheet. It is more complex when the ESCO finances the installation. First, one should determine whether the EPC should be considered as a lease contract. On the one hand, this may depend on the standard the firm is submitted to, since the defined scope of the standard on leases varies between the IFRS, the IFRS

for SMEs and the SWISS GAAP FER[56]. On the other hand, whether or not EPC should be accounted as a lease is subject to the interpretation of the definition of a lease. In the international standards, "A lease is an agreement whereby the lessor conveys to the lessee in return for a payment or a series of payments, the right to use an asset" (IAS 17 (2003)). As can be seen on the webpage "Leases project summary" (2015), this definition has been subject to recent discussion. Recommendations such as IFRIC 4 (2004) provide additional guidance to determine whether a contract contains a lease. This illustrates well the complexity of interpretation of the standards, even at the international level. Additionally, it is worth mentioning that it is the substance of the contract which matters, regardless of the form of contract. This means that the contract must not have the legal form of a leasing contract to be considered as such in accounting. As a result, and quite surprisingly, the question does not depend on the ownership of the asset[57].

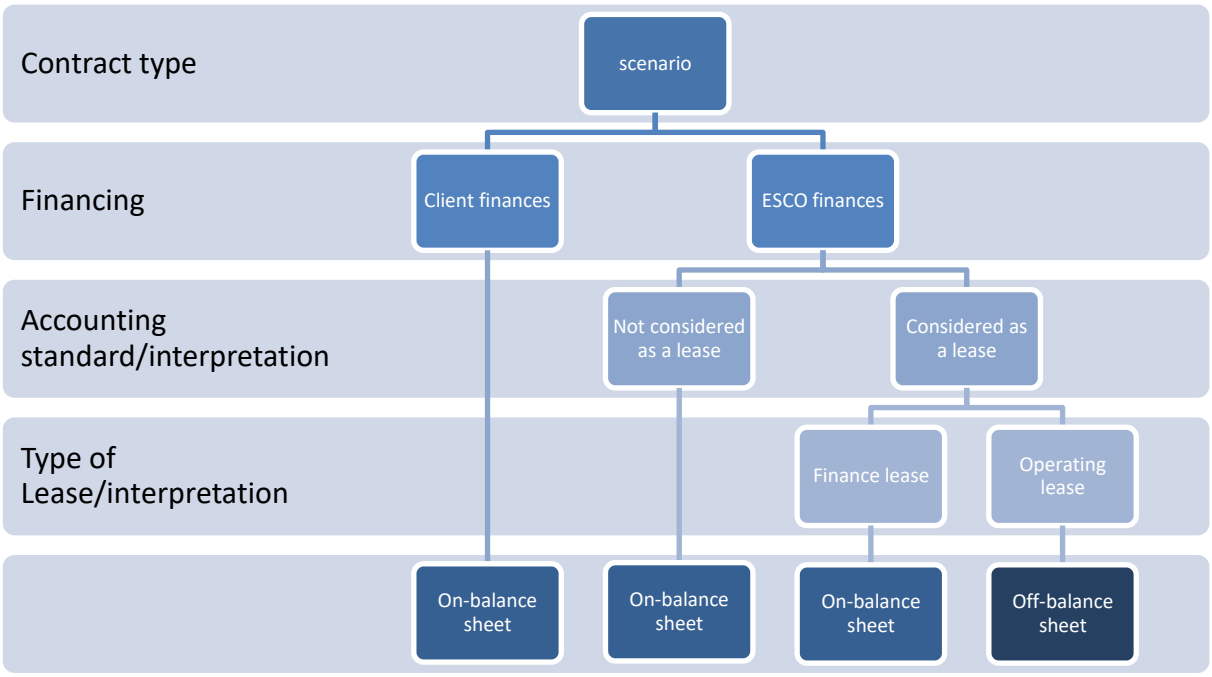


Figure 9 On-balance or off-balance sheet financing for private clients

[56] See IFRS (2015) for which kind of firm is submitted to which standard. This profile can be subject to changes from time to time. See PWC (2011), pp. 83 and ss. or more recent version for more information on the differences in the scope of Leases' standards.

[57] When EPC projects are financed by the ESCO, both ownership schemes are seen: sometimes the ESCO directly transfers the ownership to the client. This is the case particularly when (1) the ESCO wants to avoid the transaction costs and complexity linked to easements needed to keep ownership and when (2) transferring the ownership is unavoidable because of the energy-efficiency measures implemented, such as envelope retrofitting, where easement are not allowed. In other cases, when it is possible, the ESCO keeps the ownership during the whole contract duration, by the mean of an easement.

An EPC project typically transfers the right to the client to use an asset, installed by the ESCO, in return for a payment. As such, it can be considered as a lease. But the details underlying the definition are more complex than that, as described in IFRIC 4 (2004): A contract should be considered as a lease if two conditions are met:

1. The execution of the agreement depends on the use of one or several specific assets
2. The agreement conveys the right to use an asset, i.e. one of the 3 following conditions is satisfied:
   a. The client has the possibility or the right to exploit the asset while obtaining or controlling more than an insignificant part of the production or utility of the asset.
   b. The client has the possibility or the right to control the physical access to the asset in order to obtain or control more than an insignificant part of the production or utility of the asset.
   c. It is not probable that one party, other than the client, will take more than an insignificant part of the production or utility of the asset during the contract and the payment of the client is not fixed by produced unit.

As a result, if the accountant scrupulously follows these recommendations, there are at least two examples of EPC which should not be accounted as a lease.

First, when the ESCO finances the EPC and that only a certain quantity of energy savings is specified, but no specific asset is determined in the contract, i.e. the ESCO has the right and the possibility to use any asset in order to meet these energy savings, then the contract should not be considered as a lease, as condition (1) is not satisfied[58].

Second, in the case where the ESCO finances the project and is 100% repaid by the energy savings achieved during the whole contract duration[59], and that the ESCO controls fully the exploitation of the installation, then none of conditions 2a, 2b or 2c are met.

Beyond these specific instances, if the contract's agreement substance leads to conclude to a lease contract, the accountant must determine whether it is a finance lease or an operating lease. As can be seen in Figure 9, this is what makes the complete difference and may allow accounting for EPC off-balance sheet. In this case again, the international standards' definition may be subject to interpretation.

At first sight, when considering the general difference between these two kinds of lease, EPC would rather be determined as an operating lease[60]. Indeed, IAS 17.12 (2003) states that if the contract does not transfer the quasi-totality of the risks and ad-

[58] This is however rare in practice since the contract often specifies with precision which are the actions that will be implemented.

[59] This can be used by the client as a mechanism to reduce the contract's length to its minimum.

[60] The following development explains the details of the International Financial Reporting Standards (IFRS). Some small differences may occur in case of IFRS for SMEs or SWISS GAAP FER. See PWC (2011), pp. 83 and ss. or more recent versions for more information on this.

vantages onto the client, the contract should be classified as an operating lease, and as such, off-balance sheet is allowed. As a result, with regard to this sentence, any EPC contract that can be considered as a lease should be an operating lease because some of the risks are borne by the ESCO, either because it provides the client with a guarantee on the energy savings achieved or because it shares the energy savings with them. In the latter case, the advantages of the installations are also taken partly by the ESCO, supporting further the classification as an operating lease.

However, considering EPC as an operating lease may be contradicted by several elements, which, taken individually or jointly, should lead to the conclusion that EPC must be classified rather as a finance lease (17.10 (2003)). The elements which are likely to be satisfied in EPC contracts are cited here:

1. The contract transfers the ownership of the asset to the client at the end of the contract
2. At the beginning of the contract, the actualized value of the payments to the ESCO is at least as high as the value of the asset installed
3. The assets are so specific that only the client can use them without greatly modifying them
4. If the client can terminate the contract, the losses borne by the ESCO related to the termination are at the expense of the client

To summarize, whether an EPC, financed by the ESCO, can indeed present the advantage for off-balance sheet accounting is subject to interpretation and depends on the details of the agreement between the ESCO and the client.

How to improve the situation:

The client will probably need the advice of accounting experts to resolve the issue on a case by case basis if the procedure cannot be standardized by legal means. Anyway, the preceding development has shown that it would be wrong from the ESCOs' perspective to systematically present EPC as a way to account for investments in energy efficiency measures off-balance sheet.

b) Accounting EPC for public clients

In the context of public clients, the accounting practices in terms of leases are even more complex to determine. Reporting in details how EPC should be accounted for in each public jurisdiction is out of the scope of this study. It is worth mentioning, however, that the number of different public accounting standards at each cantonal level is likely to be reduced in the near future, since all cantons agreed to harmonize their accounting procedures according to a standardized model (MCH2 (2014)), which they should be implementing within the next 10 years. Several details could lead one to conclude that the MCH2 treats the lease contracts similarly to the IFRS procedure detailed in the preceding section. For instance, this model also recommends considering the substance over the form of the contract in order to establish whether it contains a lease. Second, a finance lease contract is also defined as transferring to the client the quasi-

totality of the risks and advantages. And finally, as in the IFRS, if the accountant can conclude that it is rather an operating lease, then off-balance sheet accounting is required (CSPCP (2010)).

In any case, even when off-balance sheet would be allowed with regard to the accounting requirements, it is possible that additional requirements, such as an approval from the executive organ of the canton or municipality, may exist for off-balance sheet accounting. This is because it would require allocating part of the expenditures account for investments' purpose. And in some cases, as in the canton Vaud, this approval has to be reconfirmed every year, again considerably increasing the transaction costs.

The possibility to use off-balance sheet accounting is a crucial element to be clarified for public entities. In the current conjuncture of low credit costs, ESCO's financing may only be interesting if it allows public entities to invest in energy efficiency when credit constrained by debt ceilings. But circumventing debt ceilings may only be possible through off-balance sheet, i.e. accounting the project as an operational expenditure and not a capital expenditure.

This leads to the conclusion that, in Switzerland, perhaps in contrast to other countries, off-balance sheet accounting and therefore ESCO's financing can hardly be shown as a systematic advantage of EPC for public clients until the legal requirements are not clarified.

6.3.3 Transfer retrofit costs onto the tenants to overcome the split incentives barrier

The difficulty for landlords to transfer the costs of energy-efficiency measures implementation onto the tenants can result in split incentives and subsequently to underinvestment in energy efficiency. As we have already mentioned in chapter I, this explains why this legal barrier is often used to explain a significant part of the energy efficiency gap[61]. As a result, it is not surprising that ESCOs are also confronted with this problem when trying to implement an EPC project in a building containing some tenants.

At first sight however, when exploring the legal framework in Switzerland, this barrier does not really seem binding. Indeed, in theory, it appears that the landlord could transfer the energy efficiency measures costs onto the tenants. The Swiss obligation code first states that: "in general, the rents are not abusive when they are justified by a raise in costs or by some value added from the landlord" (art. 269*a*, let. b, Code des obligations (CO)). This value added is determined notably as the following energy improvements (art. 14, al.2. OBLF-VMWG (1990)):

- "The measures to reduce the energy losses of the building envelope"
- "The measures for a rational energy use"
- "The measures to reduce the emissions of the technical installations"
- "The measures to use renewable energy"

[61] See for instance Gillingham & Palmer (2013)

- "The replacement of high-energy consuming appliances with low-energy consuming appliances".

In practice, however, the application of the obligation code and the order is more complex. First, a 100% transfer of the costs may not be allowed since the law mentions "value added". Hence, for instance, if the landlord replaces old windows with double-glazing windows, they cannot transfer the total cost of these new windows since the value added is only the difference between the double-glazing and the old windows. As a result, the computations of this "value added" are subject to interpretation and the landlord is not protected from refusal by the tenants once the energy efficiency measures have already been implemented.

Moreover, some cantons may be more restrictive in the way the costs of energy efficiency measures can be transferred onto the tenants. This is the case for instance in Geneva, where rents are already high and the law on demolitions, transformation and retrofit of residential houses (LDTR (1996), art. 9, al. 6) gives a precise limit over which the landlord cannot transfer the costs onto the tenants.

Adapted EPC solutions have been implemented in the US and Australia to overcome split incentives (Nolden and Sorrell (2016)). These include for instance on-bill financing, i.e. repayment through the electricity bill. Such schemes may however not be applicable in Switzerland since the law forbids the owners to transfer capital costs onto the variable charges of the tenant[62]. However, if EPC involves only equipment optimization without investment, then the tenants could pay for it within its charges.

To conclude, whether the ESCOs can actually help the landlords to invest in energy efficiency measures will probably depend on their ability to advise these actors on how and under which conditions they have the possibility to transfer the costs onto the tenants.

6.4 Political barriers

In the following, we introduce how the energy policy currently lead by the Swiss authorities is perceived by the ESCOs as affecting the EPC market deployment.

6.4.1 Lack of legally constraining objectives on energy savings

Currently, large energy consumers are obliged to improve their energy efficiency[63] and with this a political defined threshold is set. For such companies, EPC can be a tool to satisfy these requirements, under certain conditions (see the following subsection). For all other energy consumers, the need for energy efficiency measures is lower since not

[62] One exception is district heating (OBLF 6a: Ordonnance sur le bail à loyer et le bail à ferme d'habitations et de locaux commerciaux.) The law is however unclear when it concerns a heating system owned by an ESCO but still in the building, as is typically the case in ESC. This lack of clarity represents also a barrier to ESC as shown by Klinke (2016).

[63] The thresholds for large consumer definition are established at an energy demand for electricity above 0.5 GWh per year and or a heat demand of above 5 GWh per year.

only the legally constraining objectives are lacking but also low energy prices are decreasing the pressure to act.

One can see this segregation between large consumers and all others as a lack of legally binding constraining objectives on energy savings, which can therefore be perceived as a barrier to both energy efficiency and EPC for a part of the market. In response to this, interviewed cantonal authorities have pointed to the fact that policy on large private consumers is already ambitious, with the aforementioned legal requirements (cf. section 7.2).

How to improve the situation:

A potential approach to increase the market deployment through energy efficiency obligations could be to lower the legal threshold of defined large consumers. The cantonal authorities interviewed emphasized that in order to do so they would first have to make sure the supply side is sufficient to respond to this increase in demand.

Another possibility is to support the realization of EPC projects within public buildings. Indeed, large public energy consumers are an interesting target for EPC, and the latter could add external incentives to public institutions in order to increase energy efficiency in their buildings.

Regarding low energy prices, cantonal authorities are powerless. However, at the federal level the new constitutional article (131.a) currently in consultation could increase general incentives by replacing subsidy schemes starting in 2025 with an incentive system based on fuel and electricity taxes.

6.4.2 Accreditation for CO_2-tax exemption, tax reduction and/or reimbursement

The second barrier mentioned at the political level concerns the ESCOs, which want to target large private energy consumers subject to cantonal requirements. As mentioned in section 5, ESCOs must be accredited by the Energy Agency of the Swiss private sector (EnAW) or ACT, in order to supply solutions to the consumers willing to contract a universal convention of objectives. However, this may represent a barrier to potential entrant ESCOs if they cannot acquire the accreditation easily. Indeed, without such a certification, they consequently lose an important EPC advantage for this segment of clients.

How to improve the situation:

As a response to this problem, some cantonal authorities have claimed that they could eventually support potential entrant ESCOs in order to secure an accreditation.

Another solution has been found by another actor, who could certify its own monitoring tool at the federal level, in order to certify the list of actions of its clients to satisfy to the universal convention of objectives. This implies that the system is not rigid and that ESCOs may independently find a solution at the federal level. However, the implemented measures still have to be followed by the monitoring system from EnAW or ACT in order to be certified. However, the ESCOs often cannot rely on external expertise. Therefore, two parallel measure and verification processes need to be implemented for the clients who want to adopt both a universal convention of objectives and an EPC. As a conclusion, this system persists as a barrier and more specifically as a barrier to entry of the Swiss EPC market.

6.5 Behavioral and cultural barriers

A general "wait and see" attitude has also been mentioned as a potential problem in the Swiss market[64]. This is probably an important difference with respect to other countries such as Germany, where public-private facilitators, such as the Berliner Energieagentur or the DENA have been sooner proactive in promoting the EPC market. However, public authorities are currently stepping in, especially the Swiss Federal Office of Energy (SFOE) that organized some information meeting for public entities about EPC. Potential involvement from cantonal authorities, which is described in section 7.2, is also likely to change in the near future.

[64] see A. Huterer (2012) for more details on the real options decision pathway for building retrofit

7 Government's involvement

The public authorities have different roles to play in the context of EPC. On the one hand, public authorities are defining the legal framework under which the EPC market takes place (see sections 6.3 and 6.4). On the other hand, the public sector is a potential client for EPC since he owns and manages buildings with often large energy consumption. Furthermore, the authorities can act as energy agencies facilitating EPC.

It is not sufficient to consider only the different roles of the public sector. The different competences at each administration's levels are relevant to understand the current situation of EPC in Switzerland. The national and cantonal authorities share the decisions regarding the energy law, but the cantonal level is of higher relevance for EPC since the cantons define the building regulation framework. On the national and municipal level, authorities have fewer possibilities to define the legal framework. Yet, they can act as potential clients and as participant in energy agencies.

In section 7.1 we describe the already existing policy instruments regarding energy efficiency with a potential impact on the EPC market demand. A summary of the involvement of different public entities regarding EPC is provided in sections 7.2 and 7.3. Section 7.4 presents the energy policy measures and other policies influencing the supply-side of the EPC market.

7.1 Existing policy instruments on energy efficiency and their relation to EPC

At the federal and cantonal level, many policy instruments exist to promote energy efficiency and CO_2 emission reductions. These policies, can indirectly promote the EPC market by inducing investment requirements in these domains. The investors can see EPC as a solution to benefit from these instruments or to meet the legal requirements.

Table 12 provides a non-exhaustive overview of the policies currently existing[65]. In addition to these policy instruments, many measures have also been taken at cantonal or even at municipal levels to promote energy efficiency, either financially or by the means of minimal requirements, standards, and information campaigns.

[65] see BFE (2014a) and EnDK (2015) for more details on these instruments and BFE (2014a) for an overview of the international policy framework.

Table 12: Existing policy instruments for energy efficiency.

Name	Description	Targets	Organizational level	Relation to EPC
Duty of exemplarity	Public entities are legally required to set an example in terms of the energy efficiency and CO_2 emissions of their buildings.	Federal and cantonal public buildings as well as entities under the federal jurisdiction: EPFL/ETH, Post, SBB/CFF, Skyguide and Swisscom	Federal and Cantonal	EPC can be used as a tool to meet the requirements
KliK (Foundation for climate protection and CO_2 compensation)	Foundation which accomplishes for oil companies their duty in terms of CO_2 emissions compensations. These compensations include financial support and quality guarantees for building automation investments	Public and private: Offices, hotels, restaurants, schools, conference halls, hospitals, shopping centers, multi-family houses	Federal	EPC often includes building automation technologies
Action plan "Energy Efficiency"	Elaborated in 2008, it includes 15 measures to reduce fossil fuel and electricity consumptions and to develop best practices strategies. It has closely contributed to the development of some of the following measures (e.g. MoPEC, Building Program, CECB), to the promotion of R&D and formation in energy efficiency and to the implementation of minimal standards	Public and private buildings. Also targets mobility, electrical appliances, lighting and industrial processes	Federal	EPC indirectly promoted (e.g. via a benefit from R&D and formation in energy efficiency)
ProKilowatt	Provides financial support to projects or programs that promote energy efficiency and which are selected via a call for proposals	Public and Private buildings	Federal	EPC as possible support tool to improve energy efficiency

EnergieSchweiz/ SuisseEnergie (See EnergieSchweiz (2013))	Implements information campaigns, formation and advices in the domain of energy efficiency and renewable energy. It also contributes financially to the development of global projects, the diffusion of new technologies and to the collaboration between federal, cantonal, municipal and private actors.	Public and Private buildings. Also targets industry and services, mobility and electrical appliances	Federal	Indirect via induced investments in energy efficiency and direct via support to *swissesco*
Model of Cantonal energy code (MuKEn/MoPEC)	Prescribes measurable minimal requirements, objectives and legal requirements on buildings that the cantons can apply, whilst granting them flexibility in their energy policy. It describes the common denominator to all cantons energy strategies and objectives and includes prescriptions regarding the following measures (e.g. subsidies, large energy consumers, CECB)	Public and private buildings	Cantonal	EPC could be included as tool to achieve energy efficiency targets
Large energy consumers (see also sections 5 and 6.4.2)	Large energy consumers are required to take reasonable actions to analyze and/or optimize their energy consumption. In many cantons, these consumers can choose between 3 options: 1) universal convention of objectives (UCO) 2) cantonal convention of objectives (CCO) 3) Energy Consumption analysis (ECA)	Private or public large energy consumers (>5 GWh of annual heating consumption or >0.5 GWh of annual electricity consumption)	Cantonal for CCO or ECA Federal for UCO (energy agency for the economy (EnAW) or Swiss cleantech agency (act))	EPC as a turnkey solution (when the ESCO is certified)

Building Program (Gebäudeprogramm / Programme Bâtiments)	Subsidy scheme promoting energy efficiency measures in buildings. Financed through the CO_2 tax and cantonal funds	Private buildings (insulation refurbishment projects, renewable energy, heat recovery and energy optimization of technical installations)	Federal and Cantonal	Indirectly via induced investments in energy efficiency
Cantonal energy certificate for buildings (GEAK/CECB)	This certificate allows determining the energy label (from A to G) of a building, based on its energy needs. Some cantons provide subsidies for refurbishment projects which lead to a gain of level(s) in the energy label.	Private and public buildings	Cantonal	Indirectly via induced investments in energy efficiency
Minergie	Represents an energy label for buildings with high quality insulation and ventilation. Some cantons provide some financial supports to reach the standard of the label.	Private and public buildings	Cantonal (initially), now Federal and Cantonal	limited (often used in new buildings and more rarely to old buildings retrofitted as in EPC)
CO_2 compensation	Projects that are proven to contribute to CO_2 reductions can be recognized by the federal office of environment as a compensation projects for fuels importer	Private and public buildings	Federal (BAFU/OFEV)	Indirectly via induced investments in energy efficiency

7.2 Cantonal involvement

7.2.1 Cantons acting as regulators

In certain cantons, such as Vaud, EPC is explicitly mentioned in the law, where EPC has a broader definition than what we consider here. Indeed, any contract including an energy efficiency objective is considered as an EPC in this law, which can be used by large residential energy consumers as one of several possibilities to meet cantonal requirements for large consumers[66]. Other cantons may follow the lead of Vaud. However, this does not concern non-residential large energy consumers who can choose between three options (cf. sections 5 and 6.4.2) and where EPC is not a sufficient condition to meet legal requirements.

Additionally, cantons can improve the legal framework for EPC by removing some of the aforementioned barriers (see sections 6.3 and 6.4).

7.2.2 Cantons acting as energy agency

Some cantons could envisage the introduction of financial support to EPC by subsidizing pre-studies or audits. Some cantons, such as Vaud, already provide subsidies for energy analysis and pre-studies for large consumers. They also support the association swissesco to finance lectures and courses on EPC.

Cantonal authorities are also open to the possibility of providing information sessions to large private and public energy consumers about EPC. Informing large private energy consumers is easy for cantonal authorities, who are already in contact with them regarding the canton's legal requirements. Websites and brochures could also be part of the information campaign.

Moreover, the cantonal energy offices would be inclined to inform building services of the canton or municipalities about EPC and the advantages of such contracts.

7.2.3 Conditions

According to the cantonal authorities interviewed, all these potential actions will materialize only if certain conditions are met.

First, cantonal energy office directors need to be better informed about advantages and shortcomings of EPC by a neutral party.

Secondly, before informing the demand side, some cantonal authorities want to make sure the supply side is sufficiently developed to allow for adequate competition and significant examples required to validate the business model. Finally, in order to further inform other public entities, such as municipalities, the cantons must be informed about

[66] Règlement d'application de la loi sur l'énergie (RLVLEne Art. 50e), Conseil d'Etat du canton de Vaud, version 1 du 02.07.2014, entrée en vigueur le 01.02.2015

potential legal, accounting, or tendering requirements for public buildings. As a result, in a first step, cantonal authorities must probably be informed regarding all these issues. This role could be partly played by the SFOE.

7.3 Swiss Federal Office of Energy (SFOE)

7.3.1 National authorities acting as clients

The SFOE is currently considering the implementation of a pilot EPC project on a federal public building to be shown as an example.

7.3.2 National authorities acting as energy agency

- The SFOE provides financial and staff support to the association *swissesco* in its first 4 years of operation
- The SFOE is also considering several measures, including the target to define unified methods of measurement and verification, staff training, and facilitated access to financing.
- SFOE is currently supporting different studies and actions which aim to reduce information barriers described in section 6.1.

Overall, public authorities, at both the federal and cantonal levels, are ready to step in to help foster the emerging Swiss EPC market.

7.4 Policy measures influencing the supply-side of the EPC market

Interviewees were asked whether any policy measures, such as the liberalization of the electricity market for large consumers, or other future potential regulations, had or could have any influence in the interest to provide EPC. None of the utilities interviewed considered the electricity market liberalization as a trigger to provide EPC. As a matter of fact, only one actor mentioned it as having played a potential role in their decision to enter the EPC market, in order to retain their clients, but only as a conjunction to other more important factors, such as a general willingness within the firm to promote sustainability using market instruments.

The new constitutional article (131.a) currently in consultation has also been mentioned as a factor that could increase general interest in providing EPC. The suppliers will indeed have to respond to a demand increase for energy efficiency solutions, triggered by the system based on fuel and electricity taxes implemented in this new law.

The so-called "Lex Weber" has also been mentioned as having a potential impact on the EPC provision in some cantons. Entered into force in January 2016, this constitutional article prohibits the construction of secondary residences in municipalities, which have already reached a 20% share. In some highly-impacted cantons, such as in Valais, this law provokes an important slow-down in the construction sector and particularly affects

the business of small local entrepreneurs. According to Prof. Stéphane Genoud (HES-SO Valais), this is likely to give a forced incentive to these actors to retarget the construction sector towards energy refurbishment of existing buildings, and to possibly involve themselves in EPC projects, either as ESCOs, in a consortium of small entrepreneurs, or as suppliers of the ESCOs.

8 Conclusions

In this report, we analyzed the framework conditions for the EPC market in Switzerland. Our study indicates a growing interest and suggests an active start from the first actors who have recognized the potential of this business model. However, various barriers exist and prevent EPC from reaching its full potential within the country. In particular, it is the combination of several barriers which currently increases the transaction costs in such way that the involved parties opt for less binding energy services, namely without guaranteed or shared savings. More specifically, the design of guidelines for public tendering is expected to play an important role in the EPC market deployment in Switzerland. EPC with public entities has indeed been a trigger in the EPC markets abroad (chapter I) and the complexity of public tendering procedures applied to EPC seems to be its most binding constraint. Our analysis concludes that the success of these guidelines depends on their ability to strike the appropriate balance between the rigor required by the law and the flexibility required to prevent unnecessary transaction costs and allow for innovative measures. The results also show that it is important to devise some guidelines as to how the costs of EPC projects can be legally transferred to the tenants accounting for cantonal specificities. This, however, may be less of an immediate priority since rented buildings may not be the initial EPC target.

This chapter also presents several contractual mechanisms or other instruments that could be used to reduce potential financing barriers to EPC. Our findings show that it is not advisable for Swiss ESCOs to systematically present EPC as an off-balance-sheet financing solution for energy efficiency projects. In Switzerland, using the off-balance-sheet argument does not appear as a winning argument for EPC. In fact, the question requires further research on comparing different possibilities by accounting experts.

Our analysis emphasizes that the facilitators are important players in supporting customers, especially public clients, to implement EPC projects. Their technical and legal experiences are crucial for negotiations before the contract is signed. They could also provide valuable assistance with public tendering procedures and legal requirements at the cantonal or municipal level that determine how and under which conditions a private party can invest in a public building.

Finally, a single persisting barrier is the difficulty for some entrant ESCOs to be accredited to allow large energy consumers to apply for tax exemption. This may require a change in the regulatory framework from public authorities.

To overcome the barriers, the public administration has a role to play, not only by reducing the lack of information from the consumer's perspective (e.g. by supporting the activities of *swissesco*), but also on the legal framework (e.g. by clarifying the conditions of a transfer of retrofit costs onto the tenants or off-balance sheet financing) as well as a client. The public sector acting as one of the potential clients can play this additional role for facilitating the market growth and simultaneously benefiting from reduced energy bills. Although this process might be time consuming, it gives the interested parties the necessary feedback and support to further develop the business.

III. Market demand for energy performance contracting and its future potentials

Abstract

This chapter aims to provide empirical evidence on the decision mechanisms through which EPC can induce investments in energy efficiency and to explore their underlying trade-offs while accounting for preference and decision patterns heterogeneity among building managers. This analysis is based on a discrete choice experiment among 297 potential EPC clients, i.e. managers and owners of large private and public buildings. The results show that the performance guarantee and the resulting risk sharing provided by EPC is consistently facilitating the willingness to invest in energy efficiency. The ESCO's financing, on the other hand, is considered positively only by a minority of respondents. These are mostly public entities, presumably with debt ceilings. We found no divergence in the decision-making or in the valuation of contractual attributes between private and public entities. The results also show that when considering complex choices such as investments in energy efficiency, one has to account for preference heterogeneity as well as divergences in the decision process simplification. We explored these using a latent class model with attribute non-attendance. The results provide interesting insights about the behavioural complexity and heterogeneity underlying the decision process regarding energy efficiency investments. Finally, while EPC can mitigate important barriers to investments, it is also facing an intrinsic reluctance from potential clients which could not be explained by its contractual attributes, such as the contract's duration or the payment to the ESCO. We argue that this reluctance mostly comes from misunderstandings of the concept and therefore could be mitigated by fostering awareness. The recent efforts provided by the federal government and the swissesco association to foster awareness of EPC solutions should therefore not decline.

1 Introduction

Energy performance contracting may be complementary to the foreseen policy measures to reach the objectives set by the Swiss energetic strategy 2050 and promote investments in renewable energy and energy efficiency. Such market-based instruments are especially important because public concerns about governments' direct interventions such as taxes and subsidies could raise barriers against energy transition policies. For instance, the Swiss energy strategy is currently questioned by a public referendum.

Empirically assessing to which extent and through which channels EPC can promote investments in energy efficiency is of primary interest for policy-makers. Provided that EPC fosters investment, then this market, which is only emerging in Switzerland, should be deployed rapidly in order to take advantage of its potentials. Evidence for positive impact would be a rational basis for government support to mitigate barriers on the EPC markets (Klinke et al. (2017b)), especially as the latter appear to be easier to address than the direct obstacles to energy efficiency investments. Furthermore, such an empirical study does not only inform about EPC adoption, but provide information on the determinants hampering investments in energy efficiency. If the energy efficiency gap exists, it is of particular concern for policymakers to focus primarily on the most binding constraints. The challenge here is to empirically explore those constraints while accounting for heterogeneity across building owners and managers, which is likely to be important in this context.

The main channels through which EPC can induce investment, such as risk sharing, access to capital, technical expertise and performance maintained over time, have been often highlighted in theoretical literature (cf. chapter I). However, quantitative evidence in support of these conjectures is rather scarce. A recent exception is Polzin et al. (2016) who surveyed 1298 German municipalities and explore the determinants of EPC interest in context of LED retrofits. They assess the impacts of stated barriers and drivers of energy efficiency investments and of EPC projects on the probability to consider EPC for street lighting LED retrofits. They find that municipalities do not value the risk-sharing advantages of EPC. However, when constrained by budget or personnel capacity, they are more likely to consider EPC options.

While providing useful insights, the current state of the EPC literature lacks empirical evidence on the decision mechanisms through which EPC can induce investments, and on their underlying trade-offs and heterogeneity. This chapter attempts to reduce this research gap using a discrete choice experiment targeted to managers of large energy-consuming buildings in Switzerland. While such experiments have been used extensively in other domains (e.g. Banfi et al. (2008), Rose et al. (2012), Blasch and Farsi (2014), Caputo et al. (2014), Hole et al. (2016)), it has to our knowledge never been applied to the EPC context. Heterogeneity in the importance attached to EPC's benefits and costs is accounted for using stated attribute importance and inferred attribute non-attendance using a latent class model. This empirical strategy permits to explore the diversity of channels through which EPC can foster energy efficiency investments.

The next section develops a series of hypotheses about drivers and mechanisms through which EPC could induce investments and reduce barriers to energy efficiency and renewable technologies. Section 3 presents the methodology, i.e. the survey design, the target group and the econometric framework. A description of the data and summary statistics are provided in section 4. Then, the results are presented and followed by robustness checks and guidelines for further research in section 6. A general discussion with conclusions and policy implications is provided in the final section.

2 Hypotheses

In chapter I (section 3.2), we highlighted four main reasons for potential under-investment in energy efficiency:

1. Credit constraint
2. Imperfect and asymmetric information
3. Landlord-tenant split incentives
4. Behavioral biases

EPC is expected to directly mitigate the impacts of the first two. Therefore, this chapter focuses mainly on these, i.e. credit constraint and imperfect information.

ESCOs can facilitate access to financing, either by financing the installation themselves through the shared-savings EPC scheme, or by third party via the "forfaiting" scheme for instance[67]. Whether the facilitated access to capital provided by ESCOs is indeed valued by buildings managers depends on their actual credit constraints with respect to energy efficiency investments. These constraints may be caused by limited access to credit at reasonable costs, debt ceilings (for some municipalities) or limited budget for non-core activities (for some private firms). In the current Swiss context with low interest rates, the first reason may be less valid. ESCO's financing may indeed be unattractive as compared to bank credits in the current conjuncture. Also, public entities may be able to circumvent debt ceilings via the ESCO's financing only if the EPC project can be accounted off-balance sheet[68]. Therefore, a share of potential clients may not value the financing advantage of EPC. As a matter of fact, this advantage is not consensually perceived as decisive by the Swiss ESCO market experts interviewed in Klinke et al. (2017b). While some experts described the clients' interest for ESCO's financing, others mentioned that the lack of need for external financing is actually hampering the deployment of the EPC market in Switzerland. In view of these considerations, we propose the following hypothesis:

H1: EPC induces energy efficiency investments through financing only in cases where credit constraints are important.

The exploration of this hypothesis will provide insights on the relative size of this subgroup of potentially credit constrained building owners.

Investment risks can be mitigated by EPC through the risk-sharing mechanism that comes along with EPC. ESCOs either provide a performance guarantee or get paid on a share of the energy savings achieved. In either case, the client benefits from the technical knowledge of the ESCO and share some of the performance risk. This leads to the second hypothesis:

[67] Because we focus here only on the client's point of view, we ignore the fact that ESCOs may also have difficulties to finance their projects (cf. chapter II), what respondents of the survey were not informed of.

[68] The feasibility of financing EPC off-balance sheet is not yet clarified (cf. chapter II, section 6.3.2)

H2: EPC induces energy efficiency investment through performance guarantee[69] which results in risk sharing.

A guarantee in business terms usually comes at a cost, which is represented by the risk premium paid to the ESCO. As in the case of ESCO financing, respondents are likely to have heterogeneous preferences and perceptions towards the technological risk. Latent class models and stated attribute attendance account for the heterogeneity in considering or not the risk-sharing advantage of EPC.

As we have seen in the literature review (chapter I), the landlord-tenant split incentive is unlikely to be solved by ESCOs. The following hypothesis follows:

H3: Having tenants decreases the likelihood of energy efficiency investment, with or without EPC.

Finally, behavioral biases are expected to have a substantial effect on the investment decision. EPC may contribute to mitigate them through awareness raising and discussion on the potential solutions for energy efficiency. Facilitators (Bleyl (2011)) may also be more relevant to reduce barriers in this context. Assessing these conjectures is beyond the scope of this study. The exploration of attribute non-attendance that we conduct in this study, may however be interesting to assess the simplifications occurring in the energy efficiency investments decision-making.

Energy performance contracting involves an additional payment which is expected to have a negative impact on EPC adoption. The impact of the contract's duration is however ambiguous *a priori.* On one hand, duration is valued negatively by the respondents reluctant to a long-term commitment and the lack of independence these contracts entail. On the other hand, a longer contractual period increases the duration of the performance maintenance and also allows more comprehensive refurbishments. Private entities may be more responsive to the first argument while public entities are likely to value more long term contracts.

H4: The payment to the ESCO has a negative impact, while the effect of contract's duration is ambiguous and depends on type of clients.

While EPC is assumed to reduce barriers related to credit constraints or technical knowledge, the literature review showed that other barriers hamper the deployment of EPC adoption as such. In the Swiss context where the concept is unknown, the lack of awareness is likely to have an impact on the willingness to adopt EPC:

H5: Unawareness to EPC results in a reluctance towards EPC solutions.

This reluctance is likely to remain after controlling for observed contractual clauses. This reluctance can be visible in differences in the way costs and energy savings are valued depending on whether they are presented in an EPC or not, once all other contractual

[69] We refer here to the general meaning of performance guarantee, which can either be provided indirectly through the shared-savings scheme or directly via the guaranteed-savings or the "forfaiting" scheme. Even if in the choice experiment we consider only the direct guarantee for simplicity, it is assumed to capture the general effect of all direct and indirect performance guarantees provided by EPC.

clauses are controlled for. It can also appear through the fact that some respondents never choose EPC, regardless of the attributes presented. In other words, contractual attributes of EPC are systematically ignored. Attribute non-attendance latent class models will be useful to explore this phenomenon. Follow-up questions on the reasons why EPC was disregarded provide interesting additional information on this and may bring guidelines for ESCOs and policymakers.

3 Methodology

3.1 Survey design

The survey is targeted to the potential demand side of EPC in Switzerland and was designed to collect the necessary data sources to explore the hypotheses described in the previous section.

The survey creation software Sawtooth was used to prepare and host the survey online. Each respondent was assigned an individualized access code so that responses could be tracked (see section 3.2 for description of target groups). This also provided the respondents with the ability to leave the survey and come back so that they could complete the questions within their own schedules.

3.1.1 Survey structure

The survey was composed of five main parts:

- Part 1: Introductory questions on the building and the respondent
- Part 2: Current situation of the building
- Part 3: Information on Energy Performance Contracting
- Part 4: Choice experiment
- Part 5: Decision process

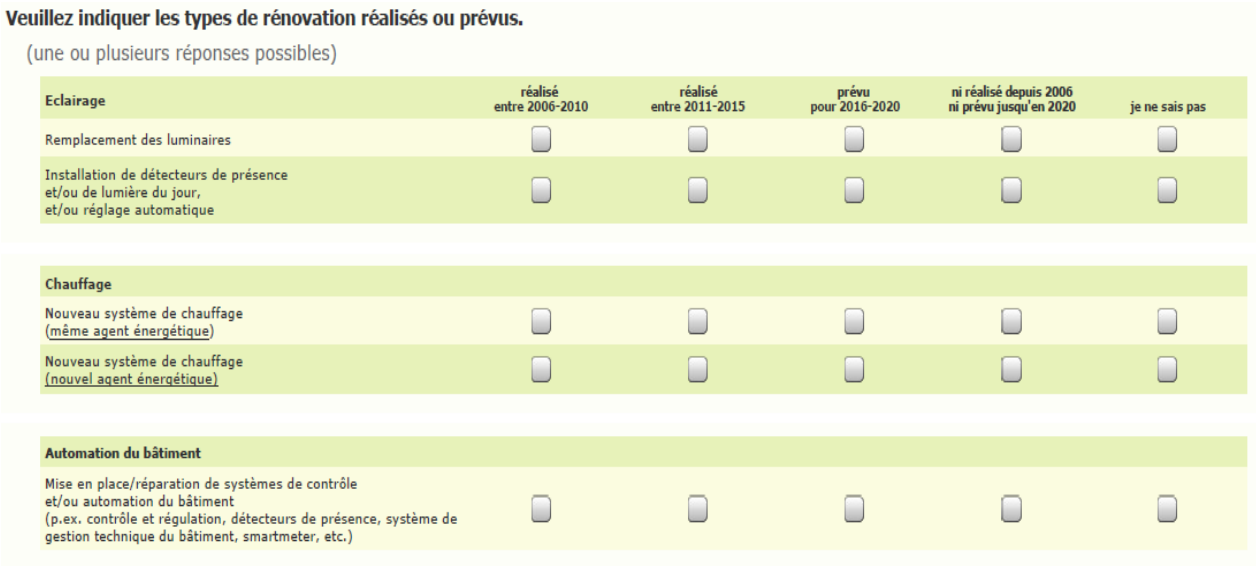
a) Part 1: Introductory questions on the building and the respondent

This section gathered general information on the building such as the type and the location of the building. The responsibility of the respondent and its decision role regarding the building was also assessed. If the respondent declared having no role in the decision process regarding investments, operation or revisions on energetic or technical aspects of the building, he was asked to give the contact of another person in charge and exited the survey. This implies that only respondents with a role to play in the decision process completed the survey. Therefore, part 1 was also intended to capture the potential heterogeneity in the respondents' roles. These can lie between advising the directors on the alternatives and taking part in the final decision.

b) Part 2: Current situation of the building

The second part aimed at capturing in detail the building characteristics such as the construction year, the presence of tenants and the size in terms of heated floor area (square meters). Special emphasis was put on the type of heating system and its age. Information on energy and electricity yearly costs was also collected as well as the presence of ventilation or cold in the building. The respondents were then asked to state if the building was managed by an employee in charge of the energetic and technical aspects, if it was certified with the 'Minergie' label and if an audit has been made since 1990. Finally, grid questions as in Figure 10 gathered information on planned and real-

ized retrofits on the walls, roof, windows, lighting, heating, ventilation and building automation.



Veuillez indiquer les types de rénovation réalisés ou prévus.

(une ou plusieurs réponses possibles)

Eclairage	réalisé entre 2006-2010	réalisé entre 2011-2015	prévu pour 2016-2020	ni réalisé depuis 2006 ni prévu jusqu'en 2020	je ne sais pas
Remplacement des luminaires	☐	☐	☐	☐	☐
Installation de détecteurs de présence et/ou de lumière du jour, et/ou réglage automatique	☐	☐	☐	☐	☐
Chauffage					
Nouveau système de chauffage (même agent énergétique)	☐	☐	☐	☐	☐
Nouveau système de chauffage (nouvel agent énergétique)	☐	☐	☐	☐	☐
Automation du bâtiment					
Mise en place/réparation de systèmes de contrôle et/ou automation du bâtiment (p.ex. contrôle et régulation, détecteurs de présence, système de gestion technique du bâtiment, smartmeter, etc.)	☐	☐	☐	☐	☐

Figure 10 Example of question on realized and planned retrofits

c) Part 3: Information on Energy Performance Contracting

Because the energy performance contracting market is only emerging in Switzerland, we expected to have a relatively high share of respondents unfamiliar with this notion. A complete section was therefore allocated to explain the concept in detail.

This included Figure 11, describing the EPC concept; an EPC example illustrated as in Figure 12 and a simplified definition of these contracts:

"Some companies provide their client with adapted energy efficiency improvement measures. Through a contract of mid- to long-run, these providers insure the operation and maintenance of the installations. Sometimes, they finance themselves partly or completely the upfront investment and/or they guarantee the client that the energy savings will achieve a minimal amount, otherwise they pay the difference. In return, the client pays a fee during the contract's duration."

For simplicity, the definition of EPC did not distinguish the "shared-savings" from the "guaranteed-savings" scheme. In the choice experiment (see next section), some of the contracts proposed included both a guarantee and a part of the investment financed by the ESCO. It was therefore important in the definition not to exclude one from the other. Also, because of the necessity to simplify the choice tasks in the experiment, only fixed payments were presented in the contract. We therefore excluded from the definition the case in which the client can pay according to a share of the energy savings achieved as in the "shared-savings EPC" scheme.

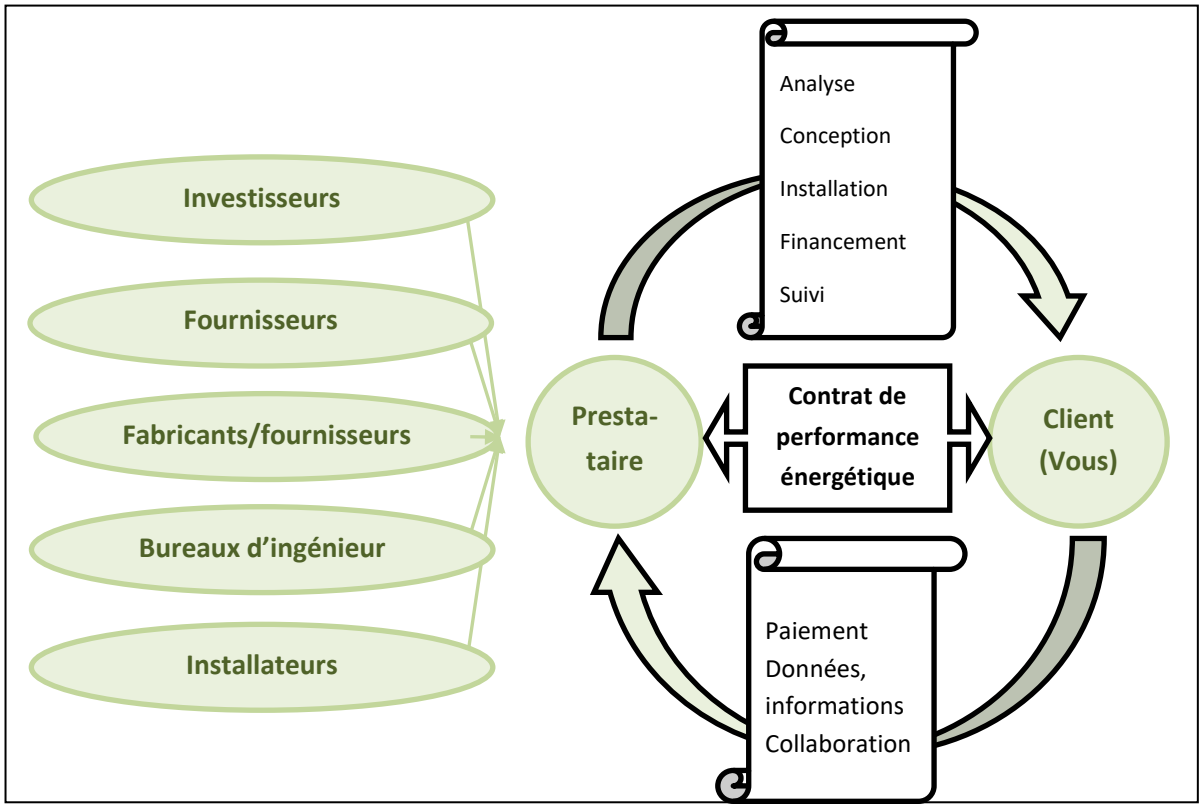


Figure 11 EPC concept diagram

The definition, diagram and example were selected in order to explain the EPC concept the more precisely and briefly as possible. The selection was made on a pretest targeted towards non-energy professionals in the friend and family circle of the authors. In these test survey, the respondents were asked between several combinations of explanations, examples and diagrams which one was the clearest. The combination used in the survey was the one which made the majority of respondents satisfied in this pretest.

After the explanations of the EPC concept, the respondent was asked about his level of understanding of these contracts. This was used further to test the potential impact of misunderstanding on the choices made in the experiment.

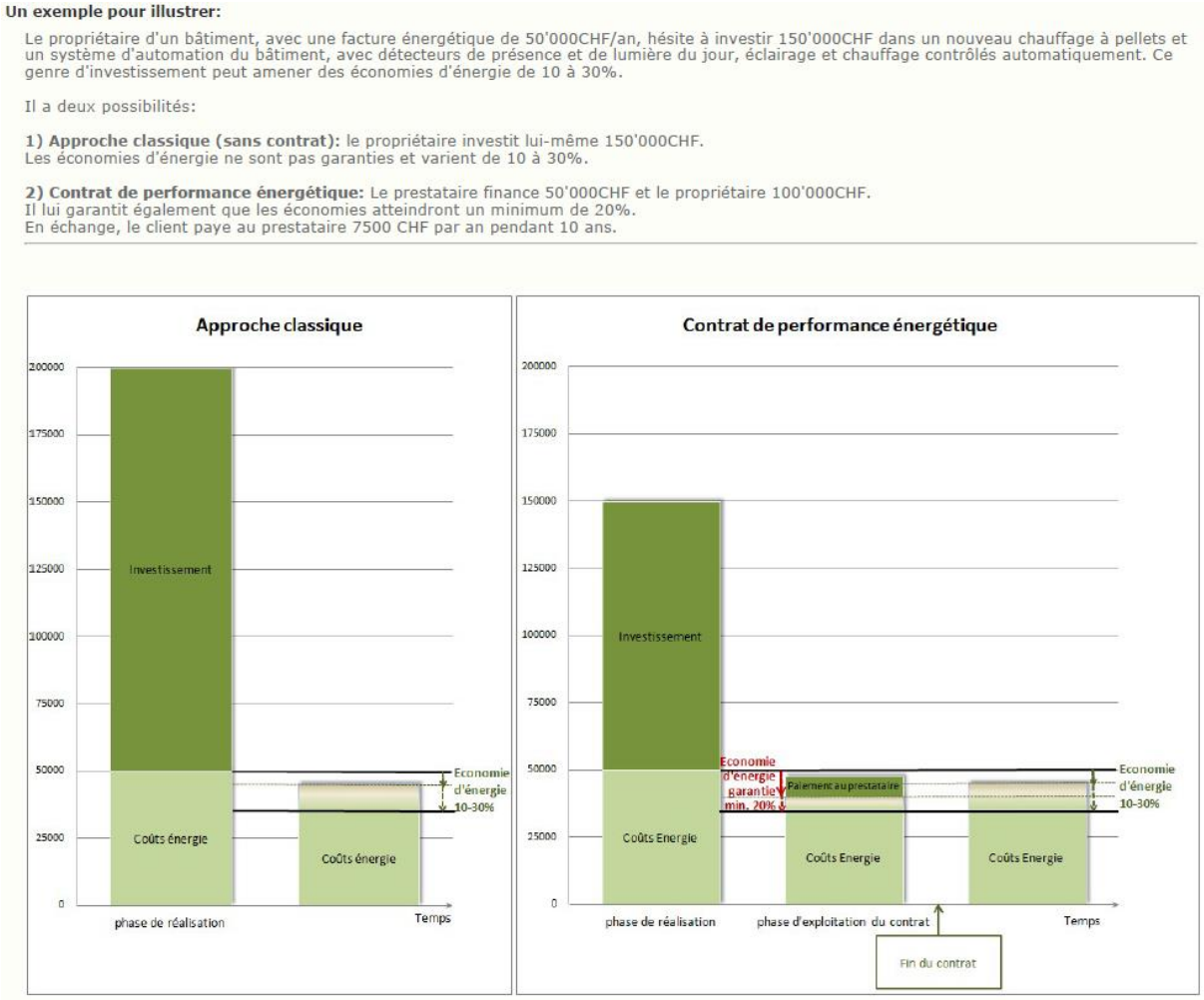


Figure 12 Example and illustration for EPC concept

d) Part 4: Choice experiment

The next section was dedicated to the core of the survey, i.e. the choice experiment, in which 4 choice tasks were presented to each respondent.

Introductory elements

We asked expressly the respondents to imagine the situation in which a revision on the building would be soon necessary when making their decision. In each task, they were invited to decide if they would opt for energy efficiency measures, with or without contract, or if they would rather choose a simple overhaul. As illustrated in Figure 13, each choice task was presented as a two-step process in which they first had to choose between overhaul and invest in energy efficiency measures without contract. In a second step, an EPC proposition was added to these 2 alternatives. The overhaul alternative always has a cost but no energy savings, while investments without contract include a cost, energy savings and a variation of savings. Energy performance contract, finally, adds the possibility of ESCO financing part of the upfront cost, the possibility to have a guarantee on the savings (therefore, reducing the energy savings variation presented) an additional payment fee to the ESCO and a contract's duration.

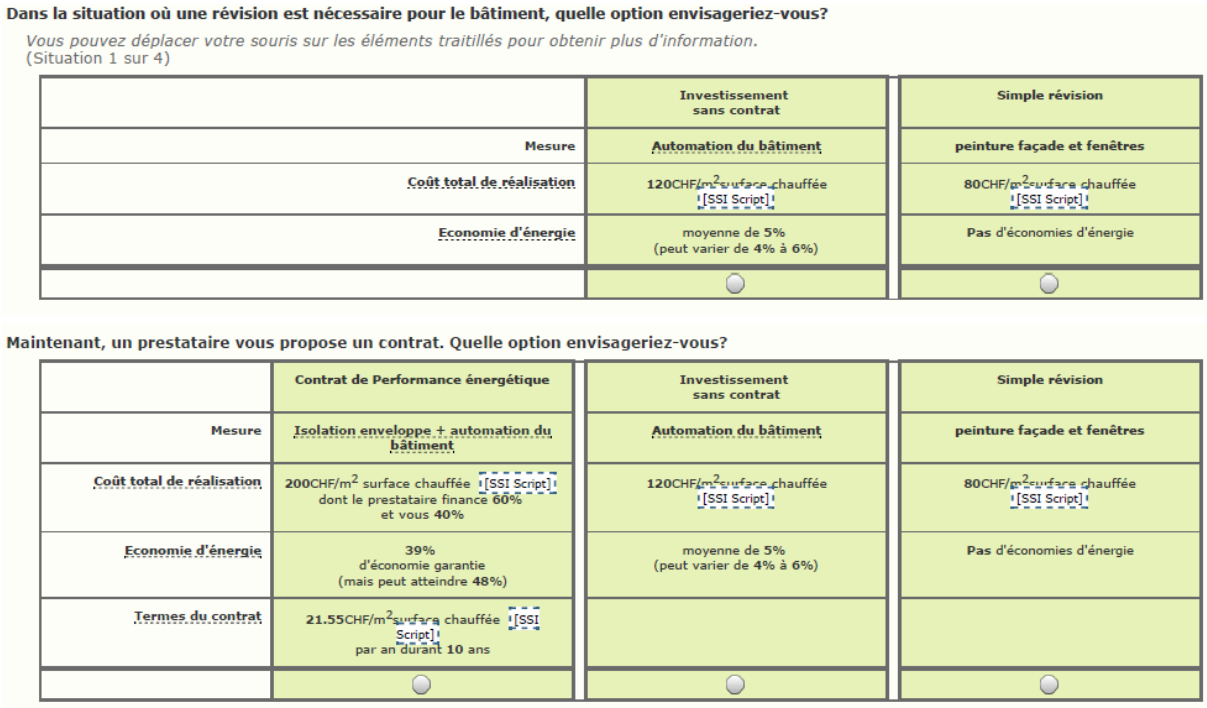


Figure 13 Choice task example[70]

Just before entering the choice experiment, two kinds of information were randomly presented to the respondents. First, we provided additional information on energy efficiency measures regarding their non-monetary benefits such as comfort, safety and CO_2 emissions mitigation. Second, we attracted the respondent's attention to the fact that EPC also provide the client with guarantee on the upfront cost of the installations. Depending on a random distribution, respondents could see both information, one of them or none. This was aimed to determine whether these additional features of EPC and energy efficiency measures would have an impact on the decisions, without further increasing the information burden within the choice tasks.

Choice experiment design

The choice experiment has been designed so that the types of energy efficiency measures proposed would be the most relevant and adapted to each respondent's building. In order to do so, we used the information regarding the realized retrofits illustrated (from the question on Figure 10), and distributed accordingly the respondents in different types of choice experiments. This allocation was made as illustrated in Figure 14.

[70] *[SSI script]* was replaced by the amount in CHF/m² for respondents who gave a precise amount or an estimation of the building's heated surface in squared meters. It was left blank for respondents who did not provide this information. The elements with a dashed-under-line provided the respondents with further information when he moved his mouse on them.

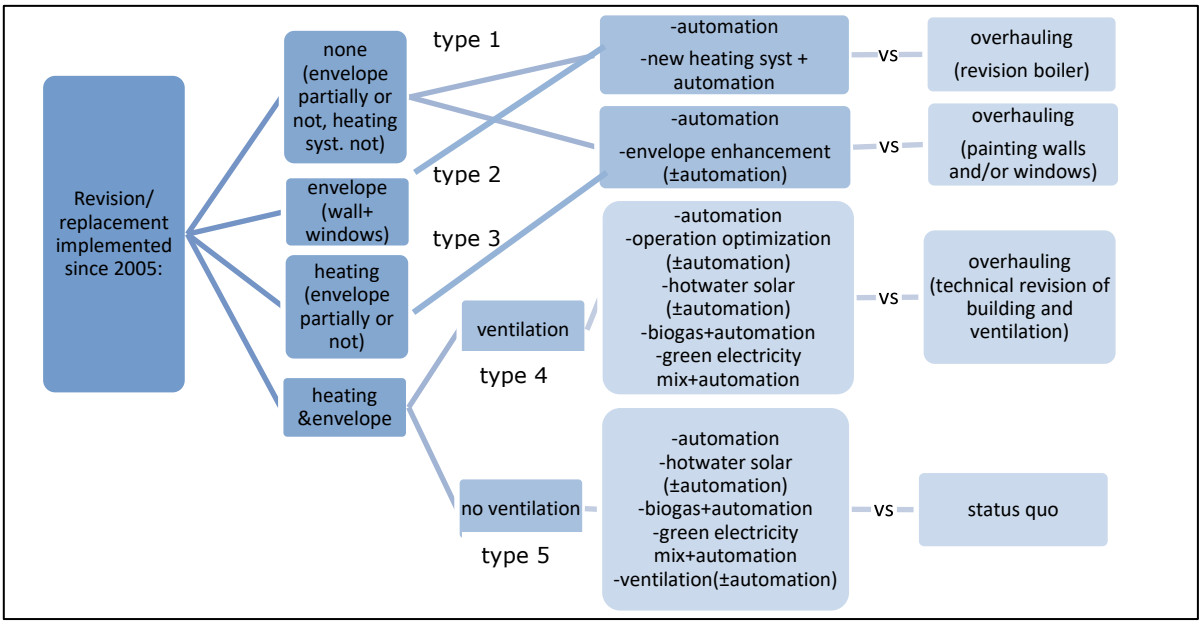


Figure 14 Choice experiments allocation

For instance, for buildings in which envelope refurbishment only had been realized, the respondent was directed towards type 2's choice experiment, which included measures such as new heating systems (with or without building automation) or building automation. The overhaul alternative (without energy efficiency measure) was in this case a simple revision of the boiler.

When nothing had been done since 2005, or envelope refurbishment only partially, we then proposed heating systems or envelope enhancement in choice tasks of the type 1. Accordingly, these propositions were compared to overhaul situations representing either boiler revision or painting of walls and windows.

When a new heating system and the envelope had already been enhanced, the respondent had to choose between options with building automation, solar panels for hot water, automation with biogas (in case of an existing gas heating system), operation optimization (in case of an existing ventilation in type 4), green electricity mix with building automation or a ventilation system (in case of no existing ventilation in type 5). These choices were compared to the overhaul situation of a simple technical revision of the ventilation (in case the building already had one in type 4), or to a status quo (i.e. do nothing) without an existing ventilation in type 5.

The allocation of the respondents in one of these 5 choice experiment's types resulted in different levels for each attribute as described in
Table 13. The final designs have been elaborated using the Ngene software, which determined the combinations of attributes levels seen by respondents in each choice task.

Table 13: attributes and levels

Attributes	EE measure proposition levels	Overhauling levels
Total up-front cost (includes realization cost but not payment to ESCO) CHF/m2 surface heated	Types1+3 80–100–120–150–180–200–250–300 Types2+4+5 80–100–120–150	Types 1-4 20–40–60–80 Type 5 0
Energy efficiency measure Allocation determined acc. to the upfront cost	Type 1 BA,HP+BA,Wood+BA,Envelope,Envelope+BA Type 2 BA,HP+BA,Wood+BA Type 3 BA,Envelope,Envelope+BA Type 4 BA,Nebo+,solar+BA,biogas-green elec.+BA Type 5 BA,ventil.,solar+BA,biogas-green elec.+BA	Type 1 Revision boiler,painting wall and/or windows Type 2 Revision boiler Type 3 painting wall and/or windows Type 4 technical revision of building and ventilation Type 5 do nothing
Expected Energy savings % kWh saved	Types 1+3 5–10–20–30–40–50–60–70 Types 2+4+5 5–10–20–30	0
Energy savings variation % of expected en. sav	Types 1-5 20–40–50–60	-
Part of up-front cost financed by ESCO (%)	Types 1-5 0–30–60–100	
Guarantee from the ESCO	Types 1-5 1-Expected energy cost savings guaranteed 2-guaranteed savings at 0.5*upper bound determined by the savings variation level 3-guaranteed savings at upper bound determined by the savings variation level 4-No guarantee	
Annual Payment to ESCO (interest rate (r) and ESCO's value added (VA) in equation (1)) CHF/m2 surface heated	Types 1-5 (0%; 0%) (5%; 5%) (10%; 10%) (15%; 15%)	
Contract's duration years	Types 1-2-3 5–10–15–20 Types 4-5 5–10	
Notes: BA: building automation and control system (BACS class B): This includes automatic detection for lighting and daylight control, combined light and heating automatically controlled, control and optimization of operations, alarming and monitoring functions. HP: heat-pump. Wood: woodchips or pellets. Nebo+: durable energy operation optimization ("Betriebsoptimierung") of ventilation and air conditioning, adaptation of operation durations, reduction of air volumes, optimization of air humidity, reduction of electric needs for air transportation, control of air purification.		

The design was performed using a D-efficient Bayesian design[71] in which the signs of the priors were determined using economic theory. Cost, risk on savings and payment to ESCO were assumed to have a negative effect on adoption, while expected savings

[71] A design with 48 rows divided in 12 blocks of 4 choice tasks was elaborated.

and guarantee on savings were expected to have positive impacts. A prior of value zero was set on duration and ESCO's financing since we were uncertain on the sign of these determinants' impact[72]. Since no priors could be effectively estimated on the magnitude of the impacts, the magnitude of the coefficients was set so that each attribute had a similar impact on the utility level. This assumes that no attribute was more important than one another in the decision process. While being potentially restrictive, this hypothesis presents the advantage of hampering an attribute to become artificially important in the estimation. Several constraints were applied to the design elaborations in order to avoid irrelevant or dominated alternatives[73].

Only the energy efficiency measures types were allocated in a second step that did not involve Ngene. In order to increase the plausibility of the cost levels, the energy efficiency measures were allocated to the alternatives according to the upfront cost according to estimations derived from Jakob et al. (2014)[74]. Typically, measures such as envelope enhancing were assigned to the highest costs (120-300CHF/m^2) and building automation to the lowest (80-120 CHF/m^2). Details of measures-costs allocation for each design type are provided in appendix 6.6.

The yearly payment to the ESCO in CHF/m^2 was computed from the levels determined by Ngene according to the following formula:

$$\boldsymbol{Pay = \frac{fin \times cost \times r}{1-(1+r)^{-dur}} + \frac{cost \times AV}{dur}} \qquad (1)$$

Where *fin* is the percentage of upfront cost (*cost*) financed by the ESCO, *dur* is the contract's duration, and *r* and *AV* are the interest rate and the added value (expressed as a share) with the levels determined as in Table 13. The first term on the right-hand side is

[72] Contract's duration may be negatively valued by entities for whom outsourcing operation and maintenance may be constraining, while it may be positively valued by entities who perceive guarantees and maintenance benefits in a longer run. The impact of ESCO's financing is positive for credit constrained entities, but may be negative for entities with access to credit at good conditions.

[73] Constraints were for instance implemented to avoid dominated strategies when considering only cost and savings. Also, if the level for the payment to ESCO attribute was zero, then ESCO's financing was constrained to be larger than zero, in order to make sure that the payment was always positive in the EPC alternative. Finally, the risk on savings was set to be smaller for very large amount of expected savings in order to avoid energy savings upper bounds larger than 85%.

[74] Jakob et al. (2014) provide the costs for façade insulation enhancement (fig. 8, p.48) and window insulation enhancement (fig. 10, p.50) as CHF/m^2 of wall or window. In order to translate these costs into CHF/heated m^2, we used building geometries data (keeping only offices, hospitals, hotels, schools, shopping buildings) and wall surface/heated surface, windows surface/heated surface ratios provided by TEP Energy GmbH. We estimated the ranges of cost for walls and windows enhancement in CHF/heated surface from 50 CHF/m^2 (for a large (>30'000m^2) new building school) to 930 CHF/m^2 (for a small (330m^2) new office building with a large share of windows and a high ratio wall surface/heated surface)). Because the 1st quartile was at 120CHF/m^2 and the 3rd quartile was at 345 CHF/m^2, we conclude that a range lying between 120-300 CHF/m^2 is plausible. We proceeded similarly for overhauling costs assuming painting cost of 80-140CHF/wall m^2 and 50-200CHF/window m^2. Building automation costs are also provided in Jakob et al. (2014) in table 11 as price per room and we estimated a range assuming rooms of 50-60m^2 for schools, and 15-20m^2 for residential buildings, p. 54. New heating systems (wood and heat pumps) always proposed with building automation are estimated to have an upfront cost of 100-180CHF/heated m^2 and operation optimization, solar panels and biogas/green electricity mix of 80-150CHF/heated m^2.

the typical annuity computation following from the credit made by the ESCO. The second term represents a value added taken by the ESCO, which is set to be proportional to the upfront cost and the duration.

Follow-up questions

After each of the 4 choice tasks, a question assessed the certainty with which the respondent made his decision. Then, depending on the choices made by the respondents, several follow up questions appeared. If for instance the respondent always chose the overhaul alternative, the fourth choice task was again presented but this time excluding the overhaul option. The respondent was asked to state which one of the 2 options (Investment without contract or EPC) he would choose or if he would be indifferent between the two. This additional choice task was implemented in order to make sure to have sufficient data to estimate the attributes' coefficients, even in the case a large share of the respondents would always choose the overhaul option.

In order to qualitatively explore the decision made by the respondents who never invested in energy efficiency measures and/or never opted for EPC, questions were asked on the reason for these choices. Special emphasis was on the potential issue to transfer the cost onto the tenants, trust towards the ESCO and perceived legal and accounting difficulties.

Finally, the respondents were asked to state up to 4 of the most important attributes they were considering when making their choices. This information is useful to explore preference heterogeneity and non-attendance patterns.

e) Part 5: Decision process

Because of the potentially important heterogeneity in the decision process and the roles the respondent plays in it, this part aimed at assessing some factors that could have an impact on the decisions made in reality. For instance, we asked whether in practice the respondent could take alone certain or all the decisions he has made in the choice experiment. It was also assessed whether a certain contract's duration or a budget limit would force the respondent to consult other sections in the firm/entity to make the decision. This ensures that we account for the fact that there may be threshold effects in the levels of costs and duration for some respondents.

f) Part 6: Socio-economic statistics of the respondent

Since the emphasis of the survey was rather on the building characteristics, questions on the respondent himself were reduced to a minimum. Therefore, these included only the age, the gender, the level of education and the number of years of experience in the current function in the entity/firm.

g) Part 7: Contact and end

Finally, the respondents were asked to give their e-mail address if they were interested in receiving the results of the present chapter. An open question dedicated to remarks concluded the survey.

3.2 Target group

Two categories of survey participants were selected: on the one hand the public sector and on the other the private sector.

The public sector with its buildings such as offices, hospitals, schools and sport facilities is a significant energy user and commonly has a long-term planning and investment horizon. While being credit-worthy, public entities are often credit constrained. They represent therefore interesting targets for EPC. Abroad, energy performance contracting projects with the public sector often triggered the deployment of EPC markets. In Switzerland on the opposite, EPC projects in the public sector represent a small share (chapter II and chapter IV). This may coincide with the fact that the Swiss EPC market is only emerging with potentials to be exploited both in the public and in the private sector. Potential clients from the private sector are therefore also interesting to target in this study, in order to explore potential differences in the decision-making process. The selection of private buildings was performed by a bottom-up approach focusing on the technical energy savings potential of buildings, including non-residential properties with an emphasis on relatively complex buildings. It is expected that such buildings are appealing for EPC opportunities. A selection of large office buildings, shopping centers and hotels, as well as education and health care facilities were included, most of which are characterized by energy service needs, making these buildings exemplary for EPC through optimized operation.

The list of participants included institutions from all regions of Switzerland. The majority of these were located in the German speaking part, with the others located in the French and Italian speaking areas of the country. The survey was prepared in two languages (French and German) so that it could be directed at the largest number of respondents.

In total, around 2200 addresses were collected including representatives of building owners, locations and managers in the categories of high schools and universities, hospitals, shopping centers, hotels, sport facilities, public offices (federal, cantonal, and municipal), banks, and insurance companies. Respondents were divided into seven different categories generally representing the type of building use and management:

1. Schools (primary and secondary schools, private and public universities and universities of applied sciences)
2. Hospitals and private clinics
3. Hotels
4. Sports facilities
5. Shopping Centers

6. Banks and insurance institutions
7. Municipality and administrative buildings

The various criteria that were used to select participants in each of these categories are explained in the following subsections.

3.2.1 High schools and universities

Based on the public list of schools and universities in Switzerland, 247 addresses were collected from the homepage http://bildungssystem.educa.ch/de/schools_in_ch. The invitation was either directed to the director of the schools or to an info e-mail address if no name was available.

3.2.2 Health care facilities

Both public and private health care facilities were included in this category. This list was comprised of clinics and hospitals. In total, 92 addresses were considered in the survey. Addresses were collected via the homepages: http://www.krankenhaus.ch/region/1/28 accessed: 26.6.2015 and http://www.privatehospitals.ch/kliniken/?no_cache=1 accessed: 25.6.2015 for public and private hospitals, resp.

3.2.3 Hotels

The 500 largest hotels with more than 40 bedrooms were selected from the homepage https://www.hotelleriesuisse.ch/de/pub/verband/mitglieder/hotel.cfm.

3.2.4 Sports facilities

It was not possible to find addresses for sport facilities. The public administration for sport does not have information about the specific facilities. So only 33 facilities were selected and found on google.

3.2.5 Banks and insurance institutions

The addresses for banks and insurance institutions were found at: http://www.snb.ch/de/iabout/stat/bchpub/id/statpub_bankench_hist Verzeichnis der auskunftspflichtigen Institute 2014; last accessed 6.7.2015

3.2.6 Communes and public administrative buildings

Administrative buildings were considered on the level of municipalities, cantons and the federal administrations. Based on the homepage www.schweizadmin.ch, 998 addresses were collected and used for the survey.

3.3 Econometric framework

The decision to opt for energy efficiency measures, with or without contract, as opposed to adopt a simple overhaul is modeled by the random utility framework (McFadden (1974)). U_{itj} represents the utility of respondent *i* choosing alternative *j* which can be *epc* (for EPC), *ee* (for investment in energy efficiency measures without EPC) or *ovh* (for simple overhaul) in choice task *t*. Typically, the utility $U_{itj} = V_{itj} + \varepsilon_{itj}$ is constituted of an observed component V_{itj} and a residual unobserved element ε_{itj} capturing the unobserved heterogeneity across choice tasks, alternatives and individuals.

The alternative chosen by the respondent is the one that maximizes his utility. The observed component of utility in our case is described differently for each alternative as in:

$$V_{it,ee} = \beta_{0,ee} + \beta_1 cost_{it,ee} + \beta_2 sav_{it,ee} + \beta_3 risk_{it,ee} + \beta_4' meas_{it,ee}$$

$$V_{it,epc} = \beta_{0,epc} + \beta_1 cost_{it,epc} + \beta_2 sav_{it,epc} + \beta_3 risk_{it,epc} + \beta_4' meas_{it,epc} + \beta_5 fin_{it,epc} + \beta_6 guar_{it,epc} + \beta_7 pay_{it,epc} + \beta_8 dur_{it,epc}$$

$$\boldsymbol{V_{it,ovh} = \beta_1 cost_{it,ovh}} \quad (2)$$

Where $\beta_{0,j}$ denote the alternative-specific constants with overhaul treated as baseline, cost is the upfront cost in CHF/heated m^2, *sav* are the savings in % kWh saved, *risk* represents the energy savings variation determined in terms of percent difference from the expected savings *sav*, and *meas* is a vector of four energy efficiency measures types (envelope, technique, electricity/biogas mix, new heating system). The alternative with energy performance contracting adds several attributes describing contractual terms which include *fin* (the amount of upfront cost financed by the ESCO in CHF/heated m^2), *guar* (a dummy for guaranteed savings), *pay* (the annual payment to ESCO in CHF/m^2) and *dur* (the contract's duration in years). The overhaul alternative includes only the attributes' cost, with all other attributes set equal to zero (except in design 5 where the overhaul alternative is replaced by the status quo in which all attributes -including cost- are constrained to equal zero). For now, parameters are assumed to be equal across alternatives (i.e. cost has the same impact in the *ovh* as in the *ee* or the *epc* alternative), except from constants which are alternative-specific. We will however show the results if we relax this assumption.

In the conditional logit framework (McFadden (1974), also called multinomial logit by some authors (Hensher et al. (2015)), the probability that individual *i* chooses alternative *j* in choice task *t* is expressed by:

$$Prob_{it}(choice = j) = \frac{\exp(V_{itj})}{\sum_{j=1}^{J} \exp(V_{itj})}, J = 1, \dots, J \quad (3)$$

where V_{itj} represents the observed part of the indirect utility as described in equation (2). This expression for the probability follows from the assumption that the error terms ε_{itj} are independently and identically distributed and drawn from a generalized extreme value distribution. This in turn implies that an individual's unobserved preference for a certain alternative is independent of his unobserved tastes for other alternatives. This

restrictive hypothesis is known as the *independence of irrelevant alternatives* (IIA). The parameters β_i in equation (2) are estimated as the arguments of the maximization of the following log likelihood function:

$$\ln \mathcal{L} = \sum_{i=1}^{N} \ln \prod_{t=1}^{T} Prob_{it} \qquad (4)$$

where $Prob_{it}$ is expressed in equation (3).

3.3.1 Relaxing the assumption of attribute full attendance

Because the choice experiment in this study is relatively complex, we want to account for the fact that some respondents may have ignored some of the attributes when making their decision. Adopting an attribute processing rule under which one or several attributes are ignored can come from a voluntary basis to focus only on the more salient and important attributes or can be somehow unconscious and be part of a simplification of the decision process. The reason that leads respondents to ignore some attributes is difficult to establish empirically[75]. However, regardless of the cause of a so-called attribute non-attendance (thereafter referred to as ANA), numerous studies in various domain of research have shown that accounting for it has an important impact on the parameters results (Campbell et al. (2011), Rose et al. (2012), Hensher et al. (2012), Lagarde (2013), Caputo et al (2014), Hole et al. (2016)). Because of the complexity of this survey as well as the heterogeneity in the buildings characteristics and needs, it is important to explore this issue.

Two different methods can be used to explore ANA in the decision process: either through respondent's stated heuristics or via inferred attribute processing strategies.

The first one consists in directly asking the respondents which attributes were taken into consideration or ignored during the decision process (Hensher et al. (2005), Hensher and Rose (2009)). In our survey, the respondents were asked to state one to four of the most important attributes in their decision. These results can then be used to account for heterogeneity in the decision process and assess its impact on the parameters estimated. In order to do so, all the parameters are interacted with dummies equating one if the respondent stated that the attribute was important in her decision and zero otherwise. In addition to the characteristic of the question asked in our survey which imposes several assumptions[76], this method presents some drawbacks such as the lack of reliability of responses (see for instance Hess and Hensher (2010)).

[75] Weller et al. (2014) have explored the impact of choice experiment dimensions on attribute non-attendance and showed that it does not depend on the design dimension, but that it may be influenced by the number of alternatives and sets.

[76] Because of the characteristics of the question asked, i.e. respondents could not tick more than four important attributes, we were forced to make some assumptions regarding heuristics for those who ticked four attributes. Specifically, we assumed that if the respondent chose four attributes or ticked the answer "no attribute is more important than another", then he was assumed to have fully attended to all attributes.

The second approach consists in exploring attribute processing strategies using inference. This can typically be done using a latent class framework in which restrictions are imposed on the parameters to account for attribute ignorance (Campbell et al. (2011), Hensher et al. (2012), Lagarde (2013)). Hess and Hensher (2010) showed that the inferred ANA at the individual-level was not consistent with the stated decision process answered by respondents. This supports the strategy to use both methods to compare the estimations results. In the latent class model, individuals are assigned into *q* classes of attribute non-attendance patterns in a probabilistic fashion, which in the same framework as equation (3) results in the following probability of choosing alternative *j* in choice task *t*:

$$Prob_{it|q}(choice = j|class = q) = \frac{\exp(\beta_q{}' x_{itj})}{\sum_{j=1}^{J} \exp(\beta_q{}' x_{itj})} \quad (5)$$

Where x_{itj} are the attributes described in equation (2) and β_q is one possible vector of attribute non-attendance pattern in which the ignored attribute(s)' coefficients are set to zero. This approach can be seen as a random parameter model with a discrete distribution[77] that puts individuals into classes with different combinations of attributes ignored. Since the allocation of individuals within classes is a priori unobserved by the researcher, the probabilities for each individual to belong to class *q* must be estimated using the following expression:

$$H_{iq} = \frac{\exp(\theta_q)}{\sum_{q=1}^{Q} \exp(\theta_q)} \quad (6)$$

And the log likelihood function to be maximized to estimate the coefficients is transformed as follows:

$$\ln \mathcal{L} = \sum_{i=1}^{N} \ln \sum_{q=1}^{Q} H_{iq} \prod_{t=1}^{T} Prob_{it|q} \quad (7)$$

The difficulty in this method is to explore all the possible combinations of ANA patterns. With eight attributes considered in this study, there are 2^8=256 combinations possible and therefore 256 potential classes. While some studies explore all combinations (Lagarde (2013)) using an iterative algorithm eliminating the irrelevant classes in the process, other studies focus on a subset of attributes (Hensher et al. (2012), Weller et al. (2016)) while others do not explore in details pairs or triples of attributes ignored[78]. Accounting all combinations require to use equality-constrained latent class models (ECLCM)[79] (Lagarde (2013) and Hensher *et al.* (2012)), in order to focus only on heterogeneity in attribute non-attendance patterns. This reduces the number of parameters

[77] The latent class method, as opposed to the mixed logit model, presents the advantage of having no specific assumption about the distribution of the parameters across respondents but only estimate the underlying distribution in a discrete manner.

[78] For instance, Campbell et al. (2011) try several combinations with pairs and triples but show that in their context, it does not improve their model.

[79] In which parameters are constrained to be the same across classes.

to be estimated at each iteration and also allows the analyst to detect irrelevant classes, which are determined by null average posterior class probabilities. This method however comes at the cost of restraining the heterogeneity to be only in attribute non-attendance patterns and not in preferences.

The analytical strategy implemented here to explore the ANA patterns use both information on stated weights and inferred ANA using unconstrained latent class model:

1. Using respondents stated attributes' importance, we explore all combinations of important attributes concerning at least 4 persons in the sample. Each combination of important attributes represents a potential class.
2. Using an iterative process, the best combination of classes is determined by comparing unconstrained[80] latent class models' Akaike and Bayesian information criteria. Using unconstrained latent class models permits to consider heterogeneity in both attendance and preferences.
3. After selecting the best combination of ANA classes, we explore how individual or building characteristics can affect the class allocation. In order to do the latter, equation (6) is transformed by replacing the vector of parameters θ_q with a dot product of it with a vector of individual-specific variables z_i.

To summarize, the following three models will be compared:

a. A basic conditional logit model assuming full attendance (CL)
b. A conditional logit interacting the attributes with individual-specific dummies on stated importance (CL-stated weights)
c. A latent class model including inferred ANA strategies and individual/building characteristics influencing class probabilities (LCM-ANA)

In addition, we will explore whether there is some unobserved preferences for the labeled alternatives, especially between the *ee* alternative[81] and the *epc* alternative that cannot be explained by the attributes. This will be done by relaxing the assumption that the parameters are equal across alternatives. Moreover, a special emphasis will be put on the respondents for whom EPC are likely to remove binding constraints hampering energy efficiency investments. We will explore through which mechanisms it may do so. Finally, the impacts of other individual or building characteristics will be assessed. In section 5.7, we will also explore the IIA assumption, compare the unconstrained LCM with the ECLCM obtained using a method similar to Lagarde (2013) and make further robustness checks.

[80] "Unconstrained" means that coefficients are not constrained to be equal across classes as opposed to the equality-constrained latent class model (ECLCM).

[81] Investment in energy efficiency without energy performance contract.

4 Data

4.1 Data collection

Based on the address list, we selected 2 groups for a first and a second pretest (see following sub-sections), including invitees from the different interest groups. All remaining invitees were invited via direct mail and e-mails to participate in the main survey (see subsection 4.1.2 for more details).

4.1.1 Pretest

A pre-test of the actual survey was conducted in order to gauge its effectiveness and to evaluate respondents' reactions to it. By first clarifying potential problems and misunderstandings, the final survey would more reliably convey the required information to respondents so that their responses better reflect their perception of the topic. Critically, the understanding of the concept of EPC by respondents is primordial for a successful completion of the survey and so a pre-test was meant to ensure these ideas were clearly communicated.

Email invitations were sent out to a random selection of 100 of the addresses initially collected in order to conduct the pre-test. In addition to responding to the survey, these target respondents were encouraged to give feedback on its structure and content. This was done using a second survey online and phone calls with the respondents. The pre-test was also aimed at collecting initial preferences regarding the choice experiment attributes in order to estimate more precise priors that would be used to construct a D-efficient Bayesian design for the main survey's choice experiment[82].

4.1.2 Main survey

After incorporating feedback from the pre-test, the main survey was sent to a further 2090 participants. Letters were prepared in both French and German and sent to their respective speakers according to the participant list. Using both post and email, letters were sent with individualized codes used to access the online survey. It was initially decided that sending invitations by post would draw the most respondents and so this method of delivery was used for the majority of invitations.

The finalized list of respondents included some individuals who lacked either a mailing address or email address. In these cases, the appropriate method of delivery was used. Because of operational restrictions, the email invitations were sent out later than those by post (Table 14).

[82] The number of respondents in the pretest however was not sufficient to estimate these priors. Therefore, as for the pretest, we constructed a Bayesian D-efficient design using economic intuition for the sign of the coefficients of each attributes. Further information on this is provided in the section regarding the choice experiment.

Initially, around 40 letters were returned by post after they were unable to be delivered. In some cases, addresses were incomplete or the addressee was no longer at the listed location. These participants were recorded, the missing information was gathered, and the participant list was updated. Twenty of these cases were re-sent via post to the corrected addresses. The remainder was included in the mass emailing initiated later.

An email form of the invitation letter (both in German and French) was sent to 205 addresses from the participant list on June 27, 2016. Of these, around 12 remained undeliverable as correct email addresses could not be found.

Table 14 Summary of correspondence with survey repondents

Mailing Activity	Number sent	Date
Pretest invitation	125	Sept 2015
Initial invitation – post	1885	June 2016
- of which undeliverable	40	
Initial invitation – email	205	June 2016
- of which undeliverable	12	
Reminder email I	1763[a]	June 2016
Reminder email II	1578[b]	August 2016

[a] To non-respondents from the initial post invitation

[b] To non-respondents from post and email invitation

4.1.3 Reminders and follow-up

Once respondents began answering the survey, the online platform was used to track the activity of individual participants. A list of respondents who had completed or not finished the survey was maintained, along with those that had not responded at all.

On June 28th and 30th 2016, a reminder email was sent to participants that had been contacted via post but had not yet responded to or had only started, but not finished, the survey. This letter encouraged them to complete the survey online.

A second reminder email was sent on August 31st 2016 to all addresses that had not yet started or finished the survey, regardless of how we had initially contacted them, setting a deadline of completion by September 9th 2016.

By mid-October 2016, all respondent information had been gathered and no further surveys were to be accepted.

Throughout the survey process, it was noted that some participants accessed the survey, but only completed it to varying degrees. In order to understand why these participants had not continued with the survey and to further encourage them to complete it, a series of phone interviews were conducted. All those who had not finished the survey (in the case of the French speaking participants) and those who had progressed to the choice experiment (in the case of the German speaking participants) were contacted by telephone over the span of several weeks. A number of participants were successfully encouraged to complete the survey after speaking with them on the phone (Table 15).

In some cases, the survey was directed to another person within the institution or municipality. Further reasons to not complete the survey are covered in Section 4.1.4.

Table 15 Success rate of contacting respondents who had not initially completed the survey

Language of contact	Contacted by phone	Subsequently completing survey	Success rate of contact
French	38	11	29 %
German	31	12	39 %

4.1.4 Feedback from participants during the main survey

Respondents gave various reasons for not completing the survey. Through communication via email and telephone, these were found to include lack of time, lack of resources, lack of interest, or lack of access to the necessary information.

A large number of survey participants expressed concerns that none of their managed properties were scheduled for future renovation. Although the survey did not require this, there seemed to be the perception that their participation would only be relevant if this was the case. The time involved in gathering the required information in order to answer specific questions was a common cause for respondents not to complete the survey. Staff working at municipalities were especially reluctant to reply as several of them mentioned that they often receive requests for surveys and simply do not have sufficient time to complete them all. A small number of respondents simply said that the survey did not interest them enough to allocate the necessary time to respond.

4.1.5 Return and non-response analysis

In total, 2215 survey invitations were sent by post and email, with 2203 of those successfully delivered (Table 16). Overall 26 % of potential respondents looked at or began the online survey. In all, 297 respondents fully completed the survey (13 % of invitations delivered) and a further 267 did not finish it. This represents a satisfactory response rate.

Table 16: Survey invitation, response, and completion

	Number of invitations sent	Invitations successfully delivered	Surveys started		Completed surveys		
			Freq.	% of invitations delivered	Freq.	% of invitations delivered	% of surveys started
Pre-test	125	125	31	25%	15	12%	48%
Main survey	2090	2078	533	26%	282	14%	53%
Total	2215	2203	564	26%	297	13%	53%

The rate of response varied greatly between the categories of respondents (Table 17). The highest rate of response was in the case of schools (56 %), whereas the lowest were from hotels (4 %). The numbers in column 2 to 4 in Table 17 are based on the building category assumed when the invitation was sent out. The rest of the numbers in the table are from the building category stated by the respondent. The analysis of this chapter is based on the 297 respondents who completed the survey. 12 of them are respondents of pilot 2 and the remaining (285) are from the final survey. 102 of these 297 respondents are from the French-speaking part of Switzerland while 195 are from the Swiss German part.

Table 17: Response rate by participant group, including pretest.

	Invitations sent[a]	**Non-delivered**	**Delivered**	**Survey started**		**Survey incomplete**		**Survey completed**		
				Freq.	% delivered	Freq.	% delivered	Freq.	% delivered	% started
Schools	247	3	244	201	82%	65	27%	136	56%	68%
Hospitals	92	1	91	26	29%	12	13%	14	15%	54%
Public entities	1010	2	1008	74	7%	26	3%	48	5%	65%
Sport facilities	33	1	32	0	0%	0	0%	0	0%	0%
Hotels	504	8	496	41	8%	21	4%	20	4%	49%
Shopping centers	91	4	87	9	10%	2	2%	7	8%	78%
Banks/ insurance	233	0	233	31	13%	13	6%	18	8%	58%
Unspecific	12	0	12	-	-	-	-	-	-	-
Other				182	-	128	**-**	54	**-**	-
Total	**2222**	**19**	**2203**	**564**	**26%**	**267**	**12%**	**297**	**13%**	**53%**

[a] These figures include instances where multiple codes were issued to individuals for procedural reasons and therefore the totals do not match those from Table 16.

4.2 Descriptive statistics of the participants

4.2.1 Building characteristics

Table 18 provides information regarding the building types in the sample. Education facilities represents the largest share, followed by public administration and offices. A majority of buildings in the sample are publicly-owned and not rented.

Table 18: Building types

	Freq.	Percentage in sample (N=297) (%)	percentage of publicly-owned buildings (%)	Percentage of (partly) rented buildings (%)
Education facility	145	48.82	97.18	22.07
Offices	22	7.41	63.64	68.18
Hotel	20	6.73	0.00	15.00
Hospital	14	4.71	71.43	35.71
Public administration	50	16.84	100.00	48.00
Shopping center	7	2.36	0.00	100.00
Sport facility	10	3.37	100.00	30.00
Residential	14	4.71	71.43	100.00
Mixed	5	1.68	40.00	100.00
Other	10	3.37	80.00	40.00
Total	297	100	82.25	37.71

A large number of buildings in the sample could typically be targeted by EPC since they are in majority rather old buildings with a significant size, as shown in Table 19. Almost a third of the buildings were constructed between 1966 and 1979 and 85 % of the sample were built before 1990. A majority of buildings (57 %) have a surface larger than 2000m^2.

Table 19: Period of construction and surface

Year	Freq.	%	Cum.
<1920	64	22	22
1920-1946	15	5	27
1947-1965	33	11	38
1966-1979	97	33	70
1980-1990	43	14	84
1991-2000	20	7	92
2001-2010	12	4	96
2011-2016	7	2	98
missing	6	2	100
Total	297	100	

Area	Freq.	%	Cum..
<500m2	30	10	10
500-1000m2	42	14	24
1000-2000m2	57	19	43
2000-3000m2	38	13	56
3000-5000m2	31	10	67
5000-7000m2	17	6	72
7000-10000m2	18	6	78
>10000m2	36	12	91
missing	28	9	100
Total	297	100	

A majority of respondents (60 %, i.e. 178 of 297) have a heating system installed before 2005 as can be seen in Table 20.

Table 20: Year of installation of the current heating system

Year	Freq.	%	Cum.
<1991	65	22	65
1991-1995	48	16	38
1996-2000	34	11	49
2001-2005	31	10	60
2006-2010	41	13	74
2011-2016	64	22	95
Blanks	14	5	100
Total	297	100	

Table 21: Current heating system and former heating system

Heating system	Current system		Former system	
	Freq.	Percent of 297	Freq.	Percent of 55
Oil	109	36.70	46	83.64
Electricity	28	9.43	5	9.09
Geothermal heat pump	10	3.37	2	3.64
Ground water heat pump	13	4.38	1	1.82
Air heat pump	11	3.70	2	3.64
Pellets	11	3.70	0	0.00
Woodchips	36	12.12	2	3.64
Wood	5	1.68	0	0.00
Gas	86	28.96	8	14.55
Biogas	7	2.36	0	0.00
Coal	0	0.00	1	1.82
Solar panels	13	4.38	0	0.00
District heating	77	25.93	2	3.64
Other heating	14	4.71	0	0.00

Table 21 displays the percentages each type of heating system is currently in place in the sample's buildings. When the heating system has been replaced after 2006, we also have the information for 55 respondents regarding the former heating systems in place. Two geothermal heat pumps, one ground water heat pump and two air heat pumps have already been replaced. Additionally, there was only one coal based heating system, which was replaced. The relative share of oil was higher in former heating systems, while the shares of other energetic agents such as woodchips and gas are larger in current heating systems. The total of the installed heating systems is 420 indicating that some buildings are equipped with more than one heating system.

a) Energy and electricity yearly costs

Figure 15 displays box plots[83] for yearly energy costs (excluding electricity costs) spent for heating in relation to the construction period.

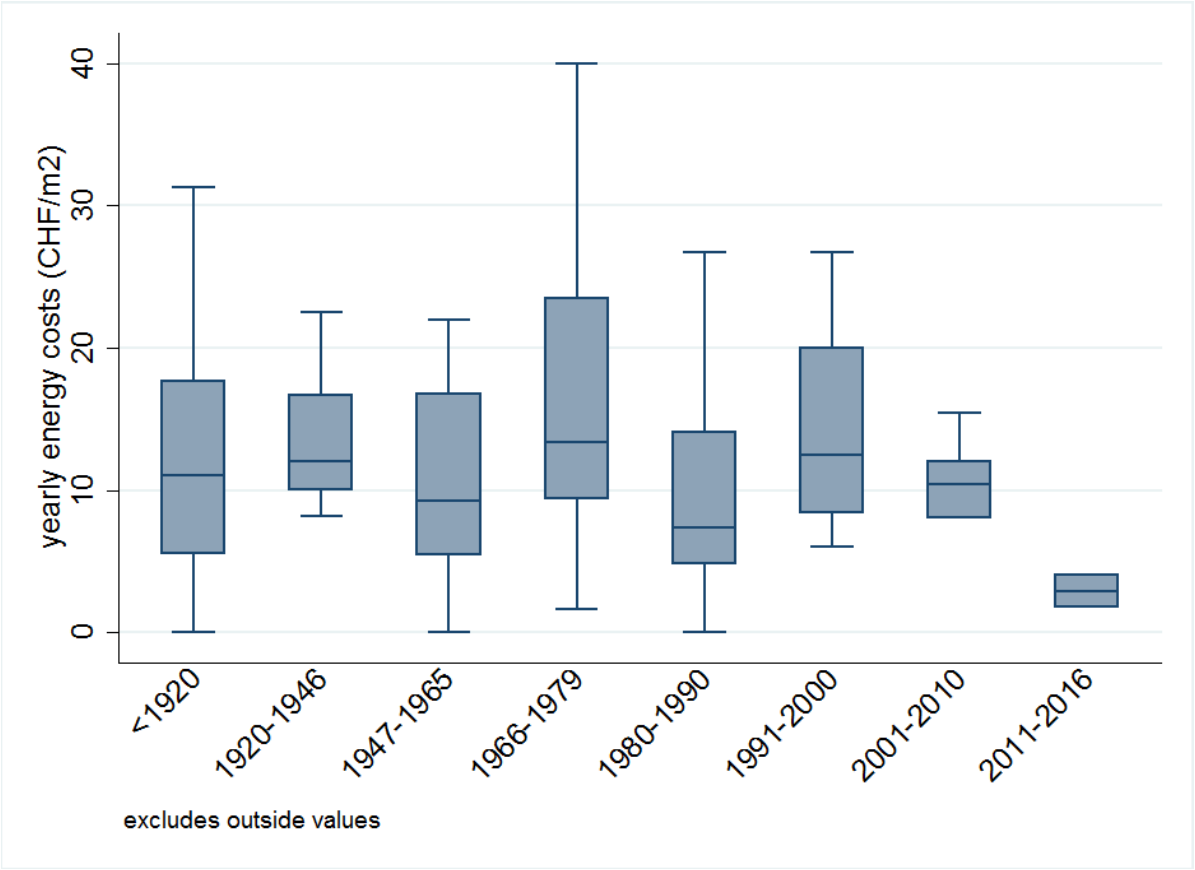


Figure 15 Yearly energy costs (excl. electricity) per area over building period

Because this graph (as Figure 16) is elaborated using the respondents' stated and estimated costs and surface, they may be subject to errors. The large variations occurring for buildings built within the same period before 2001 are likely to be explained by these estimated values, as well as by the differences in consumptions between retrofitted and old non-revised buildings. The median yearly energy costs over the sample of the 297 buildings equals 11.33 CHF/m^2 and the mean is estimated at 19.04 CHF/m^2.

The yearly electric costs per year and per area in the specific building category are shown in Figure 16, excluding electric costs for heating. The median yearly electricity cost is estimated at 6.87 CHF/m^2 and the mean at 14.08 CHF/m^2.

[83] Boxes represent 25th to 75th percentiles, the line inside the box is the median and the adjacent lines represent lower and upper adjacent values.

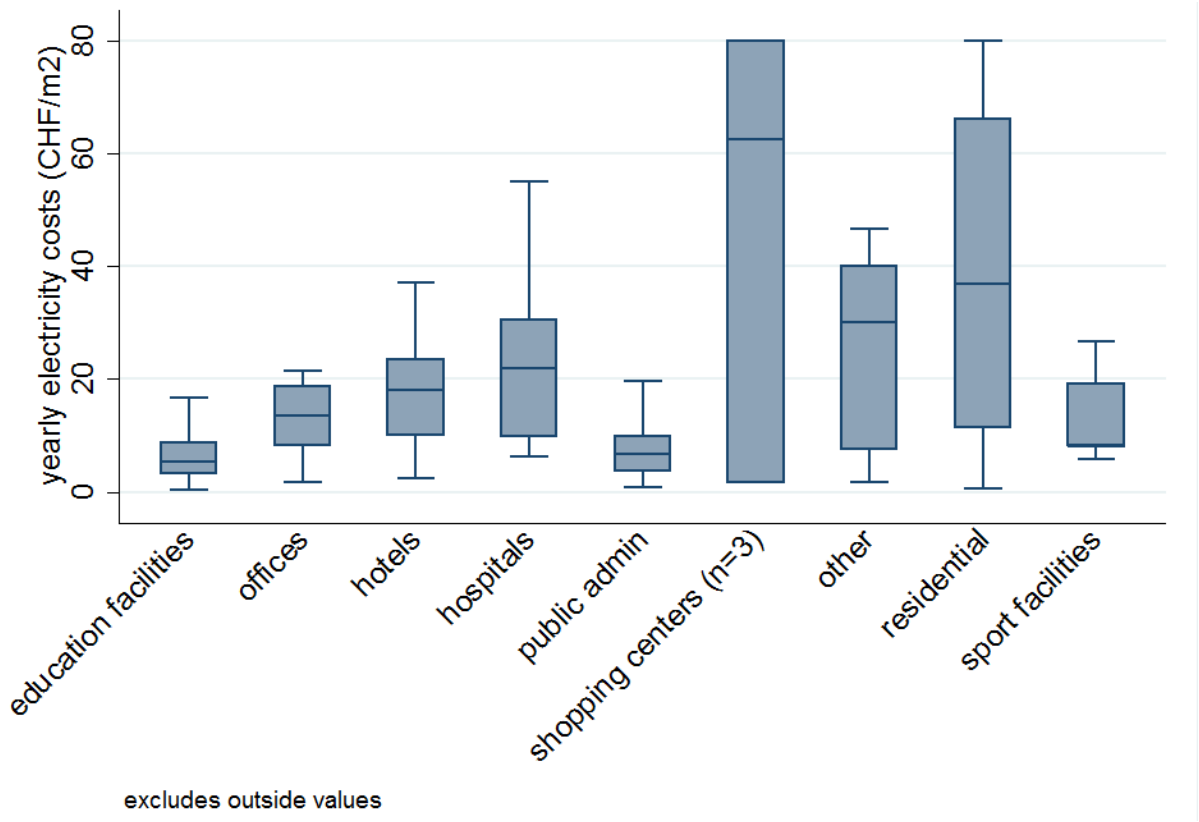


Figure 16 Yearly electricity costs per area over building category

b) Retrofits done and planned

The respondents stated the realized and planed retrofits on the building (Figure 17). The figure shows that respondents who recently replaced or implemented new technical elements inside the building are more numerous than those who enhanced the envelope insulation. Retrofitting the building envelope is planned by 33 % of the respondents, which is promising regarding the potential for energy savings. On the contrary, 20 % of the respondents stated to plan a building overhaul (such as wall painting or window painting). These could typically be interesting targets for EPC. These respondents' buildings will need a retrofit in the coming years, but they are not planning to enhance the insulation, maybe because of some barriers.

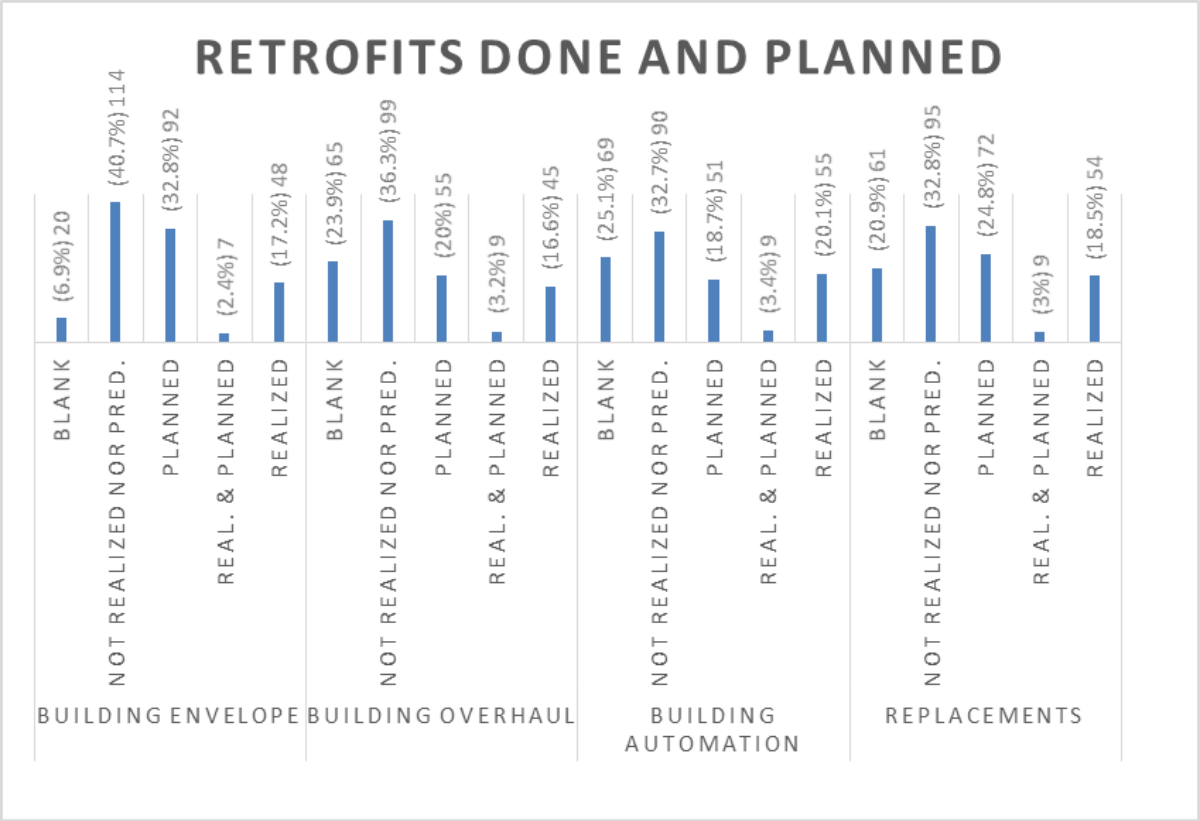


Figure 17 Specific retrofits realized (2006-2015) and planed (2016-2020)

Notes: Building envelop: windows replaced, roof repaired, roof insulation and/or wall insulation. Building overhaul: window painting, wall painting and ventilation revision. Building automation: lighting control, retrofit/install building automation and ventilation control. Replacements: lighting, heating system, ventilation replacement

c) Minergie, audit and energy manager

Out of the 297 buildings in the sample, 20 (6.7 %) are "Minergie" labelled. This relatively low share can be related to Table 19 and the large share (85 %) of buildings in the sample constructed before 1990 (the label was introduced in 1994). 94 respondents (32 %) stated that their building has been subject to an audit since 1990. While 168 respondents (57 %) stated that there is no energy manager for the building, 74 (25 %) have an energy manager working part time and 44 (15 %) have an energy manager working full time.

4.2.2 Characteristics of respondents

The function of the respondents is shown in Figure 18. The largest share is represented by managers in charge of public buildings at the cantonal or municipal level. Facility managers represent one quarter of the sample. The category "other" includes for instance municipal secretary, directors, etc.

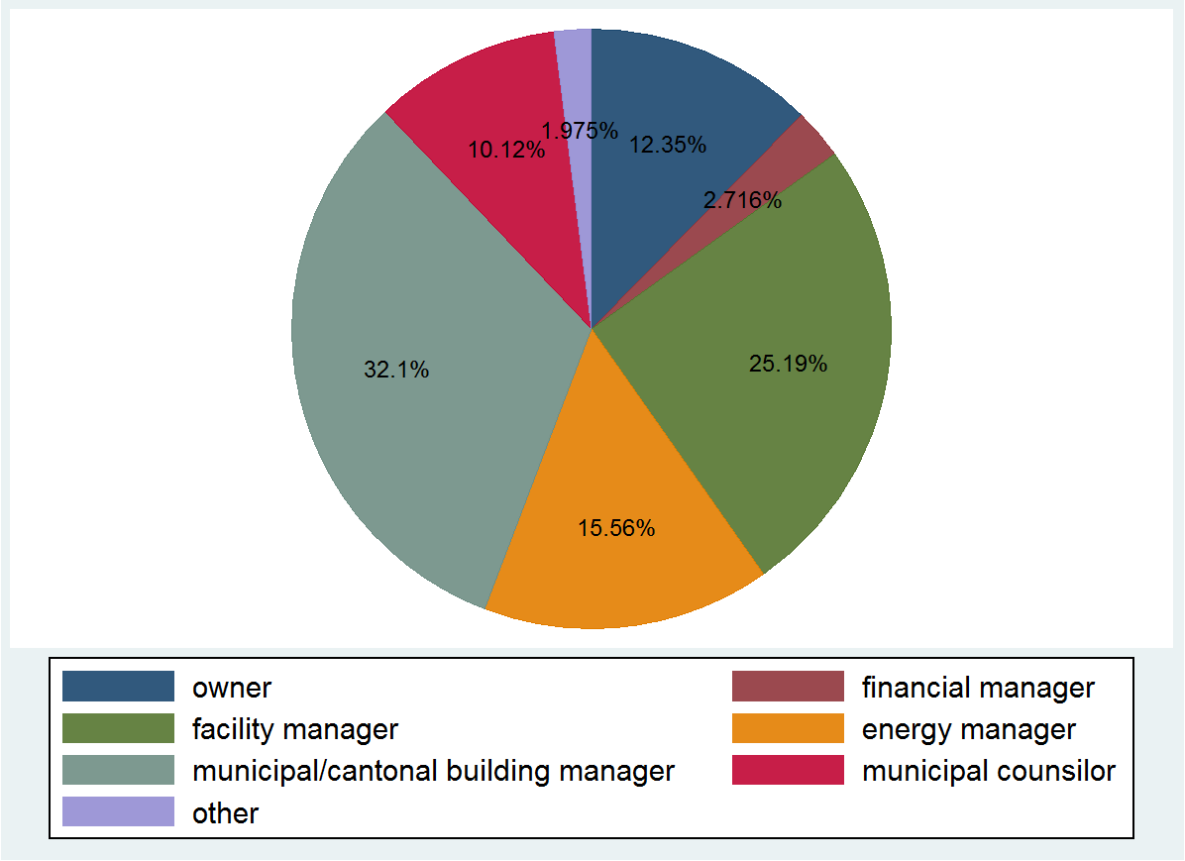


Figure 18 Job function of the respondent

In average, the respondents have an experience of 9 years in that function (with a std. deviation of 7.82). 36 (12 %) of the respondents are women while 11 respondents (4 %) did not specify their gender. 148 (50 %) of the respondents have a university or a HES degree, 92 respondents (31 %) have a professional formation, 44 (15 %) selected high school as their highest education degree and 2 (0.7 %) compulsory school. 11 respondents (3.7 %) did not provide their education level.

Table 22: decision role of the respondents

	n
Part of decision	129
Preselection	77
Advisor	81
Other role	9
Blank	1
Total	297

Table 22 shows that 129 respondents (43 %) are directly involved in the decision process, which provides credibility to the analysis. The other roles, such as preselecting the options, advising and making propositions to the direction, are also an important part of

the decision process and therefore these respondents are also considered in the analysis.

5 Results

5.1 Familiarity with EPC concept

Out of the 297 respondents completing the survey, 157 (53 %) stated that they were already familiar with the concept of energy performance contracting. The emphasis we put in the survey in order to explain energy performance contracting bore fruit since 93% of them claimed that their understood clearly the concept after the explanation. Almost half of those who claimed to have understood the concept were respondents which were unfamiliar to EPC before the survey. This suggests that the majority of respondents answered the choice experiment with a clear perception of energy performance contracting.

5.2 Investment choices

Figure 19 provides the percentage of respondents choosing each option, averaged across the 4 choice tasks, and illustrates the decisions when 2 alternatives are proposed as compared to the situation in which energy performance contracts are additionally proposed. It is first interesting to note that in average more than 5 respondents choosing overhaul in the 2 alternatives case switch for EPC when it becomes available (5.3 % out of 297, dashed green arrow in the figure). These represent more than 21 % of the 75 (25.1 %) respondents who chose overhaul in the first place. From another point of view, 34 (11.5 %) of the 297 respondents switched at least once from overhaul to EPC when it became available. This can give a rough idea of the number of persons for whom EPC might mitigate some barriers to investments in energy efficiency. We will explore in section 5.6.1 which mechanisms of energy performance contracting might induce energy efficiency investment for these respondents that we will call "EPC responsive".

In average, 24.1 % of the respondents choose energy efficiency in the first place and then opt for EPC when it becomes available. These represent 32 % from those who adopted energy efficiency in the first place. It suggests a priori that EPC can also work as facilitating investment for respondents who are already inclined to opt for energy efficiency.

The design of the choice experiment, with a first choice of 2 alternatives and a second with an energy performance contract additionally proposed, presents the interesting advantage of revealing incoherent choices. An average of 2.7 % persons chose overhaul initially and changed to investment in energy efficiency once the contract was additionally proposed. Conversely, 0.8 % in average changed their mind from investment to overhaul once EPC alternative is added. These incoherent decisions, made at least once by 29 persons in the sample of 297 respondents, represent situations in which the inde-

pendence of irrelevant alternative (IIA) assumption is not satisfied. This may result in biases in the estimations using conditional logit. This is the reason why the models were also estimated while excluding these respondents in the robustness checks section.

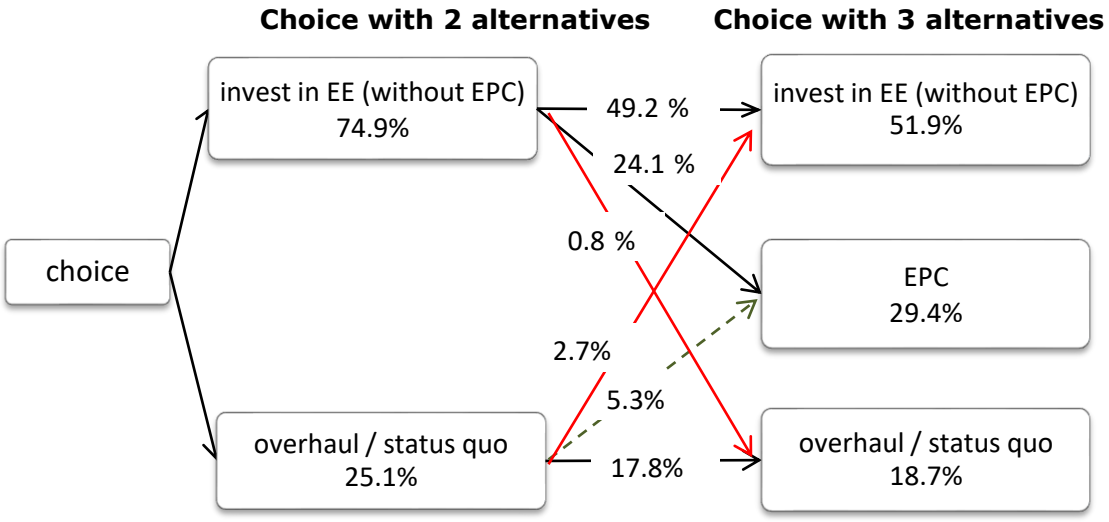


Figure 19 Experiment choices

Notes: percentage of respondents (out of N=297) choosing each option and switching from one option to another, once EPC is additionally proposed (percentage based on average number of persons across the four choice tasks). The dashed green arrow represents respondents who we call "EPC responsive". The red arrows represent choices that do not satisfy the independence of irrelevant alternative (IIA) assumption.

Despite the variations in the attributes levels, the decision patterns are very similar across choice tasks, i.e. most respondents choose the same alternatives (EE, EPC or overhaul) in all choice tasks. Exploring further this phenomenon leads to observe that in total 138 persons (70 %) persist in their choices: 26 respondents chose always overhaul, 79 always energy efficiency investments and 33 chose EPC every time it was proposed. From another point of view, 174 persons never chose overhaul, 149 never chose EPC and 33 never chose energy efficiency without contract. This observation supports the assumption that some respondents did not consider all attributes when making their choices.

Observing further the median time spent on each choice task, Table 23 suggests that respondents considered more carefully the first-choice task. The median time spent on each choice task in fact decreases drastically across the four choice tasks. This might suggest that respondents either got bored, simplified the decision process or simply learned by doing. The follow-up questions on the stated certainty of decisions made by the respondents provide additional information on the matter. Indeed, respondents stating that they consider their choice as being a clear decision are 62 % in task 1, 68 % in task 2, 72 % in task 3 and 4. This observation may therefore rather suggest that the respondents gained understanding throughout the choice experiment allowing them to save time. Robustness checks will anyhow explore the potential impacts of choice tasks, certainty and time spent on the estimates.

Table 23: Respondent's time on each choice task (seconds)

Respondent's time on each choice task	Median	Mean	Std.dev.	Min	Max[a]	N
Time on task 1	79	180.67	915.23	13	14,182	295
Time on task 2	33	62.17	125.845	6	1,265	295
Time on task 3	25	57.95	302.157	4	5,161	296
Time on task 4	18	43.63	189.118	3	2,879	297

[a]A large duration can suggest that the respondent did other activities while keeping the survey screen open.

5.3 Stated barriers to investment in energy efficiency actions

Adapted follow-up questions to respondents who never chose energy efficiency measures and/or energy performance contracts provide useful information on the barriers hampering the deployment of these options. Figure 20 provides a summary of the reasons why respondents never chose energy efficiency investments.

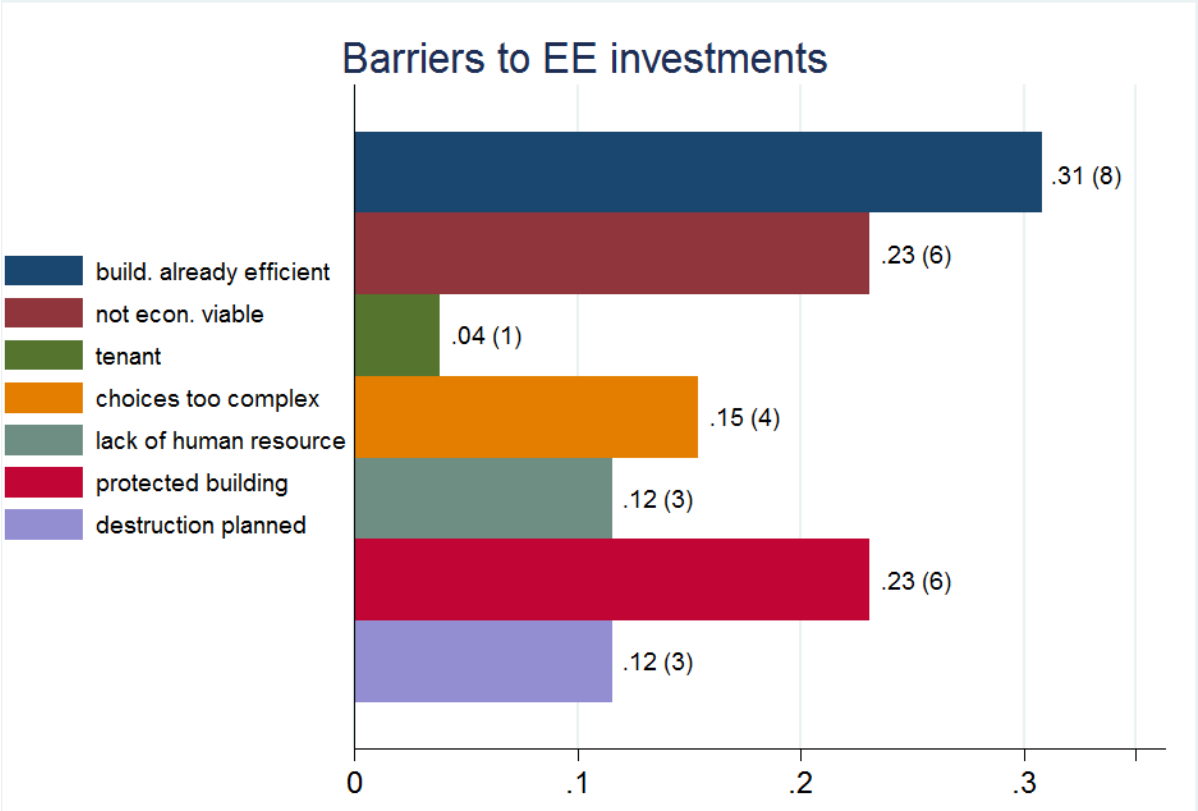


Figure 20 Barriers to energy efficiency investments.

Notes: Share of the 26 respondents who always opt for overhaul/status quo (nb. of respondents in brackets)

For instance, 8 respondents (31 %) out of the 26 individuals who always chose overhaul stated that the building considered was already efficient. It is important to note that 3 of these respondents have already retrofitted the building envelope since 2006 and 4 others have replaced their heating systems since 2011. The second category is represented by respondents stating that energy efficiency investments are not economically viable. The same number of respondents (6) stated to never choose energy efficiency measures since the building was protected and change in aspects is impossible. Then, it is interesting to see that 4 respondents chose always overhaul as a mechanism to deal with choices that were too complex for them. This interestingly suggests that, even when simplified energy efficiency options are proposed, one simple reaction is to opt for the simplest option, i.e. overhaul. These respondents are likely to be constrained by their lack of technical knowledge. 3 respondents stated also that they are constrained by a lack of human resources. Finally, one person mentioned the problem with transferring the costs onto the tenants. This person also declared in a subsequent question that she does not think that ESCOs, by providing some advice on how to transfer costs onto tenants, can help her mitigate this barrier. Other reasons mentioned by respondents were the fact that such investments were not planned in the budget. No respondent mentioned a problem of access to credit for such investments. Participants who always opted for overhaul were also asked to perform an additional choice task, identical to the fourth task, but with only EPC and energy efficiency without contract options available. While 12 participants (46 %) chose energy efficiency without contracts, 13 stated they were indifferent between the two options and only one respondent opted for EPC. This suggests an intrinsic preference for investment without contract as compared with EPC.

5.4 Stated barriers to EPC

The reluctance towards EPC is also visible in the fact that more than 50 % (149) of the sample of 297 completes never opted for energy performance contracting. The reasons as stated by the respondents are presented in Figure 21 (information is missing for one of these respondents).

The main reason mentioned is the unwillingness to outsource the control of operation and maintenance for 58 respondents. This may come from a misperception of respondents that perceived the ESCO's control of operation and maintenance as a necessity to forgive existing facility managers or employees in charge of the technical equipment. This is however not the case since the ESCO controls the operation by providing the facility managers with training courses on how to use and understand the new equipment or efficiently managing the building (Swissesco (2016)). It is followed by 44 individuals stating that EPC is not economically viable. Interestingly, a t-test shows that there is no significant difference in the mean size[84] among respondents who see EPC as not economically viable and the others.

[84] The size is described here in terms of the building's heated surface.

Then, 36 respondents said to be concerned about legal issues resulting from such contracts and 33 with complex tendering processes. This can be closely related with the complexity of the contracts, perceived also by 33 individuals. Then, 25 respondents are preoccupied by the adequacy of EPC with universal conventions of objectives that large energy consumers have to implement with federal agencies to meet legal requirements. Finally, 21 persons mentioned accounting issues and 20 lack of trust. For respondents concerned about trust and universal convention of objectives adequacy, additional questions were asked to explore these further.

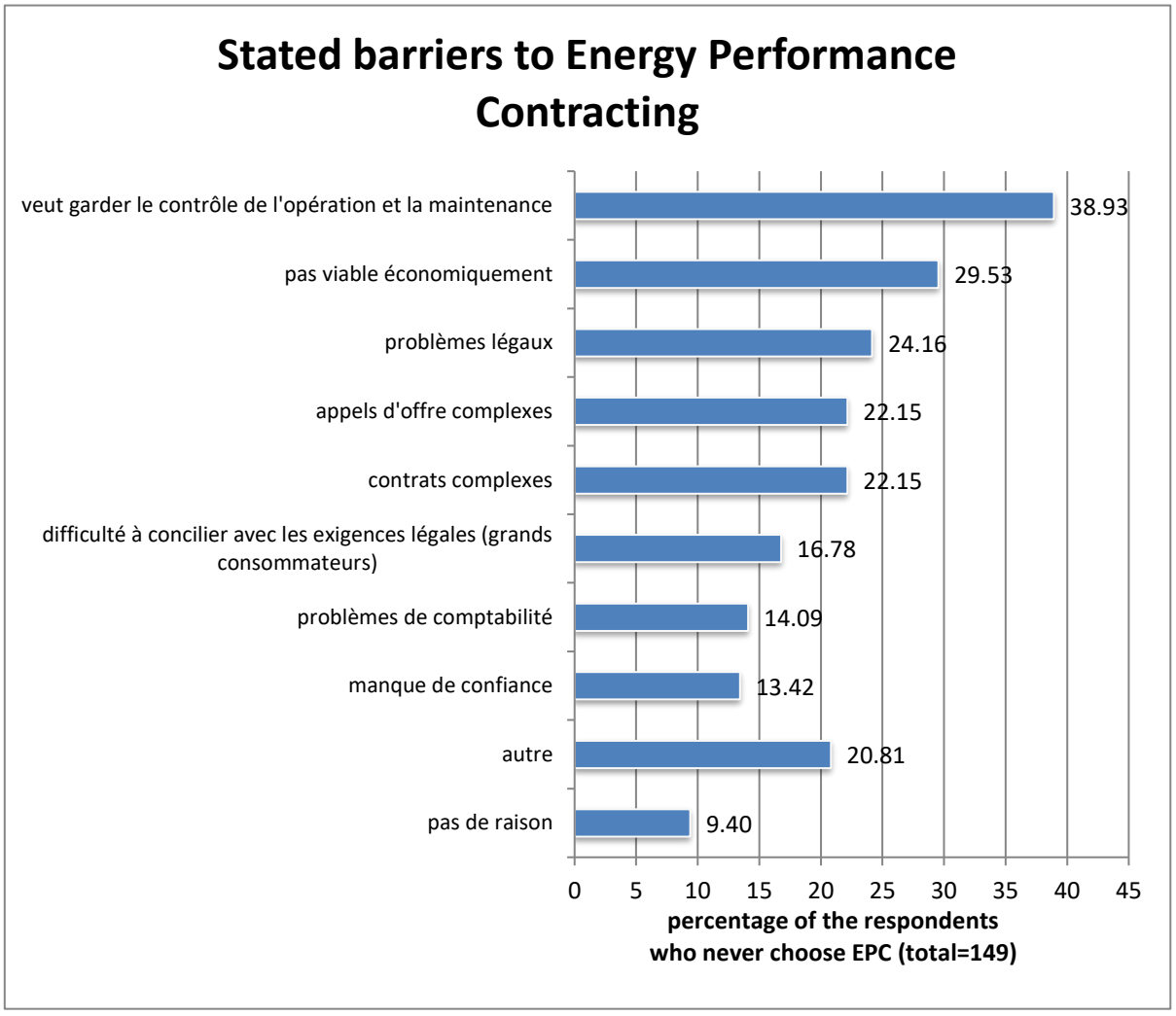


Figure 21 Stated barriers to energy performance contracting

Concerning trust, we asked the concerned participants to state whether their trust would increase should the ESCO be an energy utility. 26 % stated that indeed it would increase their trust, 68% stated that their trust would not change and 1 individual (5 %) mentioned a decrease trust towards utilities as ESCOs. This may suggest a different consideration for utilities in Switzerland as compared to Germany. Polzin et al. (2016) indeed show that existing partnerships with utilities impact negatively EPC adoption.

Concerning universal convention of objectives, we asked whether they would be more inclined to sign EPC if the ESCO was certified by a federal agency to implement such a convention. Interestingly, only 8 respondents (35 %) stated that it would increase their willingness to adopt EPC. The rest was indifferent or even less inclined (1 person) to sign. This interesting observation suggests that an important priority for ESCOs is to inform about the adequacy of EPC with universal conventions of objectives for large consumers. This is the case even for ESCOs which are already certified to implement those conventions.

14 respondents did not provide any reason to explain the fact that they never chose EPC. This could suggest an unexplained unwillingness to adopt EPC. Interestingly, 13 of these respondents were unfamiliar with EPC before completing the survey. While this cannot provide information on the causality, the correlation between unexplained distaste for EPC and unfamiliarity with the concept can suggest that information campaigns with best practices are needed to overcome the barriers linked to the novelty of this model in some people's mind. This lack of information and biased perception of EPC are also visible in the other reasons respondents mentioned for not choosing the contracts. For instance, some respondents stated that EPC was not possible since the building is public or because they were financially constrained. In fact, EPC are typically targeted to buildings with these characteristics.

Other legitimate reasons mentioned are the commitment to an external firm that these contracts involve (7 respondents), the willingness to invest themselves especially in a context where credit is as cheap as now (5 persons), the contract's duration which was too long (3 respondents) and qualified human resources already available internally (2 persons). One participant was also concerned about the difficulty to sell a building committed with an EPC. Other respondents gave the same reasons as those who always chose overhaul such as protected buildings where transformation is impossible.

To summarize, while EPC has been seen in foreign markets as an instrument to reduce and mitigate barriers to investments in energy efficiency (cf. chapter I), in an emerging market such as Switzerland where a lot of interrogations remain on the concept, it appears a priori that the perceived barriers are even stronger and more numerous for EPC than for energy efficiency investments without contracts. If EPC can indeed reduce constraints on financing and performance on the clients' side, hard work is still needed to mitigate transaction costs linked to those contracts. A large part of this task will probably include information campaigns and dissemination of best practices examples, which has already started under the impulse of the swissesco association and the Swiss federal office of energy.

5.5 Attributes summary statistics and stated attributes importance

The apparition of the type of measures seen by the respondents in the choice experiment is described in Table 24. The allocation of respondents across the different types of choice experiment depending on the revisions they already implemented since 2005 (cf. Figure 17 and appendix 6.6) resulted in a large majority (68 %) facing type 1, i.e.

the design proposing both envelope enhancement and new heating systems (with or without building automation). Type 3, including only envelope enhancement, was faced by 68 respondents (23 %). 12 respondents had already implemented envelope enhancement and were thus proposed measures including new heating systems and automation. A minority of respondents (4%) already revised both the envelope and the heating systems since 2005. Hence, they saw type 4 (9 respondents) and type 5 (4 respondents). The percentage of times each measure was proposed is presented in Table 24, where N represents the total number of observations in the choice experiment analysis, i.e. the number of alternatives (3+2) multiplied by the number of choice tasks (4) and the total of respondents (297).

Table 24: Summary statistics of measures

N=5940	**Mean**
Variables (dummies)	**(% of N)**
Group dummy control *technic*	46.35
building automation	46.01
exploitation optimization	0.69
controlled ventilation	0.25
Group dummy control *mix*	13.64
biogas mix (if already gas)	13.43
green electricity mix	0.20
Group dummy control *heating*	16.90
new heat pump	11.03
new wood heating	5.13
solar panels	0.74
Dummy control *envelope*	27.95
Overhaul façade, windows (painting)	23.54
Overhaul boiler revision	14.58
Overhaul technical revision	1.21

Note: One alternative can include several measures (e.g. heat pump + building automation)

The dummies used in the analyses of the results section are the four group dummies *technic, mix, heating, envelope*[85] which include several measures as described in Table

[85] Taking groups permits to reduce the number of parameters to estimate, which is particularly useful in the attribute non-attendance exploration with latent class models. The models were also improved when taking groups as opposed to individual dummies. This strategy is also supported by the fact that the purpose of research is to explore contractual mechanisms inducing investment in energy efficiency and not to esti-

24. Because building automation was proposed alone and as a combination with other measures, it has been the most often proposed (46 % of the alternatives). 28 % of the options were including envelope enhancement, 17% new heating systems and 14 % proposed a mix of biogas or green electricity in the current consumption.

Table 25: Summary statistics of attributes

Variable	Mean	Std. dev.	Min	Max	N
Attribute of *overhaul*, *ee*, *epc* alternatives					
upfront cost (CHF/m^2 heated surf.)	119.3	77.8	0	300	5940
Attributes of *ee* and *epc* alternatives					
expected savings (% kWh saved)	18.7	21.8	0	70	5940
savings variation (exp. sav ±%)	7.0	8.2	0	30	5940
Attributes of *epc* alternatives					
upfront cost share ESCO (CHF/m^2 h.s.)	16.8	46.8	0	300	5940
savings guarantee dummy	0.1	0.4	0	1	5940
payment to ESCO (CHF/m^{2}h.s. p. year)	2.7	7.9	0	82.1	5940
contract's duration	2.5	5.6	0	20	5940

Table 25 provides summary statistics of the attributes of interest. The upfront cost lies between 0 and 300 CHF per heated squared meters of surface and is zero for status quo alternatives. Because expected savings and savings variation concern only alternatives with energy efficiency measures or energy performance contracts, these variables are set to zero in overhaul/status quo alternatives. Similarly, all the contractual elements concerning only the EPC alternative are set to zero in the other options. Upfront cost share can also be null in EPC options without external financing as well as guarantee which is not proposed in every contract. However, all contracts involve a positive payment per year to remunerate the ESCO and a positive contract's duration[86]. The allocation of respondents across the 5 design types shaped the distributions of the attributes.

Just before entering the choice experiments, the respondents were randomly assigned additional information on energy efficiency non-monetary benefits and/or on the advantage of EPC of having a guarantee on the costs. In total, 145 respondents (49%) were provided the additional information on energy efficiency supplementary benefits

mate the WTP for specific energy efficiency measures. The overhaul measures are not controlled for in the analyses, since the emphasis is on the EE and EPC alternative and overhaul is taken as a baseline.

[86] More details on the possible levels of the attributes are provided in Table 13.

and 139 of them (47 %) received the information on EPC. Out of these, 54 participants (18 %) received both information. The impact of this information will be explored in the next section.

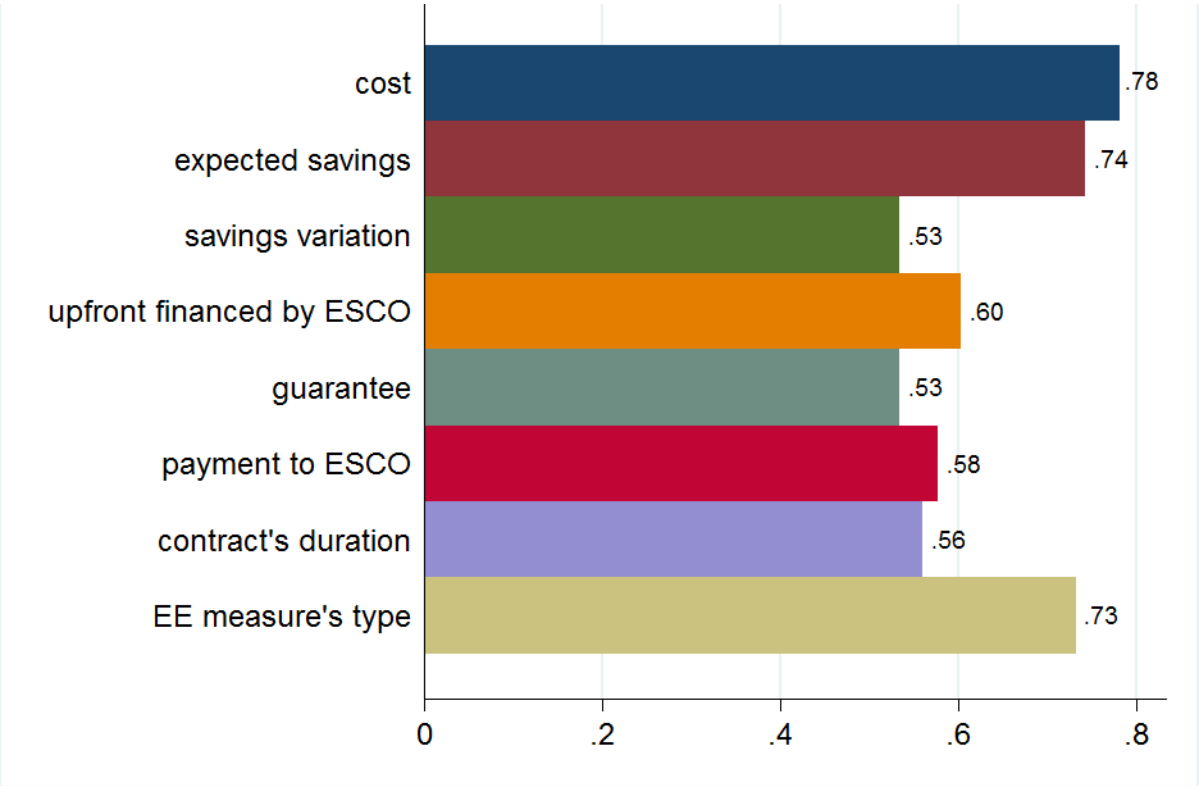


Figure 22 Stated attribute importance

Because attribute non-attendance is expected to have an impact, it is interesting to explore the responses of participants regarding attributes importance. Figure 22 illustrates the share of respondents stating that the concerning attribute was considered important in the decision process of the choice experiment.

Table 26 provides additional details on the patterns of attributed non-attendance stated by at least 4 persons. These are the patterns that were considered in the latent class models exploration (see section 3.3.1 for more details). 19 respondents (6 %) stated that they considered the costs, the savings and the measures proposed as important. As a matter of fact, costs and savings are the attributes that are present the most often in the combinations. Conversely, 23 individuals stated that no attribute was more important than another in their decision making. This can either be interpreted as full-attendance or none-attendance. In the last lines of the table, two groups of 7 individuals can be observed. For instance, 7 individuals considered costs, savings, measure and guarantee from the ESCO and 7 other stated that savings and measures were important attributes in their choices. It is interesting to note that although respondents were able to state 4 attributes considered as important, a majority of them (52 %) gave 1 to 3 attributes as important. This further supports the hypothesis of attribute non-attendance in the sample.

Table 26: Combination of important attributes (>6 persons)

Combination of important attributes	Nb resp.	Share
No attribute is more important than another	23	0.08
Cost-sav.-meas.	19	0.06
Cost-sav.-meas.-risk	16	0.05
Cost-sav.	13	0.04
Cost-sav.-meas.-fin. by ESCO	12	0.04
Cost	9	0.03
Cost-sav.-meas.-guar. / sav.-meas.	7 (2x)	0.02 (0.05)

5.6 Estimation results: Does EPC induce investment in energy efficiency and through which mechanisms?

The estimation results are provided in Table 27 for the basic conditional logit in the first column, the conditional logit for attributes interacted with individual stated attributes importance dummies in the second column. These dummies equate one when the individual stated that he considered this specific attribute as important and zero otherwise87. The latent class model for inferred ANA is provided in Table 28. One can first note that accounting for ANA increases the performance of the models according to the log likelihood, the Bayesian information criterion (BIC) and the Akaike-Schwartz Information criterion (AIC). The attributes' cost, expected savings, guarantee from the ESCO and the measure envelope are statistically significant in both conditional logit models and present intuitive directions. The hypothesis H2 is confirmed since a guarantee from the ESCO is consistently increasing the probability to invest in energy efficiency. This result contrasts with the one from Polzin et al. (2016), who find that municipalities do not positively value the risk-sharing advantage of EPC in LED retrofits projects. Conversely, having a part of the upfront cost financed by the ESCO does not seem to be significantly positively valued by the respondents, a priori refuting hypothesis H1. This confirms the observation in the summary statistics section that respondents explicitly stated that they would rather invest themselves. This suggests that access to credit does not seem to be a barrier to energy efficiency investment in Switzerland, at least in the current conjuncture. The hypothesis H1 seems *a priori* contradicted. This result contrasts with the general observation by Panev et al. (2014) that financing energy efficiency projects is one of the main issue. One should however put this result in the current Swiss context where credit is very inexpensive.

[87] Full attendance (i.e. all dummies equate one) is assumed when the individual ticked the maximum number of attributes possible (i.e. 4 attributes) and when the respondent chose the option: "no attribute is more important than another".

Table 27: Estimation conditional logit

dependent variable: choice (=1 if choose alternative *j*)	clogit full attendance	clogit stated weights
upfront cost (CHF/m² heated surface)	-0.004*** (0.001)	-0.003** (0.001)
expected savings (% kWh saved)	0.011*** (0.003)	0.023*** (0.004)
savings variation (exp. sav. ±%)	0.007 (0.008)	-0.001 (0.012)
upfront cost share ESCO (CHF/m² heated surface)	-0.001 (0.002)	0.002 (0.002)
savings guarantee (dummy)	0.401** (0.160)	0.918*** (0.214)
payment to ESCO (CHF/m² heated surface per year)	-0.001 (0.011)	-0.018* (0.011)
contract's duration (years)	-0.017 (0.015)	-0.038** (0.015)
measure envelope (dummy)	0.860* (0.441)	0.680*** (0.274)
measures group technic (dummy)	0.409** (0.186)	0.087 (0.199)
measures group biogas/green elec mix (dummy)	0.025 (0.394)	0.167 (0.311)
measures group heating (dummy)	-0.071 (0.392)	-0.073 (0.310)
alternative specific constant *ee* alt. (dummy)	0.409 (0.415)	0.638*** (0.221)
alternative specific constant *epc* alt. (dummy)	-0.243 (0.520)	-0.045 (0.251)
observations	5940	5580
individuals	297	279
loglikelihood	-1839.407	-1640.606
AIC	3704.8	3307.2
BIC	3791.8	3393.4

Notes: conditional logits (clogit) are estimated using stata. Clogit stated weights uses an interaction of attributes with dummies of individual-stated attributes importance. These dummies equate one when the individual stated that he considered this specific attribute as important and zero otherwise. Individual-cluster robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1.

Except from ESCO financing, all the contractual attributes become statistically significant once stated weights are controlled for. This supports the previous observation that contractual attributes were less considered by respondents than cost and expected savings attributes. Once we account for heterogeneity in the weights allocated to each attribute, the annual payment to the ESCO has the expected negative significant impact on the decision to opt for EPC as stated in hypothesis H4. Also, contract's duration unambiguously has a negative impact for the respondents who considered this attribute, suggesting the disadvantages of a long-term contract (e.g. commitment and depend-

ence to an external firm) offset the advantages (such as maintained performance over the contractual period. and more comprehensive refurbishments opportunities).

In order to explore both attribute non-attendance and heterogeneity in preferences, we use a latent class model. In order to select the relevant attribute non-attendance patterns, we used the respondents stated weights (Table 26) as a basis. All combinations of stated weights figuring in Table 26 and concerning more than 6 persons were considered. By an iterative process and starting with the groups representing the largest number of respondents, we tested how including each group affects the efficiency of the model in terms of information criteria (Akaike and Bayesian information criteria). We started with a LCM with two classes:

1. Full attendance, representing the group of respondents stating that no attribute was more important than another in their decision (23 persons)
2. Only upfront costs, savings and the energy efficiency measures are attended to (as these attributes are stated as important by 19 persons in the sample). All other attributes are constrained to equal zero.

We subsequently added the other groups, in the same order as presented in Table 26. When the group lead to smaller information criteria, it was kept, otherwise it was removed. In this manner, seven latent class models with two to six classes were tested. From the model, which minimized the information criteria using this process, we checked whether a more efficient model could be found by omitting one of the classes, or by adding a class previously eliminated[88]. The final combination of selected attribute non-attendance patterns which minimized the information criteria using this process is presented in Table 28. In the final model, some classes showed a very large p-value for alternative specific constants (ASC). This probably suggests that for the respondents of these classes, the label of the alternative has no impact and the attributes entirely capture the differences of preferences among the alternatives. For these classes, we therefore also set the ASC to equal zero. This phenomenon is however not observed in all classes (e.g. class 2)[89]. This suggests that some respondents have preferences towards energy efficiency, EPC or overhaul that are not entirely captured by the attributes. Further exploration of this phenomenon is provided in section 5.6.3.

Once the classes and ANA patterns determined, individual or building characteristics were tested in order to see whether they had any impact on the class probabilities. Being familiar with EPC is the only individual specific characteristic showing a significant impact in this latent class model[90].

[88] A second full attendance class or a complete none attendance class were also added to check whether the model would be improved. This was not the case.

[89] The model of Table 28 was also tested by completely omitting ASC in all classes. The model showed a milder performance in terms of information criteria, but the results in terms of sign and significance are similar.

[90] We tested other characteristics such as private vs. public buildings, tenants, yearly energy/electricity costs, heated surface, retrofits done and planed, random information on non-economic benefits of energy efficiency investments, random information on cost guarantee from EPC, function, experience, age, gender, education of the respondent. All these individual and building characteristics are tested using interaction in conditional logit models. The results are provided in section 5.6.2. We also tested whether dummies for

. Table 28: LCM with inferred attribute non-attendance

Dependent variable: choice (=1 if choose alternative *j*)	LCM Inferred ANA (6classes)				
	(1)	(2)	(3)	(4)	(5)
Upfront cost	-0.016*** (0.005)	-0.006* (0.003)	-0.006 (0.006)	0	-0.111*** (0.025)
Expected savings	0.018* (0.011)	0.034*** (0.006)	0.031** (0.012)	0.017** (0.007)	0
Savings variation	-0.030 (0.032)	0	0	0	0
Upfront ESCO	0.019 (0.012)	0	0	0	0
Savings guarantee	-0.167 (0.634)	0.660** (0.319)	0	0	0
Payment to ESCO	-0.147** (0.057)	0	0	0	0
Contract's duration	-0.345*** (0.105)	0	0	0	0
Meas. envelope	7.135*** (1.127)	0.280 (1.067)	-2.474*** (0.902)	-0.688 (0.796)	0
Meas. technic	2.175*** (0.635)	0.282 (0.391)	1.874** (0.834)	-0.566 (0.356)	0
Meas. mix	2.800*** (0.654)	-0.819 (0.944)	-1.303* (0.757)	-1.291* (0.715)	0
Meas. heating	1.095** (0.950)	-0.312 (0.975)	0.104 (0.851)	-2.098** (0.822)	0
ASC *ee* alt.	0	3.753*** (1.093)	0	0.691 (0.772)	0
ASC *epc* alt.	0	3.978*** (1.138)	0	0.896 (0.823)	0
Class probability as a function of stated weights group					
Constant	1.046*** (0.297)	0.777** (0.313)	-0.716 (0.521)	0.652** (0.326)	0
Familiar with epc(dummy)	0.625 (0.450)	0.808* (0.463)	0.938 (0.671)	-0.359 (0.589)	0
Average posterior class probabilities	0.363	0.309	0.075	0.159	0.094
observations	5940				
Individuals	297				
Loglikelihood	-1214.374				
AIC	2512.7				
BIC	2755.2				

Notes: Estimated using Nlogit. Standard errors are in parentheses. ***P<0.01, **P>0.05, *P<0.1. Attribute non-attendance is expressed as coefficients being constrained to equal zero. Familiar with EPC before the survey. ASC stands for alternative-specific constant.

The model retains five classes, including full attendance except for ASC (cf. class 1). In three of the classes (classes 3, 4 and 5), EPC contractual attributes are not attended to.

belonging to specific groups of stated attribute importance matters in the class probability. These dummies happen to be non-significant. This might suggest that the inferred attribute nonattendance not exactly corresponds to the weights stated by the respondents.

These are estimated to represent a third of the sample. These results are in line with the finding that some respondents disregarded the EPC attributes when making their choices. Costs, savings and measures are the attributes that are the most often considered. This is consistent with the stated most important attributes.

Respondents considering EPC contractual clauses are split into two classes (classes 1 and 2). Both classes are characterized by an average posterior class probability around one third. In the first group, respondents are negatively impacted by the payment to the ESCO the contract's duration. These are likely to be the respondents claiming their reluctance towards the commitment that these contracts involve. The respondents are also more sensitive to the upfront cost. In the second class, respondents are relatively more sensitive to the savings and significantly concerned by the guarantee offered by EPC. The individuals previously familiar with the EPC concept are more likely to belong to the second class, i.e. valuing positively the guarantee. The second class's respondents are also more likely to choose energy efficiency investments, with or without contracts, as expressed by the alternative-specific constants.

In the third and fourth classes, respondents consider upfront costs, savings and measures. Even if the cost is not significant in the third class, colluding these two classes does not improve the model[91]. The sensitivity to energy savings and measures is different in these two classes. The last class, with a class probability slightly larger than 9%, represents individuals considering only cost which is translated by a relatively large coefficient in this class.

Overall, the latent class model distinguishes specific groups of respondents, while accounting for heterogeneity in both preferences and attribute non-attendance. The performance of the model is higher than the conditional logit models in terms of information criteria (AIC, BIC). The models also show that even by splitting the respondents considering contractual clauses into two distinct classes, the ESCO financing attribute is still not significantly valued by respondents.

5.6.1 Differences in preferences for respondents who are EPC responsive

In order to test further the ESCO's financing attribute (Hypothesis H1), we focus on the respondents whose decisions suggest that they may face barriers to energy efficiency investments that EPC could solve. These are typically the individuals who chose overhaul when EPC was not available and changed for EPC in the second-choice task when it was proposed. A dummy "*EPC responsive*" was created which equates one for all the respondents who behaved this way, in one choice task at least. It concerns 34 participants (11% of the sample) and a majority of them (27) are representing public buildings and especially education facilities (17 buildings). These numbers are interesting to compare with the share of 20% of financially constrained municipalities in Germany

[91] The signs and significance of contractual, cost and savings attributes are the same when omitting class 4. The model performance is lower and the only difference lies in the signs and significance of the measures in class 3. This suggests that classes 3 and 4 have different preferences regarding measures and separate them permits to capture those differences.

found by Polzin et al. (2016). This dummy was interacted with all attributes and Table 29 shows the results when keeping only the interactions that are statistically significant, i.e. where there is a resulting heterogeneity in estimates[92]. First of all, the coefficient for upfront cost presents a greater negative magnitude for these respondents, which may suggest that they are limited in terms of credit possibilities. The heterogeneity between the costs estimates is confirmed by a Wald test rejecting equality at more than 90 % confidence level. More interestingly, these respondents are more likely to value significantly and positively financing from the ESCO. The difference in estimates is significant at more than 99% confidence levels. These respondents value also significantly more greatly the fact of having a guarantee (>99 % confidence level).

These results suggest that in a context where credit is available at attractive rates, most of the respondents are not facing limited access to credit for energy efficiency investments. There is however a relatively small number of exceptions, who are mostly public entities and who may be credit constrained. A natural deduction from this is that the financial constraint experienced by these collectivities come from the credit limits set by the legislative organ such as debt ceilings. This result confirms the H1 hypothesis and is in line with the findings of Polzin et al. (2016) who find higher willingness to consider EPC when financially-constrained. As a matter of fact, in the current conjuncture, such credits limits are probably the only cases where financing from the ESCO is interesting and significantly positively valued.

[92] This dummy has also been tested as an individual characteristic influencing the classes probability in the unconstrained LCM. The model however could not converge when accounting for this variable.

Table 29: Impact of contractual clauses for indiv. responsive to EPC

Dependent variable: choice (=1 if choose alternative *j*)	clogit
Upfront cost (CHF/m² heated surface)	-0.003** (0.002)
Upfront cost x EPC responsive indiv. (CHF/m² heated surface)	**-0.008*** (0.002)**
Expected savings (% kWh saved)	0.009*** (0.003)
Risk: savings variation (difference from exp.sav)	0.011 (0.008)
Upfront cost share ESCO (CHF/m² heated surface)	-0.001 (0.002)
Upfront cost share ESCO x EPC responsive indiv. (CHF/m² heated surface)	**0.009*** (0.003)**
Savings guarantee (dummy)	0.235 (0.175)
Savings guarantee x EPC responsive indiv. (dummy)	**1.390*** (0.286)**
Payment to ESCO (CHF/m² heated surface per year)	0.001 (0.013)
Contract's duration (years)	-0.022 (0.016)
Measure envelope (dummy)	0.965** (0.444)
Measures group technic (dummy)	0.405** (0.187)
Measures group biogas/green elec mix (dummy)	0.142 (0.396)
Measures group heating (dummy)	0.027 (0.398)
Alternative specific constant *ee* alt. (dummy)	0.337 (0.415)
Alternative specific constant *epc* alt. (dummy)	-0.283 (0.525)
Observations	5940
Individuals	297
Loglikelihood	-1787.218
AIC	3606.4
BIC	3713.5

Notes: Individual-cluster robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. EPC responsive indiv. is a dummy which equates 1 for respondents who, at least in one choice task, chose overhaul when EPC was not available and then switched to EPC once proposed. 34 respondents (11% of the sample) belong to the group of EPC responsive individuals.

5.6.2 Impact of individual or building characteristics

As already suggested by the results provided in the latent class model, being familiar with EPC is proven to be positively related to the willingness to adopt energy efficiency measures, with and without EPC. This has been shown by interacting a dummy for EPC familiarity with alternative-specific constants of EE and EPC in the basic conditional logit model.

Other individual and building characteristics were tested and did not have a significant impact, neither in the LCM class probabilities nor when interacted with attributes in the conditional logit model. For instance, private vs. public buildings did not result in significantly different estimates, even when interacted with the contract's duration attribute in the conditional logit model. This result contrasts with the presumption of a divergence in contract's duration valuation from private entities as compared to public institutions. Moreover, private firms do not value significantly differently a guarantee or the ESCO's financing than public entities.

The fact of having tenants did not show a significant impact on the likelihood to invest in energy efficiency, with or without contract. This result contradicts hypothesis H3. This apparent absence of split incentives barrier to investment may be explained by the fact that buildings with tenants are a minority in the sample (38 %) and more importantly private rented buildings represent a small share (8 %). Split incentives issues may indeed be less representative in public rented buildings for which the motivation to retrofit is not mainly economically-driven. Therefore, this sample may not be representative to explore the split incentives barrier to energy efficiency investment. This is also supported by the observation in section 5.3 that only one respondent mentioned the tenants as being a potential barrier to energy efficiency investment.

Then, there is no evidence of scale effects in the decision patterns, as when controlling for energy and/or electricity yearly costs (in CHF), or heated surface. We also tested whether heterogeneity in decision making processes had any significant impact on the valuation of attributes. The respondents were asked to state whether there were budget or contract's duration thresholds above which they would need to consult other entities within the firm/the institution to decide. Interaction terms of these thresholds with upfront costs or contract's duration were added to the basic conditional logit model. Because these interaction terms were not significant, it is possible to conclude that these thresholds did not have significant impacts on the estimates for these attributes. Finally, the random information provided on the non-monetary benefits of energy efficiency investments as well as the guarantee on costs provided by EPC did not have either a statistically significant impact on the decision to invest.

It is however interesting to note that if there is an existing energy manager employed in the building, the likelihood to opt for energy efficiency is significantly higher. It is suggested by the significance of an interaction term between energy manager employed dummy and the alternative-specific constant (ASC) for EE in the basic conditional logit model. The interaction with the ASC for EPC is however not significant. This result is in line with Polzin et al. (2016) who show that having personnel capacity induces in-house energy efficiency investment rather than energy performance contracting.

In the same manner, we tested whether the function of the respondent in the firm/institution has an impact on the investment decisions. If the respondent is the energy manager of the building, the likelihood to invest in energy efficiency with and without EPC increases. This could be explained by the fact that energy managers are likely to be better informed about the options to invest in energy efficiency, including EPC, which may induce investment. This also means that energy managers are aware that performance contracts do not represent a threat to their job and thus are not reluctant towards EPC. Conversely, if the respondent was the owner of the building he is less likely to opt for energy efficiency, with and without EPC. When the respondent is a municipal councilor, there is a significant reluctance to opt for EPC. Moreover, the participant's number of years of experience within the firm/institution also affects negatively the propensity to opt for EPC. Experience is however not significant when interacted with the ASC for EE. The age, the gender and the role in the decision process of the respondent does not show any significant impact.

5.6.3 Relaxing assumption of equality of parameters across alternatives: is there an intrinsic reluctance towards EPC?

149 respondents (50 % of the sample) never opted for energy performance contracting. Moreover, the previous results show that a large share of individuals did not attend to attributes specific to the EPC alternative. As presumed in hypothesis H5, all these observations suggest an intrinsic reluctance to invest in energy efficiency through EPC, even when controlling for the advantages (guarantee, financing) and costs (payment, duration) that are captured by the contractual attributes. In order to explore this conjecture further, a conditional logit with alternative specific estimates for all attributes is estimated. The results are provided in Table 30.

While the cost of the overhaul alternative does not have a significant impact on adoption, this attribute is significantly valued more negatively in the EPC alternative than in the energy efficiency without contract alternative (Wald test with >95 % confidence level). These significant differences in the cost attribute suggest a smaller willingness to invest in energy efficiency through EPC than without contract, even when controlling for all other observed differences between the two options. This means that other perceived barriers, not presented in the choice experiment, explain a reluctance to opt for energy performance contracting. An overview of these reasons is presented in section 5.4. Other attributes such as expected savings or savings variation do not show statistical differences across alternatives. Nevertheless, considering alternative-specific estimates results in a significant negative impact of contract's duration as opposed to the basic conditional logit model in Table 27 column 1. This also points towards the perceived disadvantage of long run commitment with an external firm also described in section 5.4.

Table 30: Alternative-specific estimates of attributes

Dependent variable: choice (=1 if choose alternative *j*)	clogit
Upfront cost x alt=*ee* (CHF/m² heated surface)	-0.004*** (0.002)
Upfront cost x alt=*epc* (CHF/m² heated surface)	-0.006*** (0.002)
Upfront cost x alt=*overhaul* (CHF/m² heated surface)	-0.003 (0.003)
Expected savings x alt=*ee* (% kWh saved)	0.014*** (0.005)
Expected savings x alt=*epc* (% kWh saved)	0.009 (0.006)
Risk: savings variation x alt=*ee* (exp. sav. ±%)	0.002 (0.011)
Risk: savings variation x alt=*epc* (exp. sav. ±%)	0.014 (0.014)
Upfront cost share ESCO (CHF/m² heated surface)	- (0.002)
Savings guarantee (dummy)	0.284** (0.144)
Payment to ESCO (CHF/m² heated surface per year)	-0.007 (0.011)
Contract's duration (years)	-0.026** (0.012)
Measure envelope (dummy)	0.923** (0.436)
Measures group technic (dummy)	0.474** (0.185)
Measures group biogas/green elec mix (dummy)	0.007 (0.384)
Measures group heating (dummy)	-0.081 (0.383)
Alternative specific constant *overhaul* alt. (dummy)	-0.328 (0.425)
Observations	5940
Individuals	297
Loglikelihood	-1838.062
AIC	3708.1
BIC	3815.2

Notes: Individual-cluster robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Interactions of attributes with alternative specific constants, except from the measures which are used as controls and not interacted.

5.7 Robustness checks and further research

Using an unconstrained latent class model, i.e. with varying coefficients across classes, permits to explore heterogeneity in attribute non-attendance patterns and in preferences. As opposed to an equality-constrained latent class model (ECLCM)[93] however, this increases the model's parameters to estimate and irrelevant classes are also more difficult to detect[94]. As a result, it is impossible to explore all ANA combinations using unconstrained LCM. In order to check the robustness of the LCM of Table 28, we used a method with equality-constrained latent class models to explore the ANA combinations that should be retained as relevant. The method follows the iterative algorithm proposed by Lagarde (2013) to explore ANA of single, pairs and triples ignored attributes[95]. The irrelevant classes, i.e. with average posterior class probability equal to zero, are dropped in the process and relevant ones are kept for the next steps. The classes surviving to this process are then compared to patterns with four to seven attributes non-attended to. In order to limit the number of possible combinations to consider, we use again the stated (one to four) important attributes[96] and explore only the candidates of decision process patterns present in the sample. All combinations concerning at least 4 persons in the sample are tested. This entire process is implemented in Nlogit. The final model is presented in Table 49 (appendix 6.7) and includes 7 classes. As in the unconstrained model, only two classes include attendance to contractual attributes. These however represent a smaller share (around one third) of the individuals than in the unconstrained model. Cost, savings and measures are still the attributes being the most often considered. While larger in magnitude, the coefficients in the ECLCM are similar in sign and significance to the results found in the conditional logit with stated weights[97]. 17 % of the respondents are expected to belong to a class in which no attribute matters. The existence of a none-attendance class may result from the restrictive assumption imposed on the equality of preferences across classes. In order to test whether equality constraint across classes is a restrictive assumption, one can compare the in-

[93] In which parameters are constrained to be the same across classes.

[94] Indeed, equality-constrained latent class models (ECLCM) by forcing non-zero parameters to be equal across classes allows to detect irrelevant classes since these show an average posterior class probability equating zero. In unconstrained latent class model, it is really rare to obtain an estimated class probability of zero.

[95] This process, beginning with single attributes ignored and following with a higher number of attributes ignored makes the assumption that a single-attribute ignored pattern is considered irrelevant at an early stage has no chance to become relevant once more attributes are ignored. In this process, the dummies for technologies groups representing the attribute for the energy efficiency measures are considered as a block and therefore assumed to be either all ignored or fully considered. This is justified by the fact that in this study, the focus is not on the willingness to adopt specific technologies but rather to assess the willingness to opt for energy efficiency measures as a whole, i.e. taking the measures as controls and focusing on contractual clauses, cost and savings, driving the decision.

[96] Here including the measure attribute alone.

[97] Only risk has an unexpected significant positive sign, which may be explained in heterogeneity in the way risk is perceived. We can indeed show that some respondents considered the upper bound, the lower bound or both. This translates in a misleading positive coefficient in the ECLCM.

formation criteria of the model once the constraint is relaxed. The ECLCM as presented in Table 49 does not converge when relaxing the equality constraint. We however constrained the LCM of Table 28 and this lead to a poorer performance in terms of information criteria. This suggests that accounting for preferences heterogeneity represents an advantage.

The design of the choice experiment, by asking respondents to first choose between energy efficiency and overhaul and then propose the same two alternatives with an additional EPC option, provides information on potential incoherent choices. For instance, a respondent stating that he would prefer overhaul in the choice task with two alternatives should have no reason to switch for energy efficiency once an additional option, EPC, is proposed. If he does so, then his decisions do not satisfy the assumption of independence of irrelevant alternatives, necessary to estimate conditional logit models without bias. Because these decision patterns occurred for 29 respondents in this sample, it is necessary to check the robustness of the previously found results when ignoring these incoherent choices. Robustness was also tested by omitting the choice tasks in which the respondent took less than 5 seconds to answer[98], and by eliminating the choice tasks in which the participant stated that he was uncertain to his choices. Eliminating these choice tasks, together or individually, did not affect the signs of the estimates shown for conditional logit models in Table 27, Table 29 and Table 30. Also, the differences in magnitudes were relatively small, with the largest differences (in the order of three-tenths) when omitting uncertain choices.

The models were also estimated when accounting for differences across choice tasks, by interacting choice tasks dummies with the alternative-specific constants, in order to control for the possibility of decreased attention throughout the choice experiment. Accounting for it also did not affect the variables of interest in all conditional logit models, with a maximal difference in the estimates of two-tenths.

Because the choice experiment involves two attributes for the cost, i.e. upfront cost and annual payment to ESCO, it is not possible to directly assess willingness to pay estimates. Computing these would first require making an assumption on the interest rates considered by respondents to translate it into actualized value of all the annuities paid to the ESCO during the contract's duration. Moreover, the attribute non-attendance patterns found in the previous section suggest that there is heterogeneity in the way that respondents considered the two cost attributes. Some of the participants may have considered cost alone, payment to the ESCO alone or a combination of them. In the same way, some respondents may have translated payment into an actualized value and added it to the upfront cost. This heterogeneity in the decision process heuristics could be explored in further research using for instance more elaborated versions of latent class models. The attribute non-attendance latent class models we used in this chapter could be further developed using the so-called *common-metric attribute aggregation.* In the same way that Nlogit permits to constrain parameters to be equal to zero in certain classes to account for ANA, it can allow two parameters to be estimated as being aggre-

[98] This relates to 25 observations out of the 5940.

gated in other classes[99]. Both ANA and aggregation can be part of the same class. This could be an interesting strategy to apply in further research to explore the willingness to pay for energy savings, ESCO's guarantee, ESCO's financing or willingness to accept for contract's duration.

Other research would also be needed in order to determine whether the lack of necessity of ESCO's financing from a large share of the respondents is specific to the Swiss context and if it is due to the current conjuncture or is a more structural phenomenon.

The present chapter also focuses typically on potential clients of EPC, i.e. large energy consumers with consequent energy savings potentials. It would however be interesting to enlarge the focus to explore how smaller energy consumers could be induced to invest in energy efficiency by maybe simplified versions of EPC. Pätäri et al. (2016) show for instance that Finnish SMEs are financially constrained because of other investment needs. Targeting a similar survey as here towards SMEs could be useful to assess whether external financing becomes more interesting relative to a guarantee in this context. This could bring other interesting policy implications for small energy consumers.

Landlord-tenant split incentives and legal issues linked to the transfer of retrofit costs onto the tenant did not show any significant impact on the willingness to adopt energy efficiency measures, contrasting with the results from Klinke (2016) regarding energy supply contracting. This subject should be further tested using a sample with a higher share of privately-owned rented buildings, such as residential buildings, office buildings and shopping centers.

Finally, the exploration of attribute non-attendance provides interesting insights about the behavioral biases underlying the decisions to invest in energy efficiency. Further research is needed to explore further how behavioral biases could be mitigated to foster investment and reduce the energy efficiency gap. More specifically, nonstandard beliefs resulting from a systematic underestimation of discounted future energy costs as compared to the present purchase price may be explored using the aforementioned common-metric attribute aggregation to estimate WTP for energy savings. The role of intermediaries in reducing these biases also merits further investigations.

[99] See Hensher et al. (2015) for more details on this.

6 Conclusions and Policy Implications

This chapter was aimed at determining to which extent and through which channels EPC can induce or promote investment in energy efficiency. The analysis is based on a survey of 297 managers and owners of large private and public energy-consuming buildings in Switzerland. The data collection was challenged by a very low response rate, especially for municipalities. This might suggest that these potential clients may be quite hard to reach, although municipalities have been representing the highest potentials in foreign EPC markets (chapter I). Despite the data collection challenges, more than 82% of the buildings in the sample are publicly-owned.

The econometric analysis showed first that ESCO's financing is positively affecting investment only for a minority of respondents. These are mostly public entities, presumably with debt ceilings. This result implies that for the majority, limited access to credit at reasonable costs is not a determinant of underinvestment in energy efficiency, at least in our sample. This result has also to be put in the current context of the general Swiss situation and the business cycle with low interest rates. For constrained public entities with debt ceilings, on the other hand, the ESCO's financing's advantage will only exist if it is possible to account for the EPC project as an operational expenditure off-balance sheet, which is currently not clarified (chapter II). A first policy implication is the need to clarify the extent to which public entities can indeed legally use ESCO financing to circumvent credit constraints such as debt ceilings. The rationality for legally allowing off-balance sheet in that case is supported by the ESCO's guarantee that the credit will be entirely financed by the energy savings achieved.

While credit constraints seem to concern only a minority, asymmetric information, when the client cannot observe nor verify the performance or the adequacy of a technology, seems to be relevant for a majority of respondents. This conclusion stems from the fact that the ESCO's guarantee has a persistent and significant positive impact on the willingness to invest. This suggests that the risk sharing advantage of EPC is an important driving factor for energy efficiency investments. This study failed to capture any impact of landlord tenant split incentives as a barrier to energy efficiency investments. This should however be tested further using a sample with a larger share of rented buildings.

Then, we found no divergence in the decision-making or in the valuation of contractual attributes between private and public entities. The energy costs and the size of the building did not have a significant impact either. Informing the respondents about the non-economic benefits of energy efficiency and about the cost guarantees provided by ESCOs did not influence the decisions either. However, we showed that having an energy manager induces in-house energy efficiency investment. Moreover, if the respondent is himself the energy manager, both EPC and energy efficiency adoption increases. The building owners conversely considered less energy efficiency and EPC. Finally, the politicians seem to be more reluctant towards EPC. This reluctance also increases with the respondent's years of experience in her function.

These considerations are in line with the important heterogeneity in the decision-making processes when it comes to energy efficiency and energy performance contracting. This

was also translated in the simplified decision processes used through attribute non-attendance, and the reluctance towards EPC, which cannot be explained by observed contractual clauses. These results provide interesting insights about the behavioral complexity in the decision process regarding energy efficiency investment and suggest that further research in that domain will provide interesting and crucial answers to reduce the energy efficiency gap.

Finally, while EPC can mitigate important barriers to investments, it is also facing an intrinsic reluctance from potential clients which is likely to be caused by a lack of awareness. We argue that informing about EPC to reduce this reluctance is primordial. The recent efforts provided by the federal government to foster awareness of EPC solutions should therefore not decline. More specifically, we pointed towards specific misunderstandings of EPC which could be easily overcome using information dissemination.

IV. Analysis of the energy performance contracting market provision

Abstract

In order to fully exploit the potentials of EPC to foster investment in energy efficiency, it is crucial to have a strong and competitive supply. This chapter aims to explore how the supply-side of the EPC market can be triggered using a survey among 208 active and potential EPC suppliers in Switzerland. These firms are energy utilities, gas providers, engineering firms and heating systems and appliances suppliers. After a qualitative study on barriers and drivers perceived by potential suppliers and current state of the Swiss EPC market, the willingness to provide certain types of energy service contracts in different hypothetical market and regulatory contexts is econometrically assessed using a choice experiment. The results show that an exogenous increase in EPC supply from electric utilities is consistently increasing the willingness to offer EPC from competitors (utilities and non-utilities). An exogenous increase in demand is impacting positively the supply only if it combines demands from both public and private clients. Hypothetical changes in the regulatory context, such as the extension of the electricity market liberalization to smaller consumers or the introduction of tax levies on fuel and electricity do not show significant impacts on the willingness to enter the EPC market. Concerning the firm's characteristics, several activities are estimated as being complementary to EPC provision, such as the provision of gas, heating systems and energy control and optimization systems. Interestingly, if the firm is controlled by a public entity which exerts some pressure to increase energy efficiency of the clients, the firm is more likely to offer EPC. The primary barrier that potential entrants face is a lack of internal competencies and personnel capacity. This suggests that EPC formations and increased collaboration and strategic partnerships may be needed to trigger EPC supply. Increasing awareness among potential suppliers is also an important first step. As opposed to what we found in the literature concerning mature ESCO markets, potential suppliers are a priori interested to provide EPC to small consumers and all kind of energy efficiency actions within EPC. These results are promising for the flexibility of EPC to target smaller market segments and more comprehensive energy efficiency improvement measures.

1 Introduction

In chapter III, we empirically showed that energy performance contracting (EPC) has the potential to facilitate investments and mitigate barriers to energy efficiency. The extent to which the advantages of EPC can be efficiently and sustainably delivered will not only depend on the information campaigns and facilitation on the demand-side. The quality and the abundance of the EPC supply are also likely to play a major role in the deployment of the market.

Competition is indeed a crucial element for the success of any market, and concerning the EPC market it is important not only from a price competition point of view. Iimi (2016) analyzed the winning bids of 71 EPC public tenders in Japan and shows that the number of competitors improves significantly the quality of the winning bid, especially through shorter payment periods offered. This result suggests that increasing the number of EPC providers is an important determinant of EPC projects' quality. Interestingly, not only the number of competitors matters but also their experience. Iimi (2016) finds that the experience of the ESCO, in terms of number of previous contracts awarded, impacts positively the quality of the bid offered, especially through decreased duration. As a result, a sufficient number of ESCOs would be needed, but they should also enter the market as soon as possible. The market in Switzerland is indeed only emerging, and entering the market will likely be more difficult once it will be settled and early entrants will have gained important experience.

The supply side of the EPC market could deploy without the government's intervention, unless significant barriers are hampering the involvement of additional suppliers. We showed in chapter II that ESCOs are facing several barriers on the Swiss EPC market. The extent to which these problems also hamper new entrants needs further research on a larger sample of potential suppliers in Switzerland. An extensive survey on potential entrants has not often been conducted in the literature concerning EPC.

A recent exception is Kindström et al. (2017) who explore the driving forces and barriers to providing energy services among 78 local and regional energy companies in Sweden. While they find a general interest among potential suppliers, the latter mentioned some issues on the market, such as lack of strategy from the direction, lack of interest and trust on the demand-side and lack of general resource commitment to energy services. The perceived drivers are the desire to strengthen the organization's position in the market and strategy from the top management as well as the customer demand. More generally, they argue that local and regional energy providers can be key actors in the deployment of the EPC market. While these results provide interesting insights regarding potential entrants, the authors do not explore how the regulatory and policy context on the energy market can affect the decision of potential entrants and how it can interact with the EPC market situation, such as increased demand or supply. Also, it does not explore how the firm's characteristics, such as the size, the private or public direction and the other goods and services provided, can affect the decision to enter the EPC market.

This chapter aims to explore how the supply-side of the EPC market can be triggered using an analysis among active and potential EPC suppliers in Switzerland. This research attempts to provide sound empirical evidence to guide politics towards successful energy strategies, and to explore how policy instruments to foster energy efficiency investments interact with market-based instruments such as EPC.

The analysis is based on a survey among 208 energy utilities, gas providers, engineering firms, appliances and heating systems suppliers. The willingness to provide certain types of energy service contracts is econometrically assessed based on a choice experiment. In the latter, certain types of energy performance contracts (EPC) as well as energy supply contracts (ESC) are proposed in different hypothetical contexts: increased private, public demand or utilities' supply due to a change in the regulatory framework or the implementation of new regulatory frameworks, such as a generalized liberalization of the electricity market or the transformation of incentive schemes and subsidies for energy efficiency into tax levies on fuels and electricity. The choice experiment permits to explore how these different elements can interact and trigger the EPC supply. Moreover, we explore how the firm's characteristics can affect the decision to enter the EPC market.

This chapter also includes an extensive qualitative analysis dedicated to barriers and drivers perceived by active ESCOs, potential entrants as well as firms unwilling to enter the EPC market. We explore how the organizations are strategically designing their business decisions in order to respond to the challenges they face in the Swiss energy market.

2 Methodology

2.1 Overview

A web-based survey is set up to collect empirical data on the EPC supply-side in Switzerland. The addresses of the targeted respondents were collected via public sources, as described in section 2.2. The structure of the survey and of the choice experiment is described in section 2.3 and is followed by a description of the economic framework in section 2.4.

2.2 *Surveyed target group*

The survey is targeted to the potential suppliers of EPC in Switzerland, either already active on the market or not. The target group of potential EPC providers has been composed from institutions and firms based in Switzerland of the following categories:

1. Communal and cantonal electricity and gas providers
2. Engineering and planning offices, contractors, facility managers and equipment installers

In total 835 addresses were collected through associations (e.g. association of electricity industry, VSE and association of gas industry, VSG) and specific web-sites. Some of the contacts were provided by swissesco, the recently founded association of the swiss energy service companies.

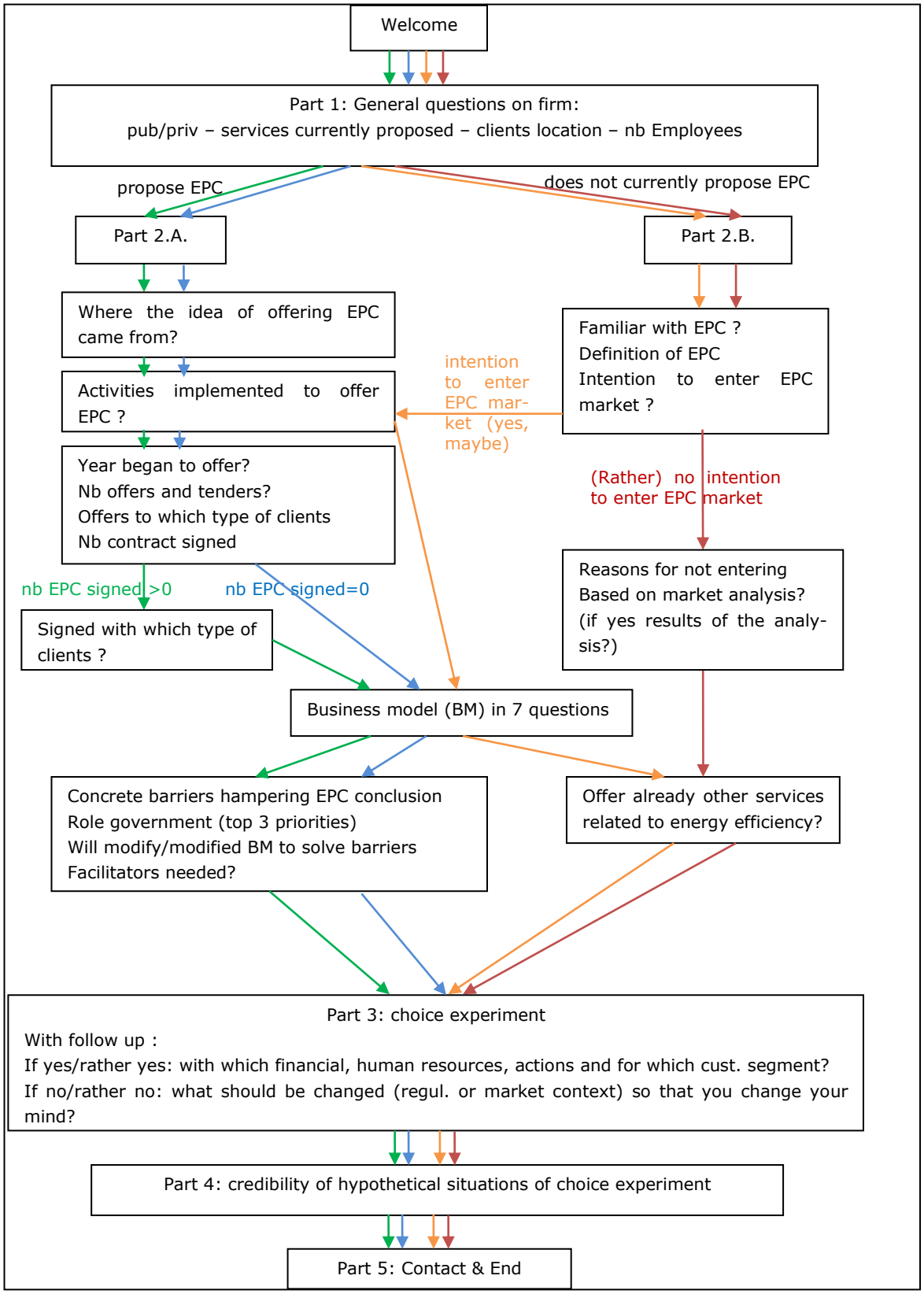
Each respondent was assigned an individualized access code so that responses could be tracked. The full survey was translated in German and French in order to target potential suppliers in both French and German part of Switzerland.

2.3 Survey structure

The survey structure is composed of five main parts:

- Part 1: General questions on the firm
- Part 2: Questions regarding EPC
- Part 3: Choice experiment
- Part 4: Credibility of hypothetical situations
- Part 5: Contact and end

In the second part of the survey, the respondents are directed to different set of questions depending on their background and experience towards EPC (see illustration in Figure 23 and explanations in the following sections). The survey creation Sawtooth software was used to prepare and host the survey online.



Notes: green arrows describe active ESCOs with signed contracts, blue are active ESCOs yet without any contract signed, red are firms unwilling to provide EPC and orange are potential future entrants.

Figure 23 Survey structure

a) General questions on the firm

The survey's introductory questions aimed at gathering a general picture about the firm, its products and services provided, the presence of a public institution in the direction or in the stockholders and if so its impact on strategies regarding the clients' energy consumption. We also collected information on the regions of activities as well as the number of employees.

b) Questions regarding EPC

Then, respondents were split into two categories. On one hand, the respondents who stated that their firm was already currently offering EPC in Switzerland were directed towards questions on their beginning, experience and activities related to EPC. On the other hand, respondents stating no current EPC activities were directed to the definition of the concept and asked whether their firm could envisage offering those services in the future. Both active ESCOs (i.e. already trying to offer EPC in Switzerland) and those who stated a potential intention to enter the EPC market were then directed to questions intended to capture the business model implemented or envisaged. The seven questions are mostly inspired from the business model canvas developed by Osterwalder and Pigneur (2010) and include:

1. The client types targeted in priority (customer segments)
2. The client's needs satisfied through EPC (value proposition)
3. The channels through which these needs are satisfied (customer relationship)
4. The remuneration scheme preferred for EPC (revenue streams)
5. The channels to reach customers (marketing)
6. The business objective(s)
7. The competitive advantage(s) of the firm on the EPC market

Then, active ESCOs were requested to indicate the barriers that they had been facing since their entry in the EPC market. They also had to rank the intervention policy-makers should implement in priority according to them. Finally, we asked them how they changed or plan to change their business model in response to the barriers they were facing on the market.

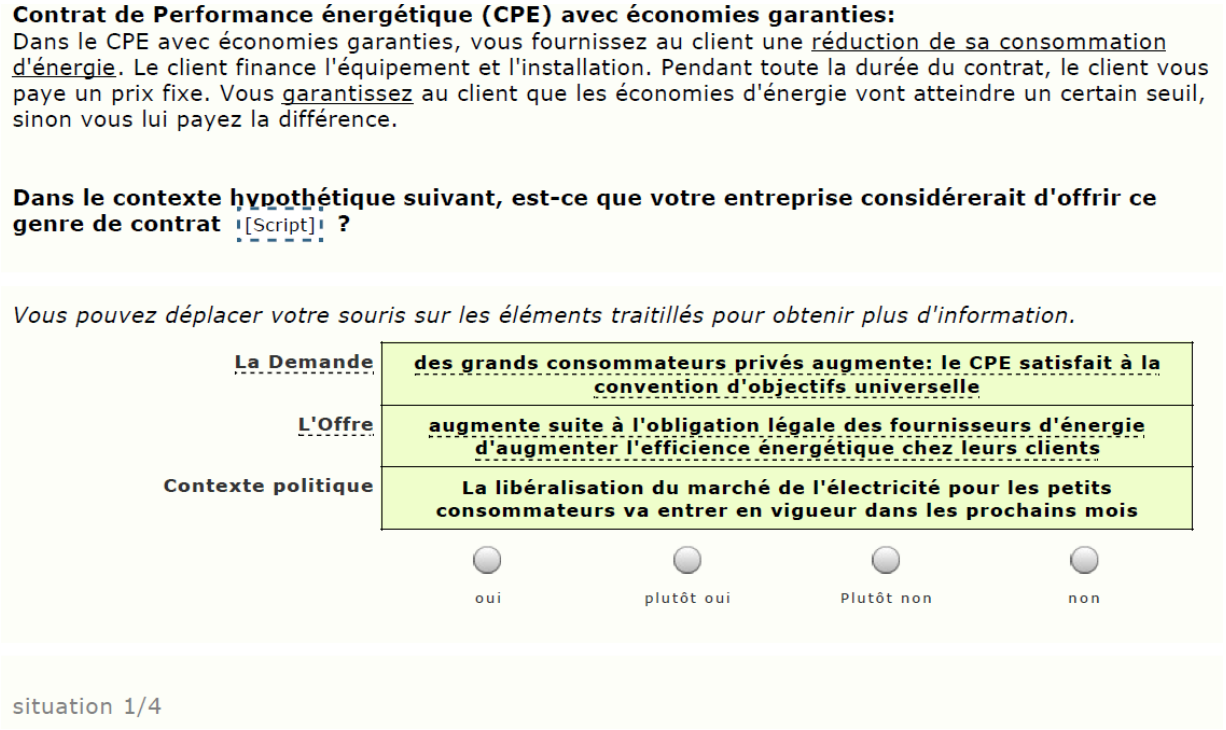
All the firms inactive on the EPC market were asked about services related to energy efficiency (other than EPC) they are already providing to their clients.

c) Choice experiment

All respondents were then directed to a choice experiment, where they had to state whether their firm would consider offering a certain type of contract, provided that the situation on the market would hypothetically change in several possible ways. All respondents faced four choice tasks with one of the following contracts proposed:

1. Shared-savings EPC
2. Guaranteed-savings EPC
3. Energy Supply Contracting (ESC)

For respondents who stated that their firm was already offering these contracts, they were asked whether their firm would consider offering this contract "more often than currently". A typical choice task is presented in Figure 24.



Notes: additional information was given in a pop-up for elements with a dashed-underline. Demand and supply typically described that it was the one from the contract proposed. "script" was replaced by a blank for respondents who stated not to offer this contract yet, and by "more often than currently" for the one already offering these.

Figure 24 Example of choice task

The two EPC contract's types were randomly assigned to the first three choice tasks while the ESC contract was assigned to the fourth choice task. A constraint on the randomness insured to have each EPC type proposed at least once.

The changes on the market described in the box of Figure 24 were determined by combinations of the attributes' levels described in Table 31. The market demand could include changes on both private and public demands, one of them or stay as current. The same applies to the regulatory context, which could include both complete liberalization and constitutional article (energy tax levies), one of them or stay as current.

The hypothetical changes on market demand and supply were chosen so that they should be perceived by the respondents as exogenous shocks on which their firm could not have any influence, so that it would not bias the results. This is the reason why all the changes are coming from a hypothetical government regulatory decision, such as a change in the requirement to fulfill the universal convention of objectives, the necessity for public buildings to consider EPC and the indirectly forced increased EPC supply through the obligation for utilities to increase their clients' energy efficiency (similar to a white certification scheme).

Table 31: Attributes and levels

Attributes	Levels
Market demand (private)	1. same as current 2. demand from private large energy consumers increases: EPC (or ESC) is now sufficient to meet the universal convention of objectives
Market demand (public)	1. same as current 2. demand from all public building increases: public entities are obliged to systematically consider EPC (or ESC) as a possible solution to energy efficiency projects
Market supply	1. same as current 2. EPC (or ESC) supply increases because the government obliges the utilities to implement energy efficiency measures in their clients' buildings
Regulatory context (liberalization)	1. same as current 2. liberalization of electricity market for small energy consumers will be implemented
Regulatory context (constitutional article)	1. same as current 2. new constitutional article (131.a) has been accepted and will be implemented in the next months: subsidy schemes will be stopped and replaced with electricity and fuel taxes.

Two hypothetical changes affecting the energy market in general could also be present in the choice experiment:

- a complete liberalization of the electricity market
- the project of a new constitutional article.

The impact of the liberalization of the electricity market has already been studied in the energy service contracting literature (e.g. Vine (2005), Delmas et al. (2007), Nguene (2008), Marino et al. (2011)). These authors argued that the increased competition brought by liberalization foster the supply of energy service contracting and other innovative energy products and services. Liberalization may however also bring uncertainty on the electricity market due to falling or volatile prices inducing a risk on the energy savings achieved in real terms and therefore may also weaken EPC services. As a result, the potential energy service suppliers' perception on the matter is of particular concern. It is particularly interesting in the current Swiss context, where these firms have already experienced a first phase of electricity market liberalization for large electricity consumers. Therefore, their perception of the impact of the second planned liberalization phase, targeted to smaller consumers, will likely be grounded upon their experience after the first phase.

The second hypothetical regulatory change presented was the project of a new constitutional article (131*a*, Swiss Federal Council (2015), Arrêté federal (2015)). This article constitutes the second step of the energy strategy 2050 and aims to regulate the transformation of an incentive system of subsidies to a system of climatic taxation on all fuels and electricity[100]. This project has been mentioned by some EPC experts as having a potentially revolutionary impact on the energy supply market (cf. chapter II). The

[100] This constitutional article project also aims to transform the current CO_2 tax and the supplement to electricity network into these fuels and electricity taxations.

consequent modification of incentives provided by such a tax levy scheme is likely to have indeed an important impact on both the demand and the supply of the energy market. This will force the suppliers to find innovative products and services to reply to the clients' needs. Assessing the perceived impact from the suppliers' point of view is relevant for policy-makers, even though the implementation of this constitutional article project is still uncertain[101].

This study will determine what are the business strategies regarding these potential important modifications of the energy market. The combination of the attributes levels presented to the respondents is determined by a full factorial design of 32 rows, using orthogonal design to combine the rows in 8 blocks of 4 choice tasks[102]. Full factorial was preferred in this context to D-efficient design because the number of attributes and levels is limited and no priors exist on the impact of these on the willingness to offer EPC or ESC contracts.

Follow-up questions

After each choice task, respondents faced follow-up questions depending on their answer:

- Firms affirmatively considering offering this type of contract (more often than currently) were then asked about the activities they would implement to do so. More specifically, they had to state with which human and financial resources they would offer this contract, for which market segment and with which energy efficiency actions.
- Respondents not considering offering this type of contract were asked to state whether they would change their mind if one or several of the elements on the market (demand, supply, regulatory context) would change.

d) Credibility of hypothetical situations

Part 4 of the survey was then dedicated to assess the perceived credibility of the hypothetical changes proposed in the choice experiment, as described in Table 31. The question is illustrated in Figure 25.

[101] It is important to note here that both the finance commission (CdF-N (2017)) and the environmental commission (CEATE-N (2017)) of the national council have recently decided not to proceed on this project. The arguments evoked were the insufficiency of the instruments proposed, their lack of diversity and impact, given the current energy market. The negative impact of such a taxation scheme on the competitiveness of the Swiss firms has also been invoked. The commission however did not deny the need of an incentive scheme and will work on another project. The parliament will also take a decision on the CO_2 taxation reform by the end of the year. The final constitutional article project will be submitted to the Swiss population and cantons. One should note here that most respondents answered the survey before the deliberations at the finance and environmental commissions. Therefore, in their mind, the project could still be a plausible evolution on the market.

[102] The design was modified to avoid the case where nothing changes, i.e. all attributes are attributed the first level.

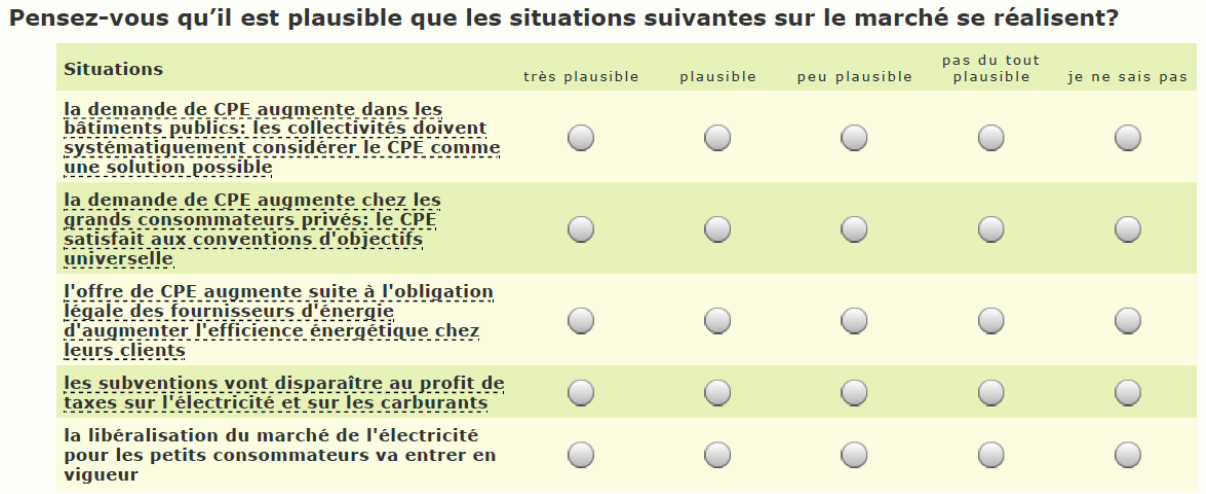


Figure 25 Plausibility of changes on the market

e) Contact and end

Finally, the respondents had to state if they wanted the results of the study. They could provide remarks on the survey and were thanked for completed the survey.

2.4 Econometric framework

In the choice experiment tasks, the respondents were asked to state whether their firm would consider offering a certain type of contract. The answer was a 4 points Likert scale:

0. No
1. Rather no
2. Rather yes
3. Yes

In order to account for the ordinal characteristics of the outcome, as well as capture all the information provided by the nuances of the Likert scale, the appropriate model is the ordered logit or probit model, also known as the proportional odds model (Long and Freese (2014)). Because each respondent *i* faced 4 choice tasks *t*, we treat the data as a panel and estimate a random-effects ordered logit model. In this model, a latent continuous response y^*_{it} is expected to have the following impact on the observed outcome y_{it}:

$$y_{it} = \begin{cases} 0 & \text{if} \quad y^*_{it} \leq \kappa_1 \\ 1 & \text{if} \quad \kappa_1 < y^*_{it} \leq \kappa_2 \\ 2 & \text{if} \quad \kappa_2 < y^*_{it} \leq \kappa_3 \\ 3 & \text{if} \quad \kappa_3 < y^*_{it} \end{cases} \tag{1}$$

in which κ_i are the cut-points and the latent variable is expressed by:

$$y^*_{it} = context_{it}\lambda + contract_{it}\delta + z_{it}\gamma + v_i + \epsilon_{it} \tag{2}$$

$context_{it}$ is a vector of dummies describing the hypothetical context in choice task t with the levels described in Table 31. The vector *contract* includes two dummies for the following types of contracts: EPC shared-savings, EPC guaranteed-savings. The contract dummy ESC is omitted and therefore considered as the baseline. Then a vector z_{it} of variables describing the firm characteristics is included. These include the type of services already offered by the firm and the familiarity with the EPC concept. The impact of other firm characteristics on the willingness to consider offering EPC or ESC will also be tested. Finally, the random effects v_i are assumed to be normally independently and identically distributed with mean zero and variance σ_v^2 and the errors ε_{it} are assumed to follow a logistic distribution and are independent from v_i.

The probability of observing outcome k for response y_{it} is given by:

$$P(y_{it} = k|\kappa, x_{it}, v_i) = \frac{1}{1 + \exp(-\kappa_k + x_{it}\beta + v_i)} - \frac{1}{1 + \exp(-\kappa_{k-1} + x_{it}\beta + v_i)} \quad (3)$$

in which $x_{it}\beta$ represents the product of the coefficients' vector to be estimated with the explanatory variables described in equation (2). This probability is used to compute the conditional distribution and in turn the likelihood function, which includes an integral that must be approximated. We use here the mean-variance adaptive Gauss-Hermite quadrature to approximate the integrated function.

In order to check the robustness of the results regarding the contractual and contextual effects on the decision to provide EPC, a conditional logit will be used. This model can account for unobserved heterogeneity among respondents even though it has some drawbacks: it implies to transform the dependent variable into a binary outcome which entails losing the observations without any choices variations. Also, conditional logit does not allow to directly exploring the firm characteristics impact on the decision to supply EPC.

We will also check the robustness of the influences of the firm specificities on the decision to provide EPC. In addition to the choice experiment data, we also asked the respondents to state their firm's interest in providing EPC in the future. The answer was also coded as a 4 point Likert scale. Using this and complementing it with the information on the firms already providing EPC, we explore the determinants to EPC market entrance using an ordered logit model. The results will be compared with those found using the choice experiment.

3 Survey Data

3.1 Survey sample

From the initial 835 addresses (see section 2.2), a total of 827 firms were possible to contact (8 E-mails failed delivery). A pre-test was prepared and sent out to 41 firms. The main survey was targeted to 786 respondents.

3.1.1 Pre-Test

A pre-test of the actual survey was conducted in order to test its effectiveness and to evaluate respondents' reactions to it. By first clarifying potential problems and misunderstandings, the final survey conveyed more reliably the required information to respondents so that their responses better reflect their perception of the topic. Critically, the understanding of the concept of EPC by respondents is integral to a successful completion of the survey.

Email invitations were sent out to a random selection of 41 of the addresses initially collected in order to conduct the pre-test (Table 33). This included 20 communal energy providers, 9 gas providers, and 12 contractors, covering French, German, and Italian speaking participants. The pre-test participants were invited to conclude the pre-test as well as being encouraged to give feedback on the survey structure and content.

a) Interviews with pre-test participants

A limited number of pre-test respondents were contacted by phone to assess their reaction to the survey. In general, the survey structure was appropriate for these respondents. An updated version of the survey was published after a few comments were incorporated and considered.

3.1.2 Main survey

a) Initial invitation

After incorporating feedback from the pre-test, the main survey was sent to a further 786 participants on December 1st and 5th 2016 (Table 32). Because of the response rates from post mailing invitations experienced in the survey of chapter III, all prospective participants were contacted using email. E-mail invitations were sent out with individualized access codes to be used for the online survey. E-mails were prepared in both French and German and sent out according to the participant list. Italian speakers were encouraged to complete the survey in the language of their choice.

Table 32 Summary of correspondence with survey repondents

Email activity	Date
Initial invitation	December 1st / 5th, 2016
First reminder	December 15th, 2016
Second (final) reminder	January 4th, 2017

b) Reminders

As the participants accessed the survey, the number of incomplete and completed entries was monitored. After approximately 2 weeks' time for respondents to answer the survey, e-mail reminders were sent to those who had not completed the survey. The first reminders were sent out on December 15th, 2016 (Table 32). A second reminder email was sent on January 4th, 2017.

Depending on the completeness of the answers, personalized messages were sent to respondents encouraging them to complete the choice experiment.

3.1.3 Return and response analysis

a) Return rate of questionnaires

From the valid number of participants invited (827), 280 respondents actually accessed the online survey, representing 34% of invitations sent. All three categories of respondents ("Utilities", "Gas only provider" and "Contractors") had approximately the same access rate.

Table 33 Number of invitations and survey response rate by participant group

	Number of invitations sent	Reminders sent	Surveys accessed		Incomplete surveys		Completed surveys		
			#	% of invitations sent	#	% of invitations sent	#	% of invitations sent	% of surveys started
Utility	20	16	5	25%	3	15%	4	20%	80%
Gas provider	9	3	3	33%	2	22%	1	11%	33%
Contractors	12	11	4	33%	0	0%	4	33%	100%
Pre-test total	**41**	**30**	**12**	**29%**	**5**	**12%**	**9**	**22%**	**75%**
Utility	602	557	208	35%	53	9%	155	26%	75%
Gas provider	47	43	16	34%	4	9%	12	26%	75%
Contractors	137	128	44	32%	13	9%	29	21%	66%
Main survey total	**786**	**728**	**268**	**34%**	**70**	**9%**	**196**	**25%**	**73%**
Utility	622	573	213	34%	56	9%	159	26%	75%
Gas provider	56	46	19	34%	6	11%	13	23%	68%

Contractors	149	139	48	32%	13	9%	33	22%	69%
Grand Total	**827**	**758**	**280**	**34%**	**75**	**9%**	**205**	**25%**	**73%**

b) Response analysis

In total, 205 respondents fully completed the survey, equaling a response rate of 25 % compared to the total number of invitees. 75 participants did not complete the survey. From these 75 incomplete data sets, 72 data sets were excluded from the further analysis since they did not start the choice experiment. However, 3 of the respondents started the choice experiment and their answers are included in the data analysis. Therefore, 208 observations are considered in the analysis.

There was only a slight difference regarding the overall return rate between the participants' groups, ranging from 22 % response rate for contractors and up to 26 % response rate for utilities.

3.2 General characteristics of the firms in the sample

Goods and services offered by the firms as stated by the respondents are described in Table 34 and mainly include electricity and gas. Other services offered by the firms were street lighting, regional energy planning, consulting on energy services, water supply, digital network or tele-communication services. 45% of the firms in the sample also stated to have services related to energy efficiency other than EPC, these include for instance energy consulting, programs of incentives to increase energy efficiency of the clients, energy optimization and planning, consulting for large energy consumers, smart metering, building automation, audits or cantonal energy certificate for buildings (CECB+). Only 9 (4 %) out of the 208 firms of the sample are already active in the EPC market (Table 34), confirming that the market is only at its infancy in Switzerland. EPC is never stated as the main activity within the ESCOs firms. They are primarily electricity providers (44 %), ESC providers (22 %) and the remaining part is gas provider, supplier of energy control and optimization and technical maintenance supplier. From these 9 EPC providers, 5 firms are privately held with a major public shareholder, 1 is a public firm and 3 are private. Interestingly, 3 of the ESCOs controlled by a public entity stated that the latter is exerting pressure to decrease their clients' energy consumption. These numbers can be compared with those for the non-EPC providers in Table 35. Despite a majority of public or publicly controlled firms in the sample (72 %), only a minority of them (28 %) are receiving pressure from the public owner to reduce energy consumption or increase energy efficiency of their clients.

Table 34: stated goods and services provided by the firm

Goods and services provided	Not providing	Providing	Share provided	N
Electricity	46	162	0.78	208
Gas	168	40	0.19	208
Heating systems	188	20	0.10	208
Electric appliances	198	10	0.05	208
Energy control and optimization	184	24	0.12	208
Facility management	199	9	0.04	208
Technical maintenance	172	36	0.17	208
Energy supply contracting	177	31	0.15	208
Energy performance contracting	199	9	0.04	208
Engineering consulting	152	56	0.27	208
Other energy efficiency services	114	94	0.45	208
Other services	185	23	0.11	208
Other activities	167	41	0.20	208

Table 35: Private vs. public firms

EPC provider	public	Private with public major stakeholder	private	total
No	107 (54%)	36 (18%)	56 (28%)	199 (100%)
Yes	1 (11%)	5 (56%)	3 (33%)	9 (100%)
Total	108 (52%)	41 (20%)	59 (28%)	208 (100%)
		149 (72%)		
Pressure from the controlling public institution to increase energy efficiency of the clients (missing answers: 11)				
	No	Yes		
No	96 (73%)	36 (27%)		132 (100%)
Yes	3 (50%)	3 (50%)		
Total	99 (72%)	(28%)		138 (100%)

Figure 26 shows the structure of the firms in the sample and compares EPC providers to the other firms. While a larger share of small and medium size enterprises is present in the sample of non-EPC providers, active ESCOs are rather medium to large size enterprises. This suggests that being an early entrant in the EPC market necessitates a sufficient size in terms of personnel capacity, but also probably of activities diversification. The econometric analysis in the next section will test empirically whether larger firms are more likely to enter the EPC market.

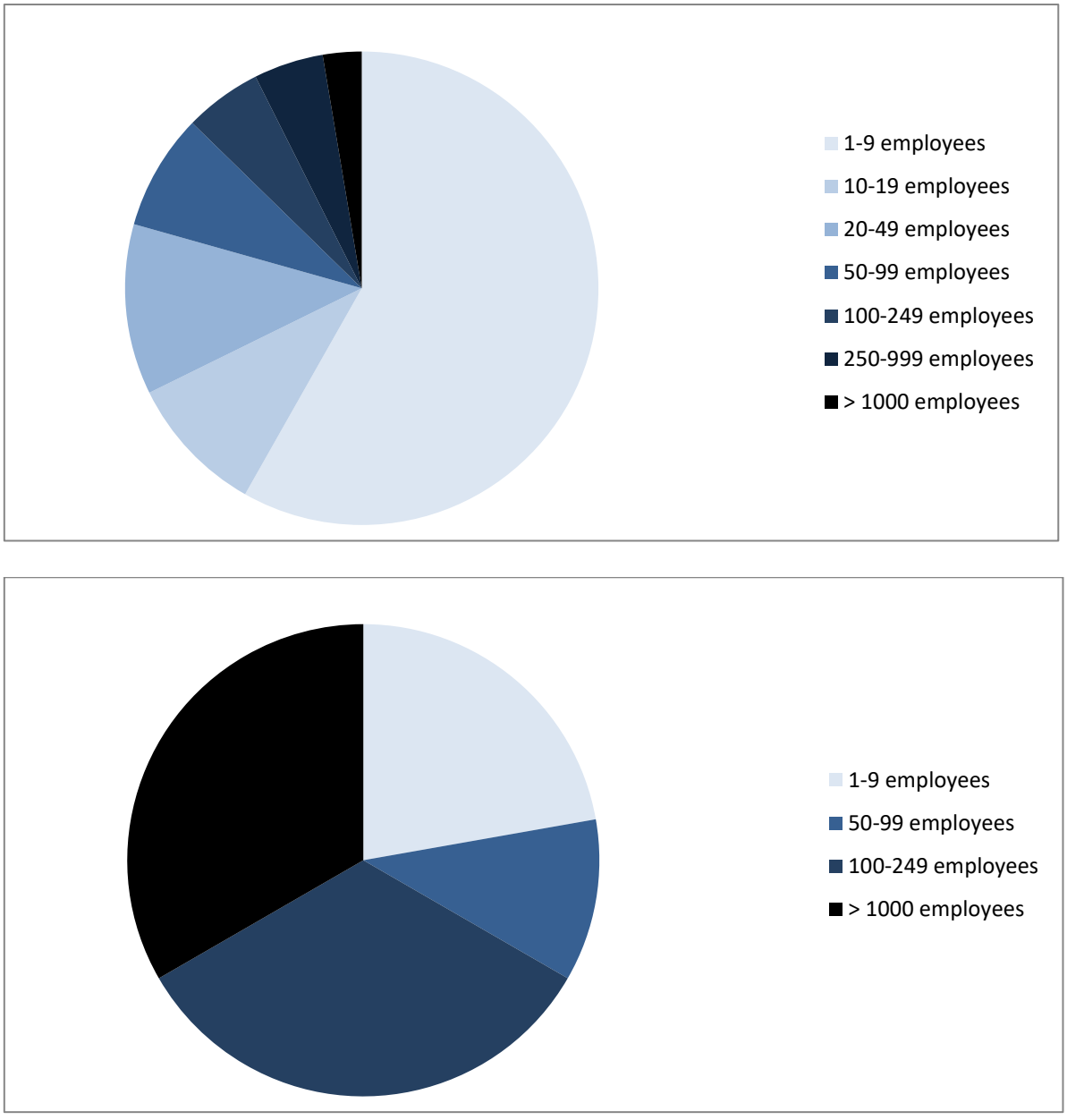


Figure 26 Number of employees (Non-EPC providers, n=199, above, and EPC providers, n=9, below)

Finally, a large share of firms (68 %) in the sample has clients in only one canton. This probably is due to the large share of electricity companies which have not yet taken

advantage of the liberalization of the market to target new clients beyond the cantonal border. 23 firms (11 %) have clients in many cantons and 24 firms (12 %) in the whole Switzerland. A remaining 5 % are active abroad and in Switzerland.

4 Results on EPC supply and potentials

4.1 EPC supply and interest

Active ESCOs were asked to state the number of EPC contracts they have already signed. Only 5 of the ESCOs have already signed EPC contracts. Not all gave precise numbers of the contracts signed but based on non-official information provided by the respondents, we can estimate 10 contracts signed with the public sector and 11 EPC signed with private entities. These contracts were concluded with education and health facilities, hotels, industries, private office buildings, residential buildings and shopping centers.

2 ESCOs started to supply EPC in Switzerland in 1999-2000, while 2 others started in the period 2008-2011. Finally, 4 ESCOs have begun to provide EPC in the period 2012-2015. This is in line with the recent emergence of the EPC market in Switzerland.

5 ESCOs have EPC projects initiated but not signed yet[103]. Again, the ESCOs did not provide an accurate number of the projects they have initiated, but we estimate 36 projects with private entities and 7 projects with public institutions. The private institutions are primarily industries, with projects concerning 6 ESCOs. Then, restaurants, hotels and private offices buildings have been targeted by 3 ESCOs. Shopping centers have also some projects initiated (with 2 ESCOs) and private clinic, private sport facilities and residential buildings (each concerning 1 ESCO). 3 firms stated they have initiated projects with schools and public offices, 2 with public sport facilities and 1 with a public hospital.

Out of the 199 firms which are inactive on the EPC market, 124 (62 %) were not familiar with the EPC concept before answering the survey. This indicates that information campaigns on EPC could also be beneficial on the supply side. Indeed,
Table 36 shows a positive correlation between the familiarity between the EPC concept and the stated consideration to provide such contracts in the future. While 32 % and 12 % of the firms which are familiar with EPC stated to be potentially interested in providing EPC (Maybe and Yes), only 18.5 % and 2.4 % are interested in providing EPC when they were not familiar with the concept. The impact of the familiarity with the EPC concept on the willingness to offer EPC in the future will be further tested empirically in section 4.3[104]. The stated consideration to provide EPC in the future will also be used to check the robustness of the results found using the choice experiment and specially to explore how the firms' characteristics affects the interest in providing EPC[105].

[103] One of these has not signed any EPC contract yet.

[104] In order to include both active ESCOs and potential entrants, the variable *familiar with EPC* will take the value 1 for active ESCOs.

[105] In order to include both active ESCOs and potential entrants, the variable *consideration to provide EPC* will take the value 3 (=yes) for active ESCOs.

Table 36: familiarity and interest in EPC

	Familiar with the EPC concept		
Considering to provide EPC in the future	no	yes	Total
No	64 (51.6%)	17 (22.7%)	81 (40.7%)
Rather no	34 (27.4%)	25 (33.3%)	59 (29.6%)
Maybe	23 (18.5%)	24 (32.0%)	47 (23.6%)
Yes	3 (2.4%)	9 (12.0%)	12 (6.0%)
Total	124 (100%)	75 (100%)	199 (100%)

4.1.1 Activities implemented to supply EPC

It is important to note that a majority of ESCOs active in EPC stated to have a small group of employees working on EPC, that is between 1-9 employees. This is the case for 7 ESCOs of different sizes in terms of total number of employees in the firm (from 1-9 employees to >1000 employees). This suggests that EPC is still a market niche, where only one ESCO stated to have 10-19 employees on EPC and one declared 100-250 employees on EPC (likely on international level). These active ESCOs have all implemented several activities to provide EPC. A majority of them (89 %) have had interviews with potential clients and elaborated a business model (78 %). 44% of them have also sent information to potential clients and looked-for business partners. 33 % have raised funds or looked for additional human resources. Finally, 22 % have lead a market research, in which the main results were:

1. the unawareness on the demand side
2. the difficulty to write public tenders for these contracts
3. interest from the client's point of view

Other activities implemented by ESCOs were mentioned such as the creation of the *swissesco* association.

These numbers are interesting to compare with the activities already implemented by the 59 firms (47 "maybe" and 12 "yes",
Table **36** 36) interested to provide EPC in the future. 32 % of those companies stated to have had interviews with potential clients. 9 firms had looked for business partners and 8 had conducted market research. These studies have led to the following results:

1. Clients do not need financing from the ESCOs
2. Clients interested in renewable energy could use EPC to finance it
3. Clients lack understanding of the EPC concept or want to finance themselves to keep the control.
4. Difficulty for the clients to understand and trust the measure and verification of the energy savings achieved: Need a process for measure and verification controlled by the confederation

Finally, while a few firms have implemented other activities, such as hiring human resources, fund raising, elaboration of a business model and sent information to potential clients, a large share (42 %) has not taken any further steps to provide EPC.

4.1.2 Business model

The business model elaborated by active ESCOs and potential entrants in the EPC market is explored using 7 questions inspired from the business model canvas from Osterwalder and Pigneur (2010). These include questions related to the primarily targeted clients and the value proposition to the clients, i.e. the clients' needs that are expected to be satisfied through EPC. Then the ESCOs were asked to state how they intend to satisfy those needs (value delivery), the revenue streams they would implement to capture the value from the clients, the pathways towards the potential clients and the business objectives set for EPC. The ESCOs then gave their perception regarding the competitive advantage of their firm in the EPC market.

1. Clients targeted

Both active ESCOs and potential entrants are primarily targeting industries for EPC (Table 37). This contrasts with foreign markets where EPC has been mostly implemented in schools, municipality buildings and hospitals. In both groups, public education facilities are following. Then, while hotels take the 3rd rank for active ESCOs in Switzerland, they are ranked at the fifth position for potential entrants. While public offices are ranked similarly in both groups, potential entrants seem to rather focus on private entities as compared to active ESCOs. One potential entrant declared to primarily target public street lighting.

Table 37: Clients targeted (6 first positions)

Active ESCOs	Potential entrants
1. Industries	1. Industries
2. Public education facilities	2. Public education facilities
3. Hotels	3. Residential buildings
4. Public offices buildings	4. Private offices buildings
5. Public sport facilities	5. Hotels
6. Public hospitals and retirement homes	6. Shopping centers

2. Value proposition

The value propositions described by the firms were various and go beyond the financing and performance guarantee considerations. In addition to external financing and energy savings guarantee, they stated the following value propositions:

1. Transparency in costs
2. Energy savings detectable and measurable
3. A partner for the project
4. A carefree package ("Rundum Sorglos-Paket")
5. Conformity with law on energy
6. Ecology
7. Operation and maintenance optimization
8. Administrative support

These propositions have been described by both active ESCOs and potential entrants, although in the latter group, 31 respondents declared not to have determined a value proposition yet.

3. Value delivery

Again, the external financing and the energy savings guarantee were mentioned but were not the only elements. Other elements included the determination of prices in a transparent way for the client as in an open book and tailor-made contractual solutions.

4. Revenue stream

Not all firms are ready to tie their revenue streams to the energy savings achieved. In a typical EPC project, the ESCO is always remunerated according to the performance achieved: either by providing a guarantee which forces the contractor to pay the difference in case of under-achievement, or by being directly paid by a share of the savings achieved. Except from 1 firm who stated to want to be paid through a fixed price, the majority of active ESCOs propose revenue streams depending on the savings. 4 ESCOs favor the shared-savings scheme, two ESCOs an indexed fixed price which is lowered in case of under-achievement, and one ESCO prefers a non-indexed fixed price reduced if underperforming. While most potential entrants have still not yet determined their preferred revenue streams, 7 of them (12% of the 59 potential entrants) declared to favor fixed price or indexed fixed price. Since these streams are not directly linked to the ESCO's revenue to the energy savings achieved as it is supposed to be in an EPC, one could conclude that their interpretation of EPC is more broad than usual. Otherwise, 4 out of 59 potential entrants favor the shared-savings scheme and 6 the guaranteed savings scheme with an (indexed or non-indexed) fixed price.

5. Paths to customers

For active ESCOs as well as potential entrants, the privileged path to reach customers is to talk directly to the current clients of other services provided by the firm. This can be related to the large share of electricity providers in our sample suggesting that it may be a privileged existing relationship that may favor the deployment of EPC. Advertisement was also used but to a lesser extent as well as postal mailing for a small minority.

6. Business target

The firms were asked to state the goals regarding EPC that the firm targets: e.g. which revenue streams need to be achieved to satisfy the company's expectations? This variable suffered from a large share of missing values in both active and inactive groups.

This suggests that either this type of information is sensible or that the firms do not target an explicit business goal at this stage of business development. For those who provided information, we observed an important heterogeneity in the targets:

- In terms of contracts: 1 per year / 2 per year / 10 per year
- In terms of turnover: 3.5 MCHF per year / 8 MCHF per year
- Intangible: political satisfaction / contribution to fossil fuels substitution and energy savings

7. Competitive advantage

Table 38 shows that active ESCOs have taken the time to think about their competitive advantage on the EPC market while the potential entrants are more indecisive.

Table 38: Stated competitive advantage on EPC market

Active ESCOs (ratio)	**Potential entrants (ratio)**
1. Numerous existing clients (5/9)	1. Numerous existing clients (10/59)
2. Very qualified employees (5/9)	2. Very qualified employees (6/59)
3. Experience on foreign EPC markets (2/9)	3. Experience on foreign EPC markets (3/59)
4. Not determined yet (1/9)	4. Not determined yet (39/59)
5. Don't want to answer (1/9)	5. Don't want to answer (7/59)
6. Others: -customer potentials from other business activities (1/9) -reliability of the firm (2/9) -multi-energy services (1/9)	6. Others: -regional reputation and reputation (4/59) -proximity to the clients (1/59)

As already emphasized in the chosen paths to customers, the most important advantage and potentials for the firms is the existing customer base that may be targeted for EPC. Utilities in that point of view are likely to have an important advantage. This result confirms the finding of Iimi (2016) who shows that utilities tend to win public procurement EPC projects with better scores, suggesting a certain competitive advantage for this type of firms.

The qualification of the personnel is the second stated competitive advantage and followed by the experience on EPC markets abroad or in Switzerland. The importance of the firm's reputation and experience in other energy-related services was also emphasized by the respondents.

4.2 *Obstacles to EPC in Switzerland*

4.2.1 Active ESCOs' point of view

ESCOs which are already providing EPC in Switzerland were asked to state which barriers they have already been facing in their activities and at which frequency. The results are given in Figure 27.

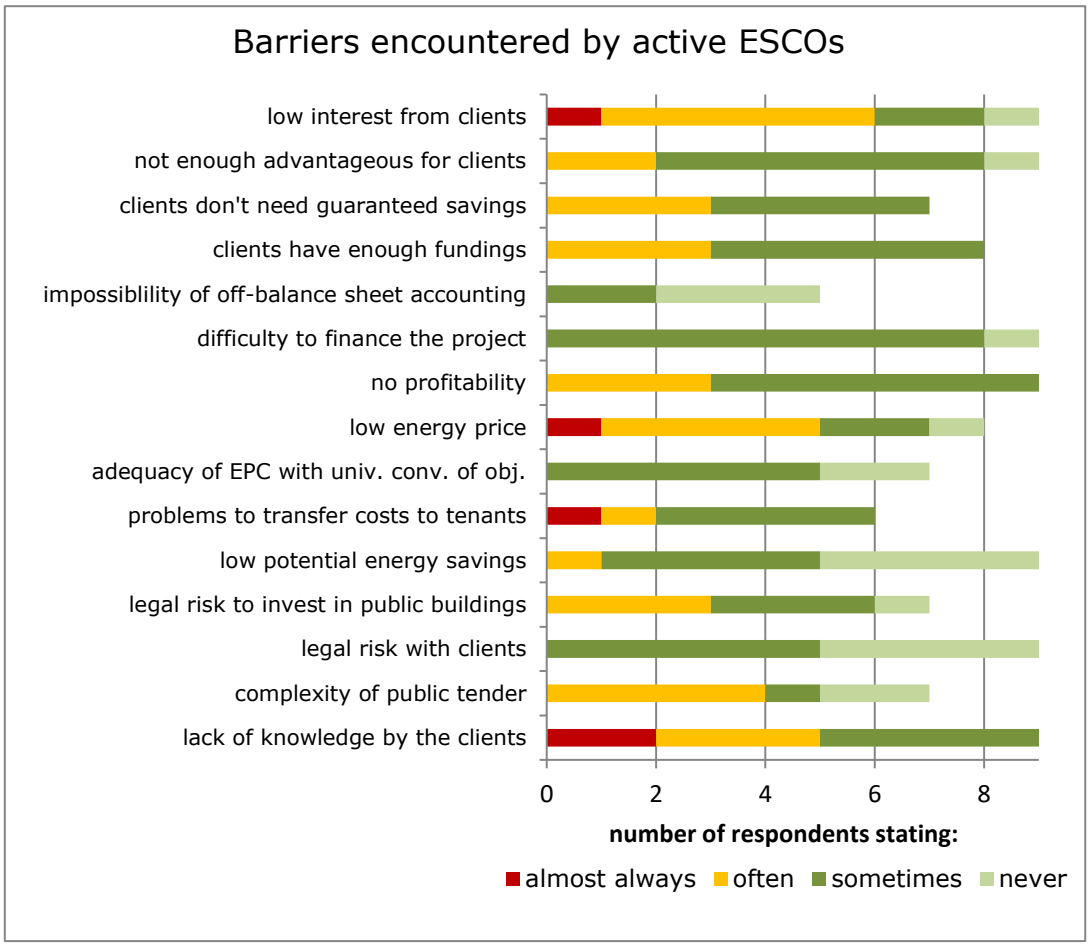


Figure 27 Barriers encountered in the Swiss EPC market

Lack of knowledge and interest in EPC is the barrier, the most often encountered in the Swiss EPC market. The (currently) low energy prices and the induced lack of profitability are following and were stated by a large share of the active ESCOs. The EPC advantages (guarantee or financing) are also often or sometimes undervalued by the clients as stated by a majority of ESCOs. All these barriers concern the demand-side of the EPC market. 8 out of the 9 active ESCOs stated that they sometimes struggle to finance a project. This reflects the financing issue we described in chapter II, which is confirmed here. It does not concern all EPC projects, but it has been a problem that almost all ESCOs have faced.

The other barriers were less consensual among ESCOs. They include off-balance sheet financing, the difficulty to certify or match an EPC project with the universal convention

of objectives for large consumers, the transfer of costs onto the tenants, low potential energy savings and the complexity of public tenders. For the latter, this may be because several active ESCOs have been targeting private entities and therefore did not face this issue.

The barriers in Figure 27 were presented to the respondents and determined using the interviews and results from module 2. Interestingly, we gathered all the relevant information into these barriers since no other barriers were mentioned by the active ESCOs. The only additional issue mentioned by one respondent was the public accounting standards, which we relate to the off-balance sheet accounting issue.

When facing market barriers, service providers have several possibilities to find a solution. For instance, they can try to convince the government to step in or change the boundary conditions; they may also adapt their business model to overcome some obstacles; or try to integrate new stakeholders, such as facilitators, into the market model.

Government support

The ESCOs were asked to rank by priority the obstacles they think the authorities should address. The lack of clients' knowledge comes first, supporting the current work of the Swiss Federal Office of Energy (SFOE) in this domain. The second obstacle that authorities should address is the low energy prices. This could typically be mitigated by an energy tax levy, as presented in the choice experiment. The third barrier that should be mitigated is the legal uncertainty regarding the possibility for an ESCO to invest in a public building. This problem has been raised in a municipality in the canton Geneva and is also likely to be linked to the possibility to account for an EPC project off-balance sheet. This problem could be solved by clarifying the legal and accounting requirements. ESCOs also stated that the authorities should try to reduce the complexity of public tenders and the adequacy of EPC with universal convention of objectives for large consumers. Finally, the extent to which the owners can transfer the costs onto the tenants should be clarified.

Business model adaptation

While all 9 ESCOs perceived the government involvement as necessary, 4 of them do not think that -or do not know how- their business model could be changed to adapt to the market's difficulties. The other 5 ESCOs tried to change their business models, first by finding solutions on their own to satisfy the client's needs or by changing the way to get in contact with the clients. One ESCO has also changed the type of clients it was targeting and another simply decreased its expectation regarding the EPC business goals.

Integration of other actors

Finally, a majority (two third) of the ESCOs emphasized the need to integrate facilitators or intermediaries in the EPC market. 3 ESCOs disagreed, however.

4.2.2 Point of view from firms unwilling to provide EPC

140 (67%) of the 208 respondents did not show interest in entering the EPC market in the future. The reasons not to provide EPC are listed below with the number of firms stating it as an obstacle and the corresponding percentage out of the 140 uninterested firms in brackets:

1. Lack of internal competencies and personnel capacity (81[58 %])
2. Lack of interest from clients (36 [26 %])
3. Not economically advantageous (35 [25 %])
4. Lack of financing (32 [23 %])
5. Lack of potential energy savings (29 [21 %])
6. Inadequacy with the core business (14 [10 %])
7. Risk too high (12 [9 %])
8. Objection from the direction (8 [6 %])
9. No interest from the firm (3 [2 %])

The first obstacle relates to the fact that many respondents are representing small firms in which the personnel capacity and competencies seem to prevent entering the EPC market. Indeed, 72 of the 81 respondents claiming a lack of internal competencies are part of firms with less than 50 employees. If these firms would be convinced of the market potential for EPC, one solution would be for them to group their competencies or outsource some of them to provide EPC.

Second, while a relatively large number of respondents mentioned the lack of interest from clients, the lack of economic viability or the lack of potential energy savings, only 5 firms (4 %) of the 140 not interested respondents stated to have conducted a market analysis to confirm these conjectures. The examples of the successful EPC projects provided by the *swissesco* association may reassure these firms regarding the economic potentials of such contracts.

The "forfaiting" EPC scheme may be an interesting solution for the firms without any financing possibilities to offer EPC (see Swissesco (2016)).

Finally, we believe that barriers such as the inadequacy with the core business, objection from the direction or the lack of interest from the firm are more intrinsic and structural obstacles to provide EPC and therefore more difficult to mitigate. These are likely firms which will not enter the EPC market. These represent however a minority and these results are therefore encouraging concerning the potentials on the supply side. This is the case of course, only if the government mitigates the aforementioned barriers.

4.3 Choice experiment descriptive statistics

Table 39 provides the numbers and shares of the willingness to consider offering EPC or ESC in each of the four choice tasks presented. This willingness is the dependent variable in the random effects ordered logit model.

Table 39: Consideration to offer contracts

	EPC shared-savings	EPC guaranteed-savings	ESC	All types of contracts
Choice task 1				
No	33 (29%)	45 (49%)	N/A	78 (38%)
Rather no	49 (44%)	27 (29%)	N/A	76 (37%)
Rather yes	24 (21%)	14 (15%)	N/A	38 (19%)
yes	6 (5%)	6 (7%)	N/A	12 (6%)
Total	112 (100%)	92 (100%)	N/A	204 (100%)
Choice task 2				
No	36 (35%)	40 (41%)	N/A	76 (38%)
Rather no	31 (30%)	36 (37%)	N/A	67 (34%)
Rather yes	29 (28%)	15 (15%)	N/A	44 (22%)
yes	6 (6%)	7 (7%)	N/A	13 (7%)
Total	102 (100%)	98 (100%)	N/A	200 (100%)
Choice task 3				
No	37 (38%)	32 (31%)	1 (50%)	70 (35%)
Rather no	34 (35%)	35 (34%)	0	69 (34%)
Rather yes	21 (22%)	27 (26%)	1 (50%)	49 (24%)
yes	5 (5%)	9 (9%)	0	14 (7%)
Total	97 (100%)	103 (100%)	2 (100%)	202 (100%)
Choice task 4				
No	0	N/A	82 (40%)	82 (40%)
Rather no	1 (50%)	N/A	57 (28%)	58 (28%)
Rather yes	1 (50%)	N/A	39 (19%)	40 (20%)
yes	0	N/A	25 (12%)	25 (12%)
Total	2 (100%)	N/A	203 (100%)	205 (100%)

Notes: In the main survey, the first 3 choice tasks were assigned to EPC contracts (randomly between shared- or guaranteed savings) and the 4th choice task was assigned to ESC. The few ESC in choice task 3 (resp. EPC in choice task 4) come from the pilot surveys. The total number of respondents is smaller than 208 because of some missing values for the contract variable. This is due to the fact that some respondents began to respond to the survey in the first pilot and finished in the main survey. When this occurred, a technical problem resulted in missing values for the randomized contracts seen in the choice experiment, therefore excluding these choice tasks from the estimation. Also, in pilot 1, some respondents were also proposed Integrated Energy Contracts (IEC), which was no longer the case in the main survey. These choice tasks were dropped from the main estimations.

From the last column of Table 39, one can note that the choices do not vary much across choice tasks. This may suggest that the firm characteristics (not varying across choice tasks) represent more important determinants for the choice to provide EPC or ESC than the different hypothetical contextual situations presented. Also, the firms did not consistently reject or accept EPC shared-savings or guaranteed-savings more often. This suggests that the choice between the two schemes is more likely to be driven by the client's choice or the context than by the firm's preference.

Finally, the share of respondents rejecting the contracts proposed (stating "no" or rather "no") represent a large majority (varying from 68-75 % across choice tasks) as can be seen in the last column of Table 39. This is consistent with the 140 (67 %) of respond-

ents stating to be (rather) not interested in providing EPC in the future as described in the previous section.

Table 40 provides the descriptive statistics of the hypothetical contexts and types of contracts proposed in the choice experiment data. The mean describes the share of apparition in the sample of each hypothetical context or contract's type. In the regression, we use a two-way interaction between private and public demand increase. This means that the variables used as explanatory variables are:

1. Only public demand increases (private demand remains unchanged)
2. Only private demand increases (public demand remains unchanged)
3. Both public and private demand increase (public x private demand increase)

Finally, in 7.2 % of the cases, the respondent was facing a contract that its firm was already proposing. In this case the question was whether his firm would consider offering the contract more often than currently under the hypothetical situation exposed.

Table 40: Descriptive statistics of attributes of the choice tasks offered to the respondents

Attributes	Mean	Std. dev	Min	Max	N
Hypothetical context					
public demand increase	0.507	0.500	0	1	811
private demand increase	0.485	0.500	0	1	811
public increases (private unchanged)	0.238	0.426	0	1	811
public unchanged (private increases)	0.260	0.439	0	1	811
public x private demand increase	0.247	0.431	0	1	811
supply increase	0.502	0.500	0	1	811
liberalization	0.544	0.498	0	1	811
taxation system (constitutional article)	0.520	0.500	0	1	811
Contracts proposed					
EPC shared-savings	0.386	0.487	0	1	811
EPC guaranteed-savings	0.361	0.481	0	1	811
ESC	0.253	0.435	0	1	811
Contract x already offered	0.072	0.258	0	1	811

4.4 *Plausibility of the hypothetical situations presented in the choice experiment*

The respondents were finally asked to state their perceived credibility of the regulatory context and market situations presented in the choice experiment. The hypothetical situation that was perceived as the most plausible by the respondents was an increase in the private demand for EPC due to a certification of EPC as satisfying the universal convention of objectives. The second most plausible situation is an increased of the public demand due to a federal obligation for collectivities to always consider EPC when retrofitting or investing in energy efficiency. The project of a constitutional article replacing subsidies with fuel and electricity tax levies was then considered plausible or very plausible by 43 % of the respondents. This legislation was also the one implying the highest share of uncertainty (16 % of "don't know"). An increased supply due to an obligation for utilities to increase their clients' energy efficiency, as in the white certifications scheme, was considered plausible or very plausible by 40 % of the respondents. This is so even if white certificates schemes have already been rejected by the Swiss parliament. Interestingly, the complete liberalization of the electricity market is considered as being the less plausible situation, with 52 % of the respondents perceiving it as hardly or not plausible. Regulatory contexts (liberalization and constitutional article) were the one that the respondents were most uncertain about (15 and 16 % of "don't know"). Using this information, we will test whether these hypothetical situations have different impacts when considered as plausible by the respondents.

Table 41: Plausibility of the hypothetical situations

	Not plausible	Hardly plausible	plausible	Very plausible	Don't know	Total
Increased public demand: publicly-owned buildings have to consider EPC						
	20 (10%)	49 (24%)	100 (49%)	16 (8%)	20 (10%)	205 (100%)
Increased private demand: EPC satisfies the universal convention of objectives						
	9 (4%)	48 (23%)	110 (54%)	18 (9%)	20 (10%)	205 (100%)
Increased supply: utilities forced to increase their clients' energy efficiency						
	33 (16%)	65 (32%)	68 (33%)	14 (7%)	25 (12%)	205 (100%)
Liberalization of the electricity market extended to the small consumers						
	36 (18%)	70 (34%)	53 (26%)	16 (8%)	30 (15%)	205 (100%)
Subsidies will be replaced by fuel and electricity tax levies						
	28 (14%)	57 (28%)	75 (37%)	13 (6%)	32 (16%)	205 (100%)

4.5 Determinants of energy service contracting supply

Based on the choice experiment data, the results of the random effects ordered logit are presented in Table 42[106]. We first show the results when the choice tasks propose either ESC or EPC contracts in column (1). Column (2) focuses only on the choice tasks in which EPC was proposed, i.e. ignoring choice tasks with ESC. From the results of the econometric estimations the most relevant findings are the following:

- It is first interesting to note that a hypothetical **exogenous combined public and private demand increase** has a significant positive impact on the willingness of potential providers to consider ESC or EPC. However, this is only valid if both private and public demands show a combined increase; an increase of only either of the segments is not sufficient. *Ceteris paribus,* having a combined increase in public and private demand translates in odds of choosing the contract[107] that are around 1.5 greater.
- An **exogenous supply increase from electric utilities** affects positively the probability that the firm will offer EPC or ESC. The impact is slightly greater than for the demand, but the odds are still around 1.5 greater. The supply increase was presented as resulting from an obligation for the utilities to increase their clients' energy efficiency. Such a policy would be similar to a white certificates scheme. In view of this, it is worth to note that an interaction term of supply variable with a dummy equating one if the firm is an electric utility is not significant. This interestingly suggests that implementing such a policy on the supply side would not only affect electricity providers, but all types of providers: Other suppliers in the energy market are likely to respond by increasing their offer in ESC or EPC services as well.
- **Neither the liberalization of the market nor an energy tax levy** as proposed by the proposal of a new constitutional article has a significant impact on the consideration to offer ESC or EPC.
- Column (1) also shows that there is **no preference for EPC schemes** (guaranteed or shared-savings) over ESC. Similarly, shared-savings is not preferred to guaranteed savings as can be seen in column (2). This suggests that the potential ESCOs are quite flexible regarding financing and are willing to response to their client's demands regarding the contractual scheme.

[106] Column (1) does not necessarily include 4 choice tasks by respondent and column (2) not necessarily 3 choice tasks per respondent. This is due to the fact that some respondents began to respond to the survey in the first pilot and finished in the main survey. When this occurred, a technical problem resulted in missing values for the randomized contracts seen in the choice experiment, therefore excluding these choice tasks from the estimation. Also, in pilot 1, some respondents were also proposed Integrated Energy Contracts (IEC), while this was no longer the case in the main survey. We therefore dropped these choice tasks from the main estimations.

[107] Odds of clicking yes vs. combined rather yes, rather no and no categories

Table 42: Determinants of ESC and EPC supply

Dependent variable: consider offering contract *j* (4pts Likert scale)	**Random effects ordered logit**			
	Both ESC and EPC proposed		Only EPC proposed	
Attributes	**(1)**		**(2)**	
	coefficients	**odds ratio**	**coefficients**	**odds ratio**
Public demand increases (private unchanged)	-0.000 (0.258)	1.000 (0.258)	0.039 (0.335)	1.04 (0.349)
Private demand increases (public unchanged)	-0.059 (0.268)	0.943 (0.252)	-0.132 (0.371)	0.877 (0.325)
Public x private demands increase	0.391* (0.210)	1.479* (0.310)	0.453* (0.257)	1.573* (0.404)
Supply increase	0.394** (0.161)	1.482** (0.238)	0.530** (0.220)	1.699** (0.374)
Liberalization	-0.228 (0.200)	0.796 (0.159)	-0.258 (0.260)	0.773 (0.202)
Taxation system	-0.077 (0.177)	0.926 (0.164)	-0.071 (0.217)	0.931 (0.202)
Contract proposed=shared-savings	-0.110 (0.238)	0.895 (0.213)	0.056 (0.211)	1.057 (0.223)
Contract proposed=guaranteed-savings	-0.112 (0.280)	0.894 (0.250)	.	.
Contract proposed x already offered	2.189** (1.096)	8.928** (9.782)	.	.
Firm's characteristics about current activities				
Familiar with EPC	1.270** (0.639)	3.562** (2.276)	1.232* (0.678)	3.429* (2.326)
s_EPC	-1.663 (1.736)	0.190 (0.329)	0.831 (1.480)	2.296 (3.398)
s_ESC	0.741 (0.905)	2.098 (1.899)	0.640 (0.957)	1.897 (1.815)
s_electricity	0.321 (0.690)	1.378 (0.952)	-0.130 (0.714)	0.878 (0.627)
s_gas	1.576** (0.781)	4.835** (3.774)	1.428* (0.797)	4.169* (3.323)
s_heating systems	2.088** (1.033)	8.065** (8.330)	2.245** (1.104)	9.438** (10.421)
s_appliances	-1.124 (1.192)	0.325 (0.387)	-0.844 (1.330)	0.430 (0.572)
s_energy control optimization	1.250 (0.873)	3.492 (3.048)	2.141** (0.886)	8.504** (7.534)
s_facility mgmt	1.070 (1.125)	2.916 (3.279)	0.795 (1.172)	2.215 (2.595)
s_technical maintenance	-0.085 (0.892)	0.918 (0.818)	-0.112 (0.938)	0.894 (0.839)
s_engineering consulting	-0.368 (0.765)	0.692 (0.530)	-0.629 (0.816)	0.533 (0.435)
s_energy efficiency services (other than EPC)	1.142* (0.638)	3.131* (1.998)	1.268* (0.668)	3.554* (2.375)
observations	811		591	
individuals	208		200	
log pseudolikelihood	-713.295		-541.534	
AIC	1476.591		1129.067	
BIC	1594.048		1230.43	

Notes: 4-points Likert scale of the dependent variable are: "no", "rather no", "rather yes", "yes". Robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Baseline contract is ESC in column (1) and EPC guar-savings in column (2). *contract x already offered* means the firm is already proposing this type of

contract (equivalent to s_EPC for column (2)). The question was in this case: would you consider offering this contract more often than currently given this hypothetical situation. Variables "s_xx" denotes that the firm currently provides the service "xx". Both estimations are performed using 36 integration points.

- **Already active as compared to non-active firms:** A dummy *contract x already offered* allowed to control for the fact that some firms were already offering the type of contract proposed. In this case, the respondent was asked whether his firm would consider offering the contract more often than currently given the hypothetical situation. In column (1), where both ESC and EPC contracts are proposed, this variable has significant positive impact, suggesting that active firms would be willing to offer the contracts more often than currently. However, when considering only EPC contracts, the active ESCOs (captured in the variable *s_EPC*) do not consider offering the contracts more often than the suppliers inactive in EPC. This suggests that regardless of the hypothetical situation, current ESCOs may not be able to offer the contracts more often. This is probably due to the barriers that these ESCOs are facing, hampering them to deploy more offers than they are already doing.
- The results show a positive relationship between the respondent's **familiarity with the EPC concept** and the consideration to offer these contracts (as well as ESC). The odds are around 3.5 greater when the respondent is familiar. Although this variable may suffer from endogeneity, it still suggests that information campaigns may be needed on the supply side of the EPC market.

Then, a series of dummies for the activities already offered by the firm were used as control, resulting in the following findings.

- Gas suppliers and to a larger extent heating system providers are more inclined to offer both ESC and EPC. Firms offering energy control and optimization appliances are also more likely to consider offering EPC[108].
- Several other firms' characteristics were tested but did not show any significant impact. This is the case for the location of the firm's clients (one or several cantons, in the whole Switzerland and/or abroad). The number of employees (as a proxy for the firm's size) has no influence either. This contrasts with the descriptive statistics showing that early active ESCOs are rather large firms. But this only confirms the necessity to have sufficient personnel capacities in order to be an early entrant in a market such as the EPC market. Being a private or a public firm does not either impact the consideration of providing EPC or ESC.

Finally, one can note that firms providing services related to energy efficiency other than EPC, are more likely to be willing to offer these contracts. This suggests that firms consider their existent technical knowledge when considering offering EPC. This result is however no longer significant when also controlling for the existence of pressure from the public entity in charge (see appendix 6.8.)[109]. If the respondent stated that **the**

[108] This effect is visible only in column 2. An interaction of s_energy control optimization with the contracts proposed in column 1 permits to see that these firms are more likely to offer EPC but not ESC.

[109] Controlling for public pressure also results in a decrease of the number of observations (n=197 in column1 and n=194 in column 2).

public entity in charge of the organization exerts some pressure to increase the energy efficiency of its clients, then the firm is more likely to consider providing EPC or ESC. Because of the missing observations for this variable, we did not include it directly into the main results, but the estimation result with this variable included are provided in appendix 6.8. This result suggests that a solution to foster EPC supply would be to sensitize and inform the public entities in charge of utilities or gas companies.

4.6 Follow up questions: How to provide EPC?

4.6.1 Resources to provide EPC

After each choice task, when the respondent stated that its firm would (maybe) consider offering the contract proposed, he was asked to state his preferences concerning the key resources to provide it. The results for EPC are illustrated in Figure 28 and Figure 29. The firms are more inclined to search for external partners for human resources than for financial resources, when subsidies are not considered as external financial partnerships. This could suggest that using strategic partnerships to complement competences is easier than for the financial part. This could also come from the fact that it is a larger effort to build up competencies internally. Another reason could be that the firms are more constrained on their personnel than on their financial capacity. This conjecture can be linked to the important share of firms unwilling to enter the EPC market because they say they lack the competencies and personnel capacity (section 4.2.2.)

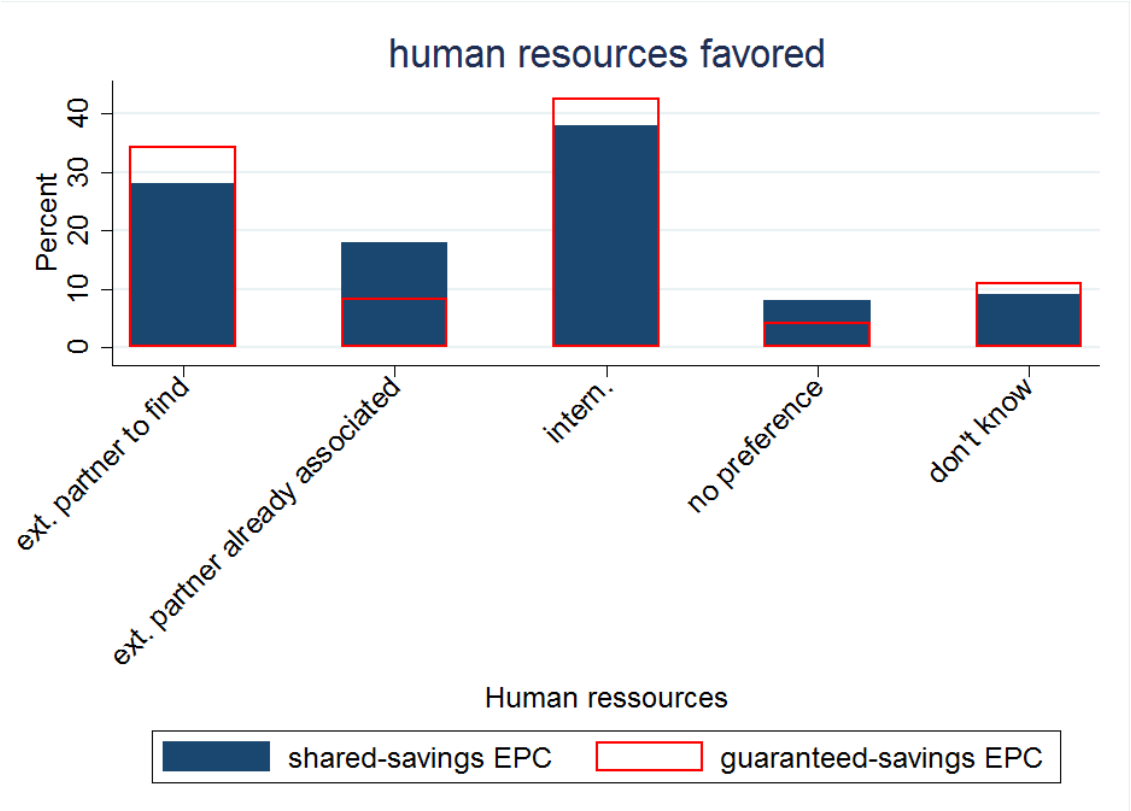


Figure 28 Human resources favored (shared savings n=90, guaranteed n=73)

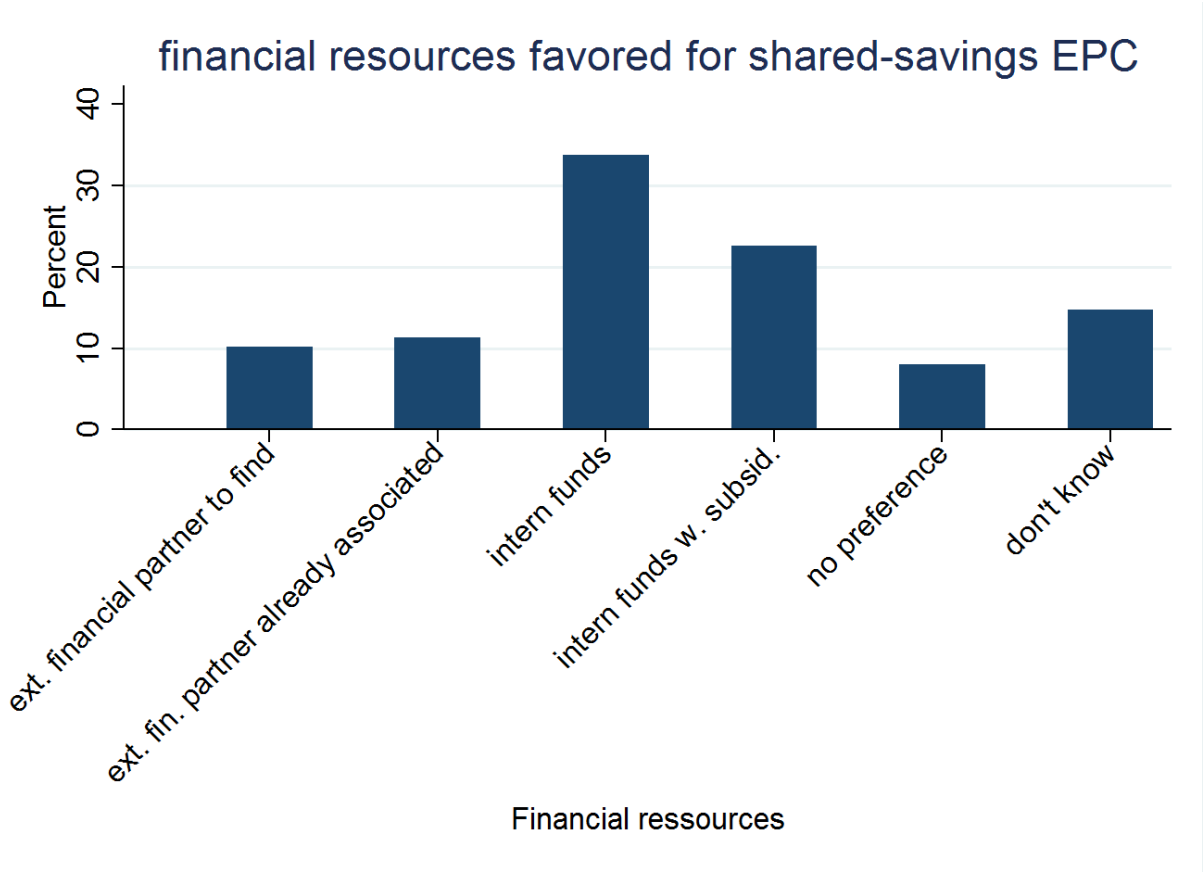


Figure 29 Financial resources favored (shared savings n=89)

One can also note that a larger share of firms stated that they would have to look for new external partners to find the necessary human resources as compared to firms willing to work with an existing partner. This tendency is not observed for financial resources with a slightly larger share of firms willing to work with existing financial partners than looking for new partnerships.

Figure 28 also shows the difference of human resources favored when the respondents were facing shared-savings as opposed to guaranteed-savings EPC. The differences are not large between the two contract types.

4.6.2 Market segment targeted and energy efficiency actions

As for the key resources, the respondents also had to inform on the market segment its firm would be willing to target, when he chose the contract proposed in the choice experiment. The difference between the contract types is more obvious when looking at the type of clients targeted. The firms are rather willing to offer guaranteed-savings than shared-savings for education facilities. The reverse is true for residential buildings.

Figure 30 confirms the previous result of firms targeting primarily industries and secondly education facilities (cf. Table 37). The owner-tenant issue does not seem to worry the respondents since residential buildings are ranked at the third position. This may

come from the fact that potential entrants on the EPC market (who target residential buildings also in the third position (cf. Table 37)) may be unaware of the issue of transferring the retrofit costs onto the tenants and/or they give more weight to the opportunities in the residential sector.

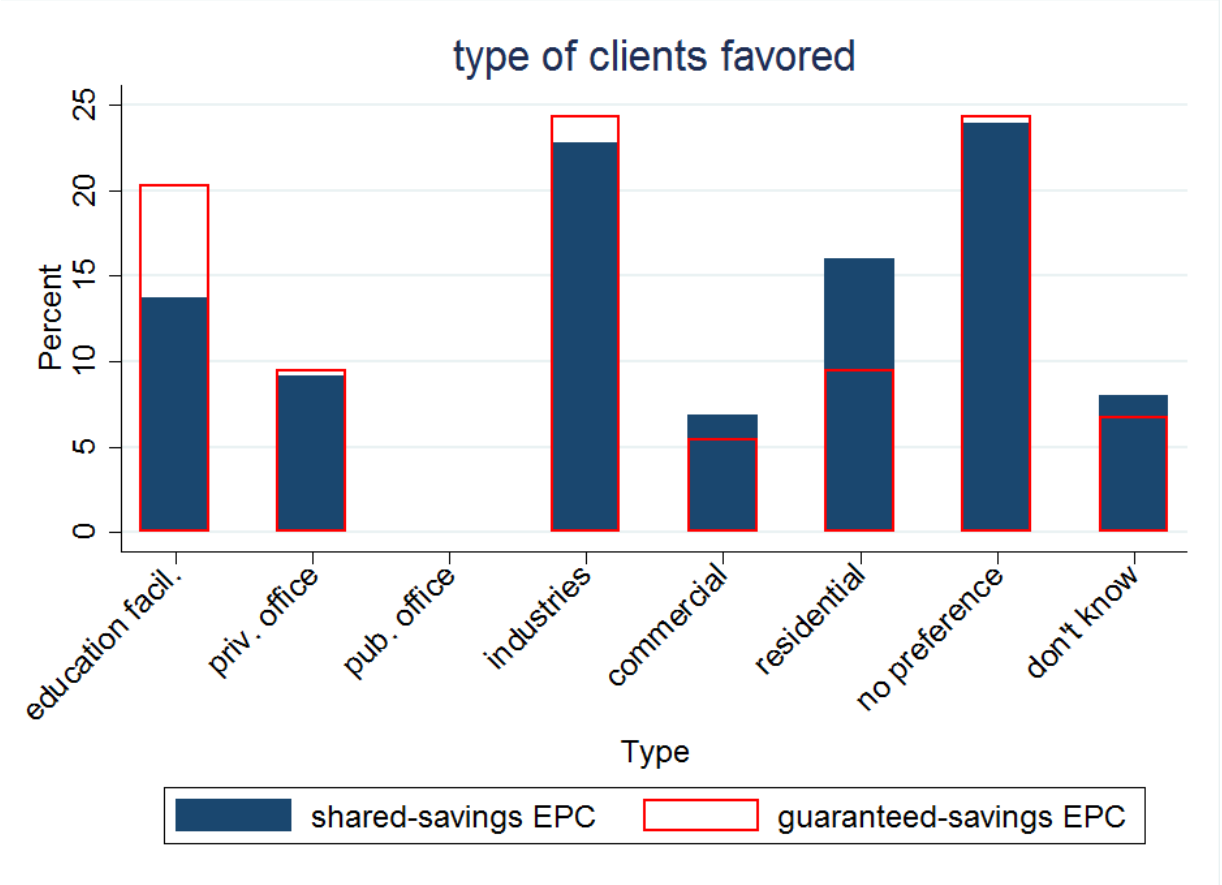


Figure 30 Types of clients favored (shared savings n=88, guaranteed n=74)

The largest client's size in terms of energy consumption was not chosen primarily by a majority of respondents to offer EPC (Figure 31). For both type of energy performance contracts, medium-sized clients were preferred by a majority and followed by the smaller size clients (50-100 MWh electricity or 100-500 MWh heating). This result contrasts with the untapped potentials of EPC for small and medium-sized clients in foreign ESCO markets (cf. chapter I).

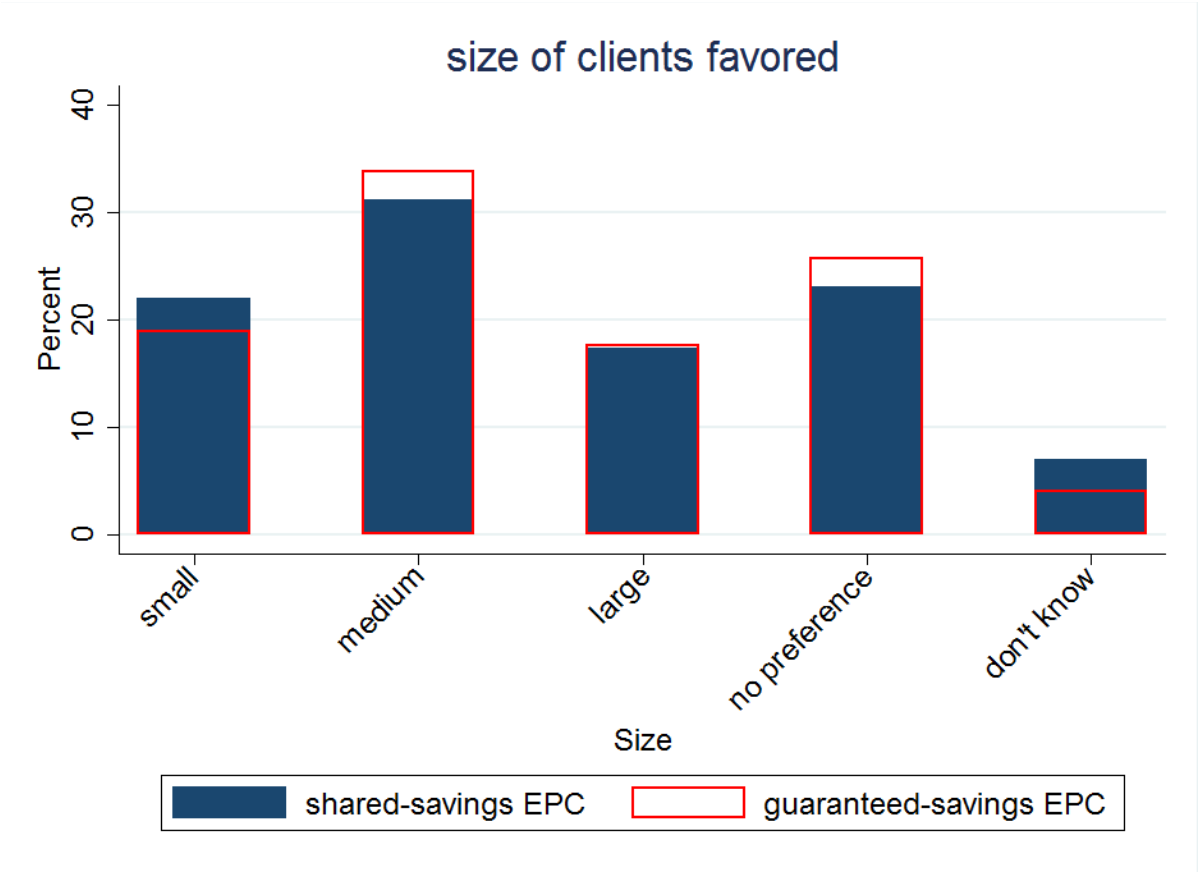


Figure 31 Size of clients favored[110] (shared savings n=87, guaranteed n=74)

Finally, while comprehensive refurbishment actions, such as envelop retrofits are less often favored than actions within the building, a large share of firms has no preference for the measures implemented (Figure 32). This can come from the fact that EPC can be tailored according to the client's need. As swissesco (2016) emphasizes, EPC can involve comprehensive refurbishments including the envelope. But these projects are likely to necessitate financing from both the ESCO and the client. While we showed that only a minority of clients are credit-constrained, such a mechanism of risk and financing-sharing seems promising to target all kinds of energy efficiency investments.

[110] Small size clients: electricity 50-100 MWh or heating 100-500 MWh, medium size clients: electricity 100-500 MWh or heating 500-5000MWh, large size: electricity > 500MWh or heating > 5 GWh.

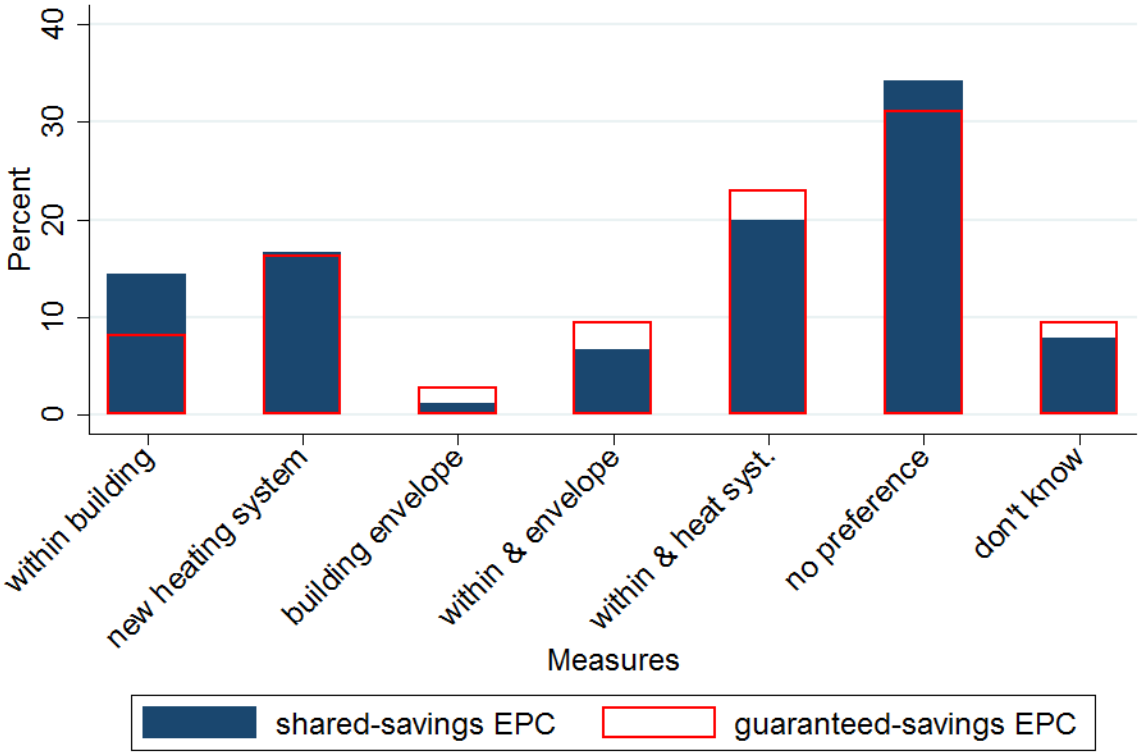


Figure 32 Energy efficiency actions favored
(shared savings n=91, guaranteed n=74)

4.7 Follow up question when contract rejected

When the respondent rejected the contract proposed in a choice task, she was asked to state under which conditions she would change her mind. In total, 576 choice tasks resulted in a rejection of the contract proposed (no or rather no answer).

In 40 % of these rejected options, the respondents stated that their choice would not change, regardless of the market situation of the hypothetical context and in another 50 %, the respondent did not know under which condition their firm would possibly consider EPC. In 7 % of the options rejected, the respondent stated that her choice would change if there would be a change on the market situation or on the regulatory context[111]. They were then asked to state under which conditions they would be likely to offer EPC. The following situations were mentioned several times:

1. higher energy prices
2. existing and sufficient demand, a greater number of large energy consumers
3. legal standard/requirements
4. Financial incentives and subsidies

An increase of energy prices would increase the energy cost savings potentials and this could typically be achieved through energy tax levies. This suggests that even though

[111] The remaining 3% of the rejected choice tasks did not receive any answer from the respondent.

we did not find a significant impact of this law on the decisions, it may still be a trigger for a few firms to enter the EPC market. The need for an increase in the demand-side as we found in the econometric part is confirmed here again. Finally, legal standards and requirements and financial subsidies were also mentioned several times, although we should not underestimate the existence of some potentially strategic answers. Finally, some respondents provided other insights that are interesting to mention here:

- Price competition and liberalization of the electricity market
- Gaz market liberalization
- Electricity shortage
- Accustomed business model
- end of taxes and subsidies

Price competition and liberalization is stated by a minority of firms (3 respondents) as an incentive to enter the market. The small share of respondents stating a potential reaction to a complete liberalization suggests that the current liberalization for large electricity consumers may not have induced a sufficient competition on the market for most of the firms to review structurally their business models. A liberalization of the gas market (mentioned by one respondent) is a trigger that has not been mentioned in the EPC literature. Then, bringing up electricity shortage means that some firms would wait for a very critical situation of an insecure electricity market to provide EPC. Waiting for the EPC business model to be accustomed may be the translation of a general "wait and see" attitude.

The last element mentioned, i.e. the end of taxes and subsidies, is really interesting. Indeed, it reminds the most attractive characteristic of EPC: it is a market-based instrument. If the government would step out of the energy market, this may well be one of the only remaining solutions for constrained energy consumers to engage in energy efficiency investments, retrofits and renewable energy.

4.8 Robustness checks

The following tests were performed on the estimations:

1. First, the random effects ordered logit provides a likelihood-ratio test which showed that there was enough variability between the individuals to favor a random-effects model as opposed to a standard ordered logit model.
2. The quality of the quadrature approximation of the integrated likelihood function was also explored by changing the number of integration points. Because the default of 12 integration points was not sufficiently accurate (the relative differences in the estimates with 8 or 16 integration points were larger than 1% for some estimates), we increased to 36 points which resulted in more robust estimates.

We also performed the following robustness checks:

1. we controlled for the plausibility of the hypothetical situations presented as perceived by the respondents (cf. appendix 6.9). We did so by interacting the situations attributes with dummies equating 1 if the respondent perceived the situation as be-

ing plausible or rather plausible. While some coefficients gained in magnitudes and/or in significance, it does not affect the overall results described above.

2. Similarly, we controlled for unobserved heterogeneity across firms using a conditional logit model (cf. appendix 6.10). In order to do so, the 4 points Likert-scale was transformed in a binary variable (1 if yes or rather yes and 0 if no or rather no). This comes at the cost of losing the individuals for whom the only variations occurred between yes and rather yes (resp. no and rather no). Also, in such a conditional logit, all firm's specific characteristics are omitted. In this model, only the utilities' supply increase keeps its significant positive impact. But this is likely to be due to the critical decrease in the number of observations (147 individuals with 567 observations dropped, 61 individuals remaining with 244 observations)[112].
3. We also checked the robustness of the firms' characteristics affecting the choice to enter the EPC market. In order to do so, we used the question about the intention of the firms to propose EPC in the future. Since this was also a 4 point Likert scale, we used an ordered logit model. We also included already active ESCOs as confirmed entrants. The results are provided in appendix 6.11 and are similar to those found using the choice experiment, except for some variables. First, being familiar with the EPC concept becomes insignificant once we add the control for the public direction pressure to increase the energy efficiency of the clients[113]. Second, providing ESC now is significantly positively affecting the decision to enter the EPC market, suggesting ESC to work as a complement to EPC. The other energy services related to energy efficiency, on the other hand, are no longer significant. We again tested other firm's characteristics, such as the number of employees, the fact of being a private or a public firm and the location of the firm's clients. These factors had no significant impact on the decision.

We conclude that the estimated impacts of a combined private and public increase demand as well as a supply increase are reliable. Being a provider of gas, heating systems or energy control and optimization also consistently increase the willingness to provide EPC. The positive impact of the pressure exerted by the public entity in charge is also robust to changes in specification. However, the fact of providing energy efficiency services other than EPC as well as being familiar with the concept have not a robust significant impact on the willingness to provide EPC.

[112] Using the same sample to run a random-effects ordered logit also leads the supply increase to be the only significant attribute. Creating a dummy equating 1 when included in the conditional logit sample and controlling for it in the initial models of random effect ordered logit does not change the former results of a combined private and public demand increase having an impact as well as a supply increase.

[113] This is likely to be due to the correlation between these two variables. When there is a public entity exerting pressure, the firm is not only more likely to be willing to provide EPC but also more likely to be aware of the existence of this instrument.

5 Discussion and conclusions

This chapter aims at exploring how the supply-side of the EPC market can be initiated and developed and how the market and the regulatory contexts affect the firm's business decisions. Using a survey and a choice experiment among 208 potential EPC suppliers, including energy utilities, gas providers, engineering offices as well as appliances and heating systems suppliers, we assess the determinants of providing energy services.

Targeting active ESCOs as well as potential entrants and firms unwilling to offer EPC provides interesting insights on the barriers hampering the deployment of the supply-side of the EPC market. This chapter also provides information on the current Swiss EPC market according to the 9 active ESCOs present in the sample. We show that EPC is still a market niche in Switzerland, which has started to be developed only recently. With the ESCOs represented in this sample, we only count a bit more than 20 EPC contracts signed in Switzerland and more than 40 projects that are currently negotiated. One should also note that the distribution of contracts and projects among active ESCOs is unequal.

The attribute that is the most consistently positively affecting the willingness to enter the EPC market is an exogenous increase in the EPC supply from electricity utilities. In the choice experiment we presented this hypothetical context as being the consequence of a new regulation forcing the electricity providers to increase the energy efficiency of their clients. Such a policy can be considered as similar to a white certificates scheme, as implemented in several European countries. Interestingly, this attribute not only affects electricity utilities but also the non-electricity providers. This result suggests that the best trigger to foster the EPC supply is the supply itself. This would increase competition, lead to a broader variety of offerings and choices and, last but not least, a widespread information about EPC on the side of potential clients.

The qualitative analysis we led provides insights on the way to trigger the EPC supply. Most of the perceived barriers encountered by active ESCOs are concerning the demand-side but also the difficulty to develop attractive services under the given set of regulatory and market boundaries. Additionally, the selection of appropriate client groups is also of high importance to foster a market position of a firm. The inactive firms, on the other hand, provide interesting insights about the barriers hampering the deployment of the supply side. They show that the primary barrier is a lack of internal competencies and personnel capacity. Therefore, the education of potential EPC providers, such as the certificate of advanced studies on EPC which will soon be implemented, is presumed to have an important role to trigger the EPC supply.

The lack of interest from the clients and insufficient existing demand is recurrently cited as a barrier by both active ESCOs and firms unwilling to enter the EPC market. We find empirical evidence that a demand increase has an impact on the willingness to offer EPC, only if both private and public demands rise together. This result suggests that entering the EPC market represents an important investment, which would be worth it only with a sufficient market volume in both private and public buildings. We also show

that this investment seems to be more important in terms of capacity building and human resource than in terms of financial resources.

Changes in the regulatory context regarding the energy market, such as a general liberalization or a tax levy system on energy does not significantly impact the decision to enter the EPC market. The non-impact of the liberalization can be explained by the fact that EPC is targeted to larger consumers that are already part of the liberalized segment of the market. Therefore, EPC is not a response to the potentially increased competition for this market segment. The non-influence of the energy tax proposal is more surprising. It may result from the difficulty for suppliers to foresee its concrete impacts on the market. Since this policy is only likely to be implemented in the second phase of the energy strategy 2050, if at all, respondents may not have evaluated its potential consequences yet.

Concerning the firm's characteristics, being familiar with EPC may be determinant to be a potential EPC provider, although this result is not robust in all specifications. We show that a majority of the firms surveyed were not familiar with the EPC concept, suggesting that information campaigns may also be needed on the supply side. Several activities are estimated as being complementary to EPC provision, such as the provision of gas, heating systems, energy control and optimization systems. Finally, the size, the clients' location or the fact of being a public firm does not affect significantly the willingness to enter the EPC market. However, we show that if the firm is controlled by a public entity, which exerts some pressure to increase energy efficiency of the clients, then the firm is more likely to offer EPC. This provides another interesting lead to foster the EPC market, i.e. increasing awareness among public entities in charge of utilities.

The qualitative analysis also shows that potential suppliers are a priori interested to provide EPC also to smaller consumers. Also, we show that all kind of energy efficiency measures can be involved in EPC, including envelope refurbishments, as long as an adequate risk and financing-sharing system is implemented. These results are promising for the flexibility of EPC to target smaller market segments and more comprehensive energy efficiency improvement measures.

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VI. Appendix

6 Appendix

6.1 Interviewees chapter II

Table 43: Interviewee chapter II

Role	Company/institution	Date
Experts active in EPC		
Energy Efficiency Specialist	Services Industriels de Genève (SIG)	May 2015
Energy Efficiency Specialist	Schneider-Electric	May 2015
Energy Efficiency Specialist	Alpiq InTec	July 2015
Energy Efficiency Specialist	Siemens Building Technologies	July 2015
Utilities		
Contracting specialist	Elektrizitätswerke des Kantons Zürich (EKZ)	June 2015
Energy Efficiency specialist	Groupe E	July 2015
Contracting specialist	ewb	August 2015
Public authorities		
Section energy and emissions, head of section	Energy Service Canton Neuchâtel	June 2015
Engineers	Energy Direction Canton Vaud	July 2015
Financial institutions		
Financial Investor	SUSI Partner	July 2015
Legal Experts		
Ordinary professor of private law & lawyer specialist of building and real-estate law	University of Neuchâtel	July 2015
Dr. lawyer specialist of administrative and public law	University of Neuchâtel	September 2015

6.2 *Interview with experts active in Switzerland (chap. II)*

Information gathered before the interview:

a) Motivation(s) of the firm to supply EPC? (What EPC brings to your firm in general (vision, strategy)?)
b) For how long have you been supplying EPC in Switzerland?
c) How many contracts have you signed in Switzerland?
d) How large is the EPC sector in your firm? (% of turnover, % of employees, etc.)
e) Is your firm public or private?

EPC and the firm

1. Has any event (a public policy decision; a market development such as energy prices or a new technology) contributed in the choice of your firm to supply EPC?
2. Which market research did you undertake to evaluate the Swiss market for EPC? Did you rely on external consultants?

Target segment: clients

3. Who are your clients? (who are you primarily targeting, types of your effective clients, number, public-private: number of each-preference-advantages, size of energy consumption: average-minimum)

Business Model: (questions useful to understand existing BM)

VALUE PROPOSITION

4. How is EPC a solution to the customer problem? (Deep truth of what consumers really value in EPC)
   What is the size of the "value pie": How many potential clients do you estimate in Switzerland (public and/or private)? What amount of energy savings do you think this represents?
5. What are you selling to your clients? (One answer possible: e.g. technology, knowhow, organization, risk-sharing (technological risks, financial risks). Energy savings cannot be an answer since it is the result) (this question aims at understanding what is the initial motivation of the firm to supply EPC.)

DELIVERY MECHANISM

6. EPC involves several vertical activities, such as financing, technology (choice, production and installation), O&M (Operation & Maintenance) and M&V (Measurement & Verification), as well as horizontal activities (complementary), such as supply contracting and facilitation.
   a. Which activities are important to own/control in-house? Why?
   b. Who performs the activities you are not controlling?
   c. Do you use facilitators? How and in what activity?
   d. Do you prefer dealing with an onsite building technical manager (from client)? If yes, how important is their contribution?

CAPTURE VALUE

7. What can we do to entice customer to pay for this service/How should the service be presented as a solution?
   a. How do you choose the types of services provided? (Audits types, technologies implemented, staff training, follow up, etc.)

b. Customers can generally finance EPC out of their projected savings. How do you convince them of this fact?
c. How do you convince the customer of your contribution (why do they do the project with an ESCO, why not themselves?)
d. How do you choose the pricing strategy? (Guaranteed savings (average?), shared savings (average?), other to be mentioned, contract duration)? How do you calculate / forecast energy demand in the building?
e. What are you doing to reduce risk of dispute and legal problems? (IPMVP (International performance measurement and verification protocol by EVO (efficiency valuation organization)), standardization, etc.) What are the main dispute topics? Why?
f. What do you think about costly audits and is there a way to avoid them and choose a simple M&V approach?
g. What are co-benefits of the EPC as a service? Customer retention (depending on contract duration)? Selling other services? IS EPC by itself profitable as business?

INDUSTRY COMPETITION/FACTORS

8. Industry competition:
   a. Do competitive offering to EPC exist in Switzerland?
   (How are they superior to your offering?)
   b. How many actors are providing EPC in Switzerland? (competitors)
   (How is your offering superior to the one of your competitors?)
   c. In order to keep a competitive advantage, would you rather differentiate the services offered or would you be willing to change your business model (e.g. customers target, revenue schemes (free service?), activities organization, avoid M&V as in IEC)?
   d. What is the market size for EPC? Who are the relevant players in the market?
   e. Are there model contracts available across the industry?

9. Business Model environment:
   a. Has a dominant design of business model for EPC emerged yet in Switzerland?
   b. How do you see your Business Model evolve?
   c. What are the **barriers** that the company is confronted with (specific at the client, general in terms of legal, economic, regulation, fostering instruments etc.)?
   d. EPC market in Switzerland seems to be lagging behind other countries, such as Germany. How would you explain this difference?
   e. What are the success factors (if any tangible)? Type of clients, personal relationship, appealing economic offer, trust, intrinsic motivation of the client etc.

Future of EPC in Switzerland

10. What should be the public policy-makers priority to reduce barriers to the EPC market according to you?
11. And if the solution was elsewhere? Do you think you could change your business model in order to overcome some barriers existing in Switzerland? In which sector

could you change your BM? (e.g. customers target, revenue schemes (free service?), activities organization)

a. Do you plan to modify your business model in the future or at least explore alternatives?
b. Do you rather plan to propose new/other services or products?

6.3 *Interview with Utilities (chap. II)*

Information gathered before the interview:

a) Is your firm public or private?
b) Which energy is your firm providing? (Electricity, gas, etc.)
c) In which cantons is your firm providing energy?

VALUE PROPOSITION

1. Does your firm propose any services to its clients to improve the energy efficiency of its clients, or reduce or manage the energy demand of its clients?
   a. If yes, what are these services?
   b. If no, is your firm interested in in improving the energy efficiency, reduce or manage the energy demand of its client in the future? Why?
2. Is your firm providing energy service contracting? ESC (Energy Supply Contracting) or EPC (energy performance contracting)?
   a. If providing EPC, ask the same questions as for experts active in EPC

BUSINESS MODEL EVOLUTION

   b. If no, have you already heard about EPC? Description of the EPC if has not heard about? Are there any other energy services that your firm is providing which are related to EPC?
   c. If yes: where?

Interest in EPC:

   d. Are you planning to diversify the product portfolio of the company, by providing for instance EPC to your clients?
      i. If yes, did you undertake some market research already? Did you prepare board requests for funding? What are the reasons for such decision? How are you setting up the new business model (strategy, targets, client group)? When are you going to offer such services? How many resources are you investing (personal, finance, other) to start this new business? Who is the driver of the new business model (the business unit or the executive board)? Do you think external facilitators could be useful? If yes, is it in legal issues or financing or marketing?

      ii. If not, what were the reasons for such decision? Did you undertake any market studies or research to estimate the market volume for EPC? Did you rely on consultants to undertake such research? Do you think your firm could be interested in providing EPC in the future?
      iii. Is your firm planning to provide other kind of services to their clients?

INDUSTRY EXTERNAL FACTORS/IMPACT OF POLICIES

3. IF provide ESC (on reseller level or costumer level): What were the principal motivation(s) of your firm to supply ESC? (What ESC brings to your firm regarding turnover and profit?) IF provide ESC: Did any public policy contributed to your firm's decision to supply ESC?

4. Non-utility ESCOs and other intermediaries seem to dominate the EPC market in the future. Do you think this would be a competitive pressure on your company / branch? If yes, how will utilities respond?
5. Does the liberalization of the electricity market for big electricity customers have changed the strategies of your firm? If so, in which way?
6. Is your firm anticipating the potential liberalization of the electricity market to all consumers by changing its strategies? If so, in which way?
7. What other policies might influence the kind of services you are offering to your clients? How?

6.4 *Interview with public authorities (chap. II)*

Public energy strategy: Information gathered before the interview:

1. What are you doing to promote energy efficiency in existing buildings? (In addition to the programs already existing at the federal level, such as tax exemption, subsidy, others?)
2. What are the programs, used by the canton, to increase the incitation of big consumers/firms to increase energy efficiency?

Role of EPC

3. Have you heard about EPC?
   If not, description of EPC
   - Who would you contact to get more information on EPC? Would there be a budget for such information request?
   - If yes, is EPC already part of some cantonal programs to promote energy efficiency? Which program? In which way?
4. Could you see EPC as a complement to the programs implemented at the cantonal level to promote energy efficiency? A complement to which programs? In which way?
   - If not, why?
5. Do you think EPC could replace some programs? Which programs? In which way?
   - If not why?

Barriers to EPC: should the government step in?

EPC market seems to be lagging as compared to some other countries such as Germany. Some Swiss experts think this is caused by:

1-lack of knowledge 2-no standardization of contract and tendering processes 3-Cultural/behavioral barriers 4-lack of public constraining objectives on energy savings 5-low energy prices 6-landlord-tenant split incentives 7-Legal issues for public collectivities to use EPC (exploitation and investments counts separated) 8-Accreditation for tax exemption not available for certain ESCOs (EnAW)

6. Do you think that cantonal authorities should step in to remove some of these barriers?
   If yes, which ones? How?
   If not, why?
7. Do you think the canton could inform the big consumers about the existence of EPC? How?
8. How do you deal with part L of the base module from the new MuKEn/MoPEC, regarding the possibility to include EPC as part of an agreement with large scale consumers? (How do you check the performance of such agreements? Is it enough that large scale consumer present key performance indicators or "list of actions" towards the authority or are additional actions needed?)
9. Do you think the canton could inform the municipalities about the tendering processes in order to implement EPC? Which difficulties might exist in the tendering process? How could such difficulties be reduced or eliminated?

10. Do you think the cantonal objectives in terms of energy are sufficient to increase energy savings in existing buildings? Could you do more? (e.g. small obligation for retrofit)
11. Do you think you could incite big consumer to save more energy (by increasing building standards, for instance) or by other means?
12. Do you think the canton could do something to help the landlords to transfer the costs of energy savings measures on the tenants who benefit from these savings?

13. Do you think that **cantonal authorities** should consider EPC in order to improve energy efficiency in cantonal public buildings?
    If not, why?
    If yes, what are the barriers that the topic has not been addressed so far?
    - Have you heard about the problem of different accounts (operating and investments)? How could this problem be solved, so that cantons could use EPC for their buildings?
    - Can a private firm invest in public cantonal buildings?

14. Do you think **municipalities** should consider these EPC in order to improve energy efficiency in public buildings managed by municipalities?
    - If yes, how could you (the canton) help the municipalities to consider EPC?
    - What would be a reasonable contract duration for the authorities to sign?
    - Have you heard about this problem of different accounts (operation and investments)? How could we solve this problem, so that municipalities could use EPC for their buildings?
    - Can a private firm invest in public municipal buildings?
    - If not, why?

15. Are accreditations for subsidies or tax exemptions limited to certain actors? Could the ESCOs be certified so that they can help their clients to get subsidies or tax exemptions through EPC? How are tax exemptions handled (legal/tax authority/rental law)?

16. EPC often involves a pre-study (audit) before the contract is signed. This can be used by the client to make a qualified selection of the ESCO. But these audits may be costly. Do you think the canton or the confederation should help the big consumers and/or the municipalities to pay these pre-studies?

Because of the important negotiation costs, EPC is suitable only for large energy consumers. But we also need to reduce energy consumption to small but numerous energy consumers.

17. Do you think we should rather help the ESCOs to target these small consumers or should we use other instruments for these small energy consumers?

6.5 *Interview with financial institutions (chap. II)*

Characteristic of the firm:

1. Is your firm public or private?
2. In your firm, have you any investment fund dedicated to investments related to energy?
   If yes, in which form?
3. In your firm, have you any investment fund dedicated to investments in energy efficiency?
   If yes, in which form?

Energy Contracting:

4. Have you heard about EPC?
   - If not, description of EPC
   - If yes, has your firm already financed EPC Projects? How did your firm analyze the EPC market (market survey), which information are you relying on? How did it analyze the specific projects it has financed? (Technical due diligence, legal due diligence, financial due diligence, others (in-house or with external consultants)?

If already financed EPC projects

a. What were the principal motivation(s) of your firm to finance EPC? (What EPC brings to your firm?)
b. Did any public policy contributed to your firm's decision to supply EPC?
c. For how long have you been supplying EPC in Switzerland?
d. How many projects have you financed?
e. Are there any conditions required for you to finance an EPC project (size, ES-CO, type of contract, etc.)?
f. Which type of contract does your company prefer to invest in?
g. What is your feedback on these projects?
h. Is it valuable to invest in these projects?

Some experts have argued that financing is sometimes hard to find for EPC because 1) the return (energy savings) is uncertain and depends on many factors (ESCO behavior, Client behavior, external factors) and 2) there are no tangible pledges to guarantee the initial amount invested

a. Are these two difficulties representing an important barrier for your firm when investing in EPC?
b. Are you taking any measure to counter these two problems?
c. Are there any other difficulties/risks you may face when financing EPC?
d. According to you, how many financial institutions are currently supporting EPC activities in Switzerland?
e. Do you think this number will grow in a near future?
f. Why aren't there more financial institutions interested in investing in these projects according to you?

Future of EPC:

a. Do you plan to continue financing EPC as you do now? Or will you increase the amounts dedicated to this business?

b. Did public policies or could they influence your decision to invest in EPC or energy?
    a. If so, how?
c. Do you predict a potential of expansion for EPC projects in Switzerland? Which kind of expansion?
    a. If yes why? If no why?
d. In general, do you think energy projects (energy renewable, energy efficiency, energy savings) will represent an interesting sector to invest in in the following years?
    a. If yes why? If no why?

<u>Don't finance any EPC project</u>

a. Which advantages you could find in investing in EPC?
b. Which disadvantages you could find in investing in EPC? Which were the key parameters for your decision, not to invest in EPC?

Some experts have argued that financing is sometimes hard to find for EPC because 1) the return (energy savings) is uncertain and depends on many factors (ESCO behavior, Client behavior, external factors) and 2) there are no tangible pledges to guarantee the initial amount invested

a. Are these difficulties representing a serious barrier for your firm to invest in EPC?
b. Could you think about a way to overcome/reduce these barriers?
c. Do you think your firm could be interested in financing EPC in the future?
    a. If yes, why and when? If not, why?
d. Is your firm planning to finance other kind of energy-related projects?
    a. If yes, why and when? If not, why?
e. Did public policies or could they influence your decision to invest in EPC or energy?
    a. If so, how?
f. In general, do you think energy projects (energy renewable, energy efficiency, energy savings) will represent an interesting sector to invest in in the following years?
    a. If yes why? If not, why?

6.6 *Allocation of energy efficiency measures according to upfront costs (chap. III)*

The percentage represents the share of alternatives with the corresponding cost which is allocated with that type of energy efficiency measure.

Table 44: Allocation measures type 1

	COST (CHF/heated m²)							
	80	100	120	150	180	200	250	300
EE measure type	BA only	25% BA only 50% Heat pump +BA 25% Wood+BA	20%BA only 20% En-velope only 40% Heat pump+BA 20% Wood + BA	25% Envelope only 50% Heat pump+BA 25% Wood+BA	25% Envelope only 50% Heat pump+BA 25% Wood+BA	50%Envelope only 50% Env+BA	Env+BA	Env+BA

Table 45: Allocation measures type 2

	COST (CHF/heated m²)			
	80	100	120	150
EE measure type	BA only	25% BA only 50% Heat pump +BA 25% Wood+BA	25%BA only 50% Heat pump+BA 25% Wood + BA	50% Heat pump+BA 50% Wood+BA

Table 46: Allocation measures type 3

	COST (CHF/heated m²)							
	80	100	120	150	180	200	250	300
EE measure type	BA only	BA only	50%BA only 50% En-velope only	Envelope only	Envelope only	50%Envelope only 50% Env+BA	Env+BA	Env+BA

Table 47: Allocation measures type 4

	COST (CHF/heated m²)			
	80	100	120	150
EE measure type	25% BA only 25% Nebo+ only 25% solar panels hotwater 25% biogas/green elec+BACS	25% BA only 25% Nebo+ only 25% solar panels hotwater 25% biogas/green elec+BACS	33% Nebo+ only 33% solar panels hotwater 33% biogas/green elec+BACS	33% Nebo+ only 33% solar panels hotwater 33% biogas/green elec+BACS

Table 48: Allocation measures type 5

	COST (CHF/heated m²)			
	80	100	120	150
EE measure type	25% BA only 25% ventilation 25% solar panels hotwater 25% biogas/green elec+BACS	25% BA only 25% ventilation 25% solar panels hotwater 25% biogas/green elec+BACS	33% ventilation 33% solar panels hotwater 33% biogas/green elec+BACS	33% ventilation 33% solar panels hotwater 33% biogas/green elec+BACS

6.7 *Equality-constrained latent class model for inferred attribute non-attendance (chap. III)*

Table 49: ECLCM inferred ANA – potential clients choices

Dependent variable: choice (=1 if choose alternative *j*)	ECLCM Inferred ANA (7classes)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Upfront Cost	-0.019*** (0.003)	-0.019*** (0.003)	0	-0.019*** (0.003)	-0.019*** (0.003)	-0.019*** (0.003)	0
Expected savings	0.039*** (0.007)	0	0.039*** (0.007)	0	0.039*** (0.007)	0.039*** (0.007)	0
Risk: sav. variation	2.387*** (0.845)	0	0	0	0	0	0
Upfront ESCO	0.100 (0.131)	0	0	0	0	0	0
Savings guarantee	3.280*** (0.578)	0	0	0	3.280*** (0.578)	0	0
Payment to ESCO	-1.278** (0.588)	0	0	0	0	-1.278** (0.588)	0
Contract's duration	-4.158*** (1.138)	0	0	0	0	0	0
Meas. Envelope	5.922*** (0.493)	5.922*** (0.493)	5.922*** (0.493)	0	5.922*** (0.493)	5.922*** (0.493)	0
Meas technic	1.501*** (0.277)	1.501*** (0.277)	1.501*** (0.277)	0	1.501*** (0.277)	1.501*** (0.277)	0
Meas. Mix	2.422*** (0.350)	2.422*** (0.350)	2.422*** (0.350)	0	2.422*** (0.350)	2.422*** (0.350)	0
Meas. Heating	1.562*** (0.299)	1.562*** (0.299)	1.562*** (0.299)	0	1.562*** (0.299)	1.562*** (0.299)	0
ASC *ee* alt.	-1.025*** (0.231)	-1.025*** (0.231)	-1.025*** (0.231)	-1.025*** (0.231)	-1.025*** (0.231)	-1.025*** (0.231)	0
ASC *epc* alt.	-1.523*** (0.261)	-1.523*** (0.261)	-1.523*** (0.261)	-1.523*** (0.261)	-1.523*** (0.261)	-1.523*** (0.261)	0
Average posterior class probabilities	0.206	0.082	0.179	0.130	0.129	0.104	0.170
Observations	5940						
Individuals	297						
Loglikelihood	-1278.486						
AIC	2595.0						
BIC	2704.7						

Notes: standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1.

6.8 *Public pressure (chap. IV)*

Table 50: Public pressure – potential suppliers' choices

Dependent variable: consider offering contract *j* (4pts Likert scale)	random effects ordered logit	
	both ESC and EPC proposed	only EPC proposed
Attributes	(1)	(2)
Public demand increases (private unchanged)	0.078	0.177
	(0.264)	(0.330)
Private demand increases (public unchanged)	-0.053	-0.186
	(0.276)	(0.384)
Public x private demands increase	0.434*	0.491*
	(0.222)	(0.270)
Supply increase	0.377**	0.462**
	(0.166)	(0.229)
Liberalization	-0.192	-0.253
	(0.205)	(0.278)
Taxation system	-0.126	-0.076
	(0.183)	(0.231)
Contract=shared-savings	-0.040	0.087
	(0.243)	(0.224)
Contract=guaranteed-savings	-0.071	.
	(0.290)	
Contract x already offered	2.326*	.
	(1.195)	
Firm's characteristics		
Public direction pressure to improve clients' EE	1.587**	1.753**
	(0.749)	(0.808)
Familiar with EPC	1.391**	1.353**
	(0.640)	(0.684)
s_EPC	-1.917	0.662
	(1.815)	(1.525)
s_ESC	0.656	0.561
	(0.966)	(1.027)
s_energy efficiency services	0.594	0.660
(other than EPC)	(0.645)	(0.672)
s_electricity	-0.053	-0.527
	(0.709)	(0.748)
s_gas	1.520**	1.418*
	(0.744)	(0.770)
s_heating systems	2.233**	2.524**
	(1.036)	(1.110)
s_appliances	-0.721	-0.450
	(0.166)	(1.323)
s_energy control optimization	1.537*	2.514***
	(0.839)	(0.875)
s_facility mgmt	1.192	0.894
	(1.163)	(1.269)
s_technical maintenance	-0.650	-0.718
	(0.859)	(0.922)
s_engineering consulting	-0.718	-0.988
	(0.766)	(0.820)
Observations	769	575
Individuals	197	194
log pseudolikelihood	-676.678	-509.756
AIC	1405.356	1067.512
BIC	1526.129	1172.017

Notes: Robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Baseline contract is ESC in column (1) and EPC guar-savings in column (2). Both estimations are performed using 36 integration points.

6.9 *Controlling for perceived plausibility (chap IV)*

Table 51: controlling for perceived plausibility-potential suppliers choices

Dependent variable: consider offering contract *j* (4pts Likert scale)	random effects ordered logit	
	both ESC and EPC proposed	only EPC proposed
Attributes	(1)	(2)
Public demand increases (private unchanged) x (rather) plausible	0.167 (0.297)	0.552 (0.403)
Private demand increases (public unchanged) x (rather) plausible	0.006 (0.318)	0.101 (0.391)
Public x private demands increase x (rather) plausible	0.527* (0.279)	0.649* (0.333)
Supply increase x (rather) plausible	0.678*** (0.244)	1.050*** (0.306)
Liberalization x (rather) plausible	-0.212 (0.293)	0.081 (0.292)
Taxation system x (rather) plausible	0.075 (0.257)	0.042 (0.280)
Contract=shared-savings	-0.087 (0.225)	0.057 (0.203)
Contract=guaranteed-savings	-0.080 (0.252)	.
Contract x already offered	2.071* (1.100)	.
Firm's characteristics		
Familiar with EPC	1.236** (0.628)	1.136* (0.642)
s_EPC	-1.793 (1.737)	0.541 (1.390)
s_ESC	0.854 (0.897)	0.778 (0.935)
s_energy efficiency services (other than EPC)	1.086* (0.626)	1.140* (0.637)
s_electricity	0.395 (0.677)	-0.029 (0.674)
s_gas	1.539** (0.764)	1.453* (0.757)
s_heating systems	1.984* (1.016)	2.009* (1.048)
s_appliances	-1.020 (1.173)	-0.684 (1.276)
s_energy control optimization	1.256 (0.860)	2.184** (0.854)
s_facility mgmt	1.096 (1.129)	0.911 (1.135)
s_technical maintenance	0.022 (0.878)	-0.040 (0.889)
s_engineering consulting	-0.362 (0.753)	-0.635 (0.782)
Observations	811	606
Individuals	208	205
log pseudolikelihood	-712.714	-539.290
AIC	1475.429	1124.581
BIC	1592.886	1225.939

Notes: Robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Baseline contract is ESC in column (1) and EPC guar-savings in column (2). Both estimations are performed using 36 integration points. All contextual attributes are interacted with a dummy equating one if the attribute is considered as plausible or rather plausible by the respondent.

6.10 Conditional logit (chap. IV)

Table 52: conditional logit-potential suppliers choice

Dependent variable: consider offering contract *j* (binary variable)	Conditional logit	
	both ESC and EPC proposed	only EPC proposed
Attributes	(1)	(2)
Public demand increases (private unchanged)	-0.508	-0.616
	(0.464)	(0.644)
Private demand increases (public unchanged)	0.119	0.510
	(0.499)	(0.584)
Public x private demands increase	0.292	0.392
	(0.394)	(0.432)
Supply increase	0.658**	0.785**
	(0.270)	(0.391)
Liberalization	-0.376	-0.316
	(0.352)	(0.432)
Taxation system	0.100	0.022
	(0.270)	(0.335)
Contract=shared-savings	-0.423	0.399
	(0.419)	(0.397)
Contract=guaranteed-savings	-0.713	.
	(0.525)	
Contract x already offered	0.556	.
	(0.767)	
Observations	244	138
Individuals	61	46
log pseudo-likelihood	-90.240	-50.536
AIC	184.226	104.493
BIC	215.700	124.984

Notes: Robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Baseline contract is ESC in column (1) and EPC guar-savings in column (2).

6.11 Ordered logit with willingness to enter the EPC market (chap IV)

Table 53: Potential supplier's choice to enter the EPC market

Dependent variable: entering the EPC market (4pts Likert scale)	ordered logit	
Firm's characteristics	(1)	(2)
Familiar with EPC	1.217*	1.121
	(0.654)	(0.696)
s_EPC	.	.
	.	.
s_ESC	1.895*	1.883*
	(1.056)	(1.078)
s_energy efficiency services	0.883	0.561
(other than EPC)	(0.684)	(0.692)
s_electricity	-0.494	-0.672
	(0.811)	(0.836)
s_gas	1.597**	1.469*
	(0.761)	(0.773)
s_heating systems	3.116***	3.480***
	(1.192)	(1.183)
s_appliances	-0.419	-0.351
	(1.080)	(1.172)
s_energy control optimization	2.912***	2.866***
	(1.048)	(1.005)
s_facility mgmt	-0.237	-0.465
	(1.617)	(1.729)
s_technical maintenance	0.146	-0.064
	(0.912)	(0.941)
s_engineering consulting	-0.046	-0.347
	(0.839)	(0.846)
Public direction pressure to increase clients' energy efficiency		1.911***
		(0.721)
Observations (=individuals)	234	220
log pseudo-likelihood	-261.319	-242.140
AIC	552.638	516.281
BIC	604.468	570.579

Notes: Robust standard errors in parentheses. ***P<0.01, **P>0.05, *P<0.1. Dependent variable: Does your firm intend, in the future, to propose energy performance contracting to its clients? 0 (no) 1 (rather no) 2 (maybe) 3 (yes). Replaced by 3 if already active in the EPC market.