Energy Contracting models in Germany and Sweden

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Abstract

There are many energy contracting models being used on the energy service market today. They have different approaches to energy efficiency and they can also work differently on different markets. This thesis looks deeper into a number of energy contracting models and assesses how they function as well as looking into their strengths and weaknesses. Furthermore, these contracting models will be analyzed on the Swedish and German markets, looking into trends, opportunities and threats. The energy contracting models that have been investigated include: Energy Performance Contracting, Energy Supply Contracting, Integrated Energy Contracting, Chauffage and Facility Management. Some of these business models have been used on the market for longer periods of time while others have recently been developed or are starting to gain market shares. The Swedish and German energy service markets are both considered mature. There are however some interesting differences which affect what types of energy contracts are common and how they are used. The different approaches to energy efficiency that the investigated business models present together with the assessment of how they can work on different markets can give insights into the current market situation and how it can develop in the future. There is a constant need to develop both existing and new business models to meet the customer needs. Hopefully, this thesis can serve as a basis for further discussions on introducing new, or developing existing business models on different types of markets.

Keywords

esco, epc, iec, esc, ee, energy efficiency, energy performance contracting, energy supply contracting, integrated energy contracting, chauffage, comfort contracting, fm, facility management

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Foreword

This thesis is part of a Master of Science degree in engineering physics, with an environmental specialization. The thesis has been done at Schneider Electric in Malmö, Sweden, and the Department of Environmental and Energy Systems Studies at Lund University.

I hereby want to thank everyone who has helped and contributed to this thesis. I would especially want to thank my advisers who have put in lots of time and dedication into helping me to realize this project. From Schneider Electric: Mattias Fredriksson and Arne Pedersen; Sami Siltainsuu has also helped out during the startup phase. I know you all have very busy schedules and I really appreciate the time you have put aside for discussions and guidance. Your dedication for the energy service market has been very inspirational. And from Lund University: Christian Stenqvist, your deep knowledge about the Swedish and European energy service markets and your experience with academic research has been very helpful. Your guidance and patience is deeply appreciated.

I also want to thank the people working at Energy Solutions (Schneider Electric) in Malmö, it has been great to get to know you all and our discussions have given important input for this thesis. I will miss you.

An important part of the research for this thesis has been through interviews, I thereby want to thank all the people who have put aside time for these interviews. I am very glad I got the chance to meet you and the knowledge you have shared has been invaluable.

Working with this master thesis has given me great insights into the energy service markets of several countries. It has been very interesting to learn more about energy efficiency and energy contracting and a privilege to meet so many competent people. I am certain that I will have great use of this new knowledge in my future career.

David Wargert, Lund 2011-10-05

Executive Summary

There are a number of energy contracting models being offered on the market today. ESCOs and energy companies are providing comprehensive energy services at an increasing rate. In this thesis a number of energy contracting models have been assessed and their use on the Swedish and German markets has been investigated.

There is a constant need to develop both existing and new business models in order to provide the best service offerings for the customers. In order to develop the business models it is important to have an understanding of different approaches to energy efficiency and how these approaches can function on a market. Hopefully, this thesis can provide the reader with new perspectives on energy contracting and an understanding to how the they can function on different markets.

Business models

Energy Performance Contracting (EPC) is a performance based business model. This means that the ESCO will be remunerated based on the energy savings generated through the EPC project. The cost savings from the *energy efficiency (EE)* measures will help finance the project. Characteristic of EPC is that the ESCO will guarantee a minimum savings level that they are then responsible in reaching. An energy baseline (energy usage before project) is set up before the project implementation. The energy usage after the project implementation is then compared to the baseline to determine the level of reached energy savings.

There are two common forms of EPC, *guaranteed savings* and *shared savings*. With the guaranteed savings model, the customer will finance the project (either through own funds or through loans) and the ESCO will in return guarantee a minimum energy savings level (percentage). Savings exceeding the guaranteed level will be split between the ESCO and customer.

With shared savings the ESCO finances the project and the savings are then split between the customer and ESCO according to a predetermined split.

EPC is well suited for large scale projects, especially in the public sector. The savings guarantee helps make EPC a “safe” investment, this is especially attractive in the public sector. EPC projects typically generate 20-30% energy savings and the contract times are generally around 10-15 years. The EE measures are generally directed at demand side measures but supply side measures (such as setting up efficient heat boilers) can also be incorporated.

EPC is a complex contract form that is not suited for smaller projects because of the high transaction costs. Procurement in the public sector can be complex. The long payback times that are generally associated with EPC can make it less attractive for the private sector. Setting up an energy baseline can be hard and the measurement and verification process needed to follow up on the project results can be costly.

Energy Supply Contracting (ESC) ensures delivery of *useful energy*. Useful energy refers to the energy that the customer has “practical” use for, such as: heat, cooling, steam, compressed air etc (as opposed to energy carriers such as oil, biomass fuels etc). The ESCO will take on

responsibility for everything needed to deliver the useful energy to the customer. For example, in the case of heating, this includes planning and installment of heat boilers, energy distribution, operation and maintenance of the production facilities, procurement of fuel etc.

ESC is generally oriented towards *decentralized* (local) power supply rather than larger *centralized* solutions. However, the ESC model can be used to build up district heating systems as well.

In most cases, ESC is investment free for the customer and the contracts typically run for 10-15 years. Energy efficiency measures are taken on the supply side to ensure lower cost of operation. Energy savings are typically around 10-20%. The biggest weakness of ESC is that all the efficiency measures stay on the supply side, there are no incentives to lower the demand side consumption.

Chauffage, also referred to as *comfort contracting*, is a contract form that revolves around providing a *function*. The function can be related to temperature, lighting level, air quality etc. Some examples can be: keeping a room at 21 degrees or keeping a work area at 500 lumen. The most common function is to provide a certain (or relative) temperature in a facility, "conditioned space". Firstly, the current cost baseline will be set up, looking at what the customer is paying prior to the contract to provide the function (for example, energy costs, service and maintenance of the technical facilities etc.). The ESCO will then deduct an amount from what the customer is paying prior to the contract and offer the customer a fixed price that is lower than the current costs. For example, if the customer is paying €10.15 per square meter and year to keep a space conditioned at a certain temperature, the ESCO might offer the customer a fixed fee of €10. The ESCO will be responsible for everything needed to provide the function, this can include setting up heat boilers/coolers, procurement of fuel, operation, service and maintenance of production facilities as well as customer side technical installations. To lower the cost of operation and maximize their earnings the ESCO will optimize and implement energy efficiency measures. Contract lengths can vary, from a couple of years up to 25 years. The longer the contract time, the more long-term investments the ESCO can make in the facilities. The chauffage model incorporates energy efficiency measures on both the supply side and the demand side, making it an "*integrated"* model.

Compared to EPC, chauffage contracts are generally less complex with lower transaction costs and without the same need for costly measurement and verification. On the other hand, EPC contracts may have more comprehensive demand side EE measures reaching a wider range of areas and may be better suited for larger building pools. The chauffage model works especially well in the commercial buildings sector.

Integrated Energy Contracting (IEC) is a newly developed business model that combines elements from both ESC and EPC. The aim of IEC is to create an *integrated* model that involves both supply side and demand side EE measures. The model tries to solve some of the problems with EPC and ESC; EPC being overly complex and expensive for many projects and ESC being completely supply side oriented. The model can be said to extend the ESC model by including demand side measures. The creators of IEC also stresses the importance of making demand side EE measures before moving on to supply side measures.

To solve some of the problems with EPC, the costly measurement and verification and baseline setting processes have been replaced by the use of *quality assurance instruments (QAI)*. The QAI aims to secure the *function* of the EE measures rather than *quantifying* the actual energy savings (as is done with EPC). To do this, simpler (cheaper) tools are used. For example, instead of measuring energy savings, calculations can be made to calculate expected savings, so called *deemed savings*. Other examples can be to use thermal cameras to ensure the function of insulation improvements etc. The specific QAI used will have to be tailored for the individual project. Some measurements can be done to assure the functionality, but not as comprehensive as with EPC.

Facility Management (FM) is by itself not an energy service. It is instead a way of managing facilities by incorporating various facility related services into an integrated solution. FM works with a wide area of services such as: catering, security, cleaning, mailroom etc. FM companies can also choose to incorporate energy related services into their offerings. Exactly how this is incorporated can vary between different companies and different contracts. Many FM companies have chosen to incorporate an EPC model where they will guarantee energy savings.

Sweden

The energy service market in Sweden has grown significantly during the last ten years. The development has been lead by building and control manufacturers up until recently. During the last few years, several energy companies (especially municipal) have started to provide energy services as well and this is a growing trend.

Sweden has a large share of district heating which affects what types of energy services are being offered. District heating reaches around 50% of all buildings, 82% of residential apartments and 68% for office space, commercial premises and public buildings (Energimyndigheten 2010).

Since most larger buildings use district heating, the use of *ESC* is very sparse and the awareness about the model is low. The biggest sector for ESC is the industrial sector. There are some new ESC companies that are trying to compete with district heating in the residential sector in areas where district heating is expensive.

EPC has been used successfully for the past ten years and seen a significant growth in the past five years. The vast use of district heating also affects the type of *EPC* projects being carried out. Projects are usually concentrated to demand side measures since there is seldom any need for supply side measures (covered by district heating). Projects that incorporate supply side measures do exist but are mostly concentrated to the cases where customers have oil heat boilers that need conversion. Typical for the Swedish EPC market is that the ESCO does not take on service and maintenance in their EPC projects, this includes the cases where supply facilities are installed. Outsourcing of the service & maintenance organization has so far not been a driver for EPC.

Guaranteed savings is the standard EPC model being used. The vast majority of EPC contracts are done in the public sector and customers in this sector generally have good economy and can get more beneficial financing on their own than any ESCO can provide. Therefore, ESCO aided financing is not a driver on the Swedish market.

The Swedish EPC market is maturing, customers have a higher awareness about the model today compared to just a few years ago. This shows in the way that projects are procured where the procurement process is becoming more standardized.

IEC is a business model that can be said to expand the ESC model to include demand side measures. Because of the lack of ESC projects in Sweden, IEC will probably not be as suited for the Swedish market compared to the German market. Some aspects of IEC, such as QAI, could very well be used when developing energy services that include demand side measures.

Chauffage, or *Comfort contracting* as it is referred to in Sweden is a growing business model. It is mainly used by some municipal energy companies. Municipal companies can, by law, only operate in its own municipality which has limited the growth of the model. There is however a growing interest in using this model, especially amongst municipal companies. The services usually include outsourcing of the service and maintenance organization. The outsourcing service is a growing trend and a driver for the model. The growing use of chauffage brings competition to other business models.

There is a growing interest from the customer side to include energy services into *FM*, for example using an EPC model. So far the results have not been overly positive, many customers have been disappointed with the results. Several of the FM companies providing energy services are new to this field and may need to change the way they approach it. There is an increasing cooperation between FM companies and ESCOs, this development will likely continue.

Germany

Germany is considered as one of the most mature energy service markets in Europe. Energy services started to emerge in the early 90s and have since grown. Compared to Sweden, energy agencies play a larger role in the procurement of energy contracts. The energy contracts are generally more standardized as well. District heating is not as widely used as in Sweden, covering about 14% of occupied accommodations (ecoheat4.eu). Instead, *ESC* plays a larger role in providing heating for buildings.

About 85% of all energy contracts in Germany are ESC . Most ESC contracts are done in the public sector followed by the private residential sector and then hospitals. The vast majority of ESC contracts are done investment free for the customer. ESC is a well established contract form in Germany and will continue to play a big role in the future. It is likely that ESC will meet some competition from integrated business models in the future that incorporate demand side energy efficiency measures as well.

EPC has been used on the market since the early 90s and has about 10% of the energy contracting market today. In 1995 the Berliner Energiagentur GmbH (BEA) started their Energy Saving Partnership (ESP) which triggered a growth on the market. Both s*hared savings* and *guaranteed savings* are used on the German market. However, the shared savings model is the most used, not least in the ESP projects. One driver for using shared savings is that municipalities often need help with financing and therefore prefers this model where the ESCO takes on the financing responsibility.

The outsourcing of the service and maintenance organization to the ESCO in EPC projects is more common in Germany than in Sweden. Even if it is not always done, it is expected of the ESCO to be able to provide this service. The lower use of district heating raises the need to involve supply side measures in the EPC projects, this is done in most cases.

EPC is a complex contract form and it is likely that there will be growing competition from simpler models in the future.

IEC is a business model that is tailored for German (and Austrian) market conditions. IEC tries to expand the ESC model to include demand side measures and with the vast use of ESC on the market, IEC could work very well. There is a clear need to extend energy efficiency to the demand side (ESC being completely supply side oriented) and EPC can be too complex for many projects. There is also a growing need for ESCOs to provide renewable energy as part of a package. IEC could very well be a solution to this. However, IEC is a newly developed model and it has not yet seen a wider use on the market.

The *Chauffage* model is not common in Germany. There are other models being developed that resemble it which can indicate that there is interest for this type of model. Chauffage could potentially provide a less complex solution compared to EPC that would benefit some customers. If the trend would follow that of Sweden, maybe chauffage could be an interesting model for energy companies (especially district heating) that want to extend their energy services to the demand side.

There is a growing interest for *FM* integrated energy services, often using an EPC model. In some instances it has been easier for ESCOs to acquire an EPC contract if they cooperate or merge with an existing FM company. As in Sweden, some of the early attempts to include EPC have not turned out as successful as expected. But with the raising interest in providing energy efficiency together with FM there will likely be a growth in the market.

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Terminology

BEA	Berliner Energieagentur
CHP	Combined heat and power
EE	Energy Efficiency
EES	Energy Efficiency Services
EPC	Energy Performance Contract
ESC	Energy Supply Contract
ESCO	Energy Service Company
ESD	(EU) Energy Service Directive
ESP	Energy Saving Partnership (Berliner Energieagentur)
FM	Facility Management
IEC	Integrated Energy Contracting
IS	Integrated Solutions
M&V	Measurement and Verification
QAI	Quality Assurance Instruments
TPF	Third party financing

1 Introduction

In a world of diminishing resources, growing population and demand, increasing concern about global warming and economic decline, it is clear that we need to use our resources more efficiently. This, of course includes our energy usage. Energy efficiency is becoming more and more recognized as one of the most important components in creating an economically and environmentally sustainable future.

Looking towards 2030, energy efficiency measures are expected to provide over 50% of the needed CO_2 emission reductions (World Energy Outlook 2009). Not only can energy efficiency measures mitigate greenhouse gas (GHG) emissions, but also do it in a way that is profitable from an economical standpoint. Studies have shown that many of the measures needed to mitigate GHG will actually have *negative* costs (McKinsey, Vattenfall 2009). Most of these (negative cost) mitigation measures have in common that they raise the energy efficiency. Furthermore, increasing energy efficiency is by far the most cost effective way of raising the security of energy supply, improving industrial profitability and raising competitiveness (Hansen 2006).

Companies have over the years incorporated energy efficiency measures into working business models. These business models have over the years proven themselves to be viable on the markets on which they operate. Some of these models have been used in different shapes for over one hundred years (Hansen 2006). Today, the *energy service* market is seeing a rapid growth in many countries, not least in the EU.

The business models, or *energy contracts*, can be of different forms and address different areas. Some are oriented towards increasing efficiency and reliability on the supply side (such as heat boilers) whilst others aim to lower consumption and increase comfort on the demand side (buildings). Others combine measures on the supply and demand side into an *integrated solution*.

This thesis will assess a number of important energy contract forms that represent different approaches to energy efficiency on the market today. It will also assess how these business models work on the Swedish and German market.

1.1 Aim

The aim of this thesis is to assess a number of energy contract forms and look into the trends and opportunities of these contract forms in the Swedish and German energy service market.

The business models have been chosen because they represent different approaches to energy efficiency and can therefore give interesting perspectives to the energy service market.

Several of the energy contract forms that were chosen are related to *integrated solutions*. In this thesis *integrated solutions* is defined as energy contracts that include energy efficiency measures on both the demand side and the supply side. In other words, contract forms that aim to lower the end-use consumption of energy in buildings as well as raising the efficiency on the supply side, such as in heat boilers.

The contract forms that have been investigated are: Energy Performance Contracting (EPC), Energy Supply Contracting (ESC), Integrated Energy Contracting (IEC), Chauffage and

Facility Management (FM). Of these, ESC is purely supply side oriented and EPC can be either integrated or demand side oriented; FM is by itself not an energy service but can contain these services.

Trends and opportunities of the listed business models have been investigated in the Swedish and German market to give a sense of the current trends and how the market can evolve.

The target audience for this thesis is people working in the energy service market (such as ESCOs, energy agencies, utilities etc). Many people working with energy services are often used to working with certain business models or on a certain market. The hope is that this thesis can introduce the reader to new business models and an understanding of how they can function on different markets. Hopefully, this can widen the perspective of the energy service market and lay grounds to discussions on developing new business models or reaching new markets.

To conclude: How do the selected energy contract forms work? What are their strengths and weaknesses? Finally, what are the trends and opportunities for these contract forms on the Swedish and the German markets?

1.2 Boundaries

The boundaries for this master thesis have been set to study the business models that have been identified as important for the aim of this thesis. The business models are Energy Performance Contracting (EPC), Energy Supply Contracting (ESC), Integrated Energy Contracting (IEC), Chauffage and Facility Management (FM). Since FM is not an energy service by itself the focus has been on the energy related parts that can be integrated into the service.

The term *integrated solutions* is in this thesis defined as: energy contracts that include energy efficiency measures on both the demand side and the supply side.

In the assessment of the business models, the aim has been to describe them in a general term in the ways that they generally appear on the selected markets.

The selected markets are the Swedish and German energy service markets. The two markets are diverse in some interesting ways and can give interesting perspectives on how trends can evolve due to the different market situations.

Definitions used for an *energy service* in this thesis can be concluded by: an energy related service that results in a raise in energy efficiency (for a more detailed definition, see the *Energy service* section).

Definitions of energy services and contracts vary from person to person and market to market. Therefore, the definitions used in this thesis can by no means be seen as universally accepted definitions. As far as possible the definitions have been set to be as generally accepted as possible but the reader is still encouraged to keep this in mind and also study other literature and sources.

The German and Swedish market will first be described in general terms, looking into the current market situation and background, and then the energy contract forms will be assessed in a country-specific manner. The market assessment will focus on the trends and opportunities of the selected business models.

1.3 Method

The research behind this master thesis has comprised of three elements, literature studies interviews and discussions with people who work in the field of energy services.

The business models have been analyzed with a SWOT model (Strength, Weaknesses, Opportunities, Threats). *Strength* and *Weaknesses* refer to *internal* factors and *Opportunities* and *Threats* section deal with *external* factors. The *internal* factors can be seen as the business models themselves and the *external* factors are the markets on which they operate. Therefore, *Strength* and *Weaknesses* will be discussed in the *business models* section (section 3) and *Opportunities* and *Threats* in the *market* specific section (section 4).

There have been difficulties with comparing numbers between the different markets when it comes to availabilities of certain energy services. Numbers are more or less limited to a select few studies on the area. The numbers can change very quickly so studies can become out of date very quickly. Then there is the case where certain energy services are common in one country but not the other, so no studies might have been made to find out the frequency of a certain energy contract form in one country. Therefore it has been difficult to collect and compare specific numbers between the countries.

1.3.1 Background to subject

The goal from the beginning was to investigate "*Integrated Energy Contracting*" as a business model. Not much is written about this concept and the sources are more or less limited to the work carried out within the "IEA DSM Task XVI" (a multi-national project to contribute to market development of energy services) driven by Jan Bleyl at Grazer Energieagentur. Much of the research for the thesis was therefore aimed at what can be said to be the two different sides of Integrated Energy Contracting, namely Energy Performance Contracting (demand side efficiency; can also be *integrated*) and Energy Supply Contracting (supply side efficiency).

However, much of the research as well as the discussions and interviews that were carried out, did not lead to an in-depth knowledge of the IEC concept but instead more towards a general understanding of the underlying energy services markets. And the areas where further development of the IEC business model could be done were considered either as too limited or based on data which would be very hard to find.

Because of this, the aim for the master thesis was shifted from just looking at IEC to instead looking at a wider range of energy contract forms and the trends and opportunities for these contract forms. The contract forms (EPC, ESC, IEC, Chauffage, FM) were first chosen because of their relevance to the concept of *integrated solutions* or as with ESC (not an integrated solutions) because of its importance on the (German) market and its importance for discussing and understanding the other contract forms. But they also represent different approaches to energy efficiency that are very relevant on the market and create an interesting base for further discussion and development. This latter notion has become more important as the subject has developed.

Studies were carried out in Sweden, Germany and Austria. Austria was then later abandoned from the thesis since it didn't really add that much to the thesis since the Austrian market is rather similar to the German, at least in comparison to the systematic differences between the Swedish and German/Austrian market.

Another reason was also that more knowledge was available and gathered about the German market.

1.3.2 Literature

Literature studies have been a central part of the research for this thesis. Various forms of literature has been used, governmental and NGO reports, conference papers, dissertations, books etc. The most important literature has been: S. Hansen: Performance Contracting, 2006; S. Hansen: ESCOs around the world, 2009; J. Bleyl-Androschin: Integrated Energy Contracting, 2009; Energimyndigheten: Analys av den svenska marknaden för energitjänster, 2011; Grontmij, K. Sernhed, J. Jeppesen: Från bulkleverantör till energipartner, 2009; Bergmasth, Strid: Energitjänster på en avreglerad marknad, 2004.

Literature studies of Germany have not been as thorough as with Sweden due to language barriers, especially because of the very technical language used in the literature. Therefore, most of the literature used about Germany has been what is available in English, although some German sources have also been used.

1.3.3 Interviews

Information gathered through interviews has been a very important source of information for this thesis. Interviews have been done face-to-face and over telephone. The interviews have been heavily adapted towards the interview subjects so there has not been a predetermined interview template used for all the interviews. When interviewing or talking to people from different companies much effort has been made to find out how they carry out their business models, what their view is on the market situation, competition, trends etc.

Interviews have been done with Swedish companies involved with energy services as well as an interview tour in Germany and Austria where several energy experts were interviewed.

Companies interviewed have been: Jonas Häggqvist (CEO) at *Eco2 Energy* (ESC) and Mats Mårtensson (manager of energy services) at *Göteborg Energi* (mainly chauffage). Several other companies were contacted but did not want to participate for different reasons.

The interviews carried out in Germany and Austria were done with the following people:
Christian Tögel, *NRW Energiagentur* (Germany)
Manuela Halbekath, *ASEW* (Germany)
Jan Bleyl, Grazer *Energieagentur* (Austria)
Christian Mayer, *Schneider Electric* (Austria)

These people have been working with energy services for many years and have very good knowledge about the markets. At the time of these interviews (Germany/Austria), the aim of the master thesis was still IEC and therefore the questions asked were a bit different from the ones that might otherwise have been asked. These interviews were done together with two trainees at Schneider Electric who were doing a market study of Germany and Austria. The information they gathered during our interviews as well as in their final reports has been very important input for this thesis as well. Some follow up questions to the interviewees have been done by e-mail. A person that we didn't manage to meet up with but has contributed with some important input (over e-mail) to this thesis is Prof. Dr. Wolfgang Irrek, *Hochschule Ruhr West* (Germany).

Information gathered from *interviews* and *discussions* will not be referenced with the name of the source in the running text, references will rather be stated as "according to an interviewee...", "comments from…" etc. The author of this thesis does not want to use quotations and direct references that the sources have not been able to verify (which has been difficult to practically achieve). Especially considering that there have been some language difficulties involved which could have lead to misunderstandings. Some information can also be compromising for the source.

In the business models section (section 3) there is much general information collected through the interviews. If there are no literature references linked to certain sections, these sections have used interviews as the source. This is especially the case in the *Chauffage* and *ESC* sections where there is not much literature available.

1.3.4 Discussions

Discussions with people who work in the energy service market have been an important source of information gathering. As the thesis was done at Schneider Electric (Energy Solutions) in Malmö, much of the discussions have been carried out with internal people at Schneider, especially when it comes to EPC. External people have been involved by visiting energy conferences, such as Energitinget 2011 (2-day national energy conference in Stockholm) and Skånes Energiting (1-day regional energy conference in south Sweden). Comments have also been gathered through email and telephone calls.

At the conferences, discussions have been carried out with people that work with or in connection to energy services. The purpose has been to get comments on business models, market situation and to find contacts with a deeper knowledge of the subject. Participation in lectures at the energy conferences has also given good input.

Representatives from companies that have given input come from (amongst others): Grontmij, Lunds Energi, Vattenfall, Eon, Bengt Dahlgren, Mälarenergi, Energy piano, ebab and Tällberg Foundation.

1.3.5 Structure

Section 2 –energy services and definitions.

Section 3 –the assessment of the researched business models. First EPC and ESC will be discussed followed by the *integrated* models. These sections can be read independently of the other sections.

Section 4 –country specific assessments. It is advised to have read through section 3 first since much discussion will be based on this information. If the reader feels comfortable with their understanding of the business models, this section can be read independently. The business model specific sections can be read independently from one and other, but it is advised that all are read. Some information that can be relevant to several business models will be mentioned where it is the most relevant.

2 Energy Services

The concept of energy services is a very wide concept with a scope without any clear borders. A generally accepted definition, and one that will be used in this report, is described here.

A short explanation is that: *an Energy Service describes an energy related service that improves energy efficiency*. Energy services can be of simpler forms, such as invoicing services with energy statistics, or of a more comprehensive character. The more comprehensive energy services usually reside within a contract and are referred to as *energy contracting*. An important aspect of an energy contract is that the service provider (ESCO) will take on economical risk from the customer. This thesis will focus on a few selected energy contracts but energy services will also be discussed in more general terms.

The energy efficiency aspect can be a direct explicit goal or it can be an indirect effect of an energy contract. A good example of the former is the *Energy Performance Contract* (see the EPC-section) which directly aims at lowering the energy consumption on the demand side; and of the latter: *Energy Supply Contracting* (see the ESC-section) where the efficiency aspect often comes into play indirectly as a means of optimizing the operation and economics of the service on the supply side.

Instead of focusing on selling a unit of energy, such as oil or electricity, an energy service tends to focus on the useful energy, such as heat, cooling, steam, compressed air, or at the concept, or function, of providing a facility with the right temperature or lighting level etc. at a lower price (Bleyl-Androschin, 2009(a)). For example, by implementing energy efficiency (EE) measures in a facility the cost of keeping the facility at a certain temperature can be lowered. Another important point can be to raise the security of operation, air-quality, comfort level etc.

The EU directive on energy end-use efficiency and energy services (2006/32/EC) describes energy services as:

> "The physical benefit, utility or good derived from a combination of energy with energy efficient technology and/or with action, which may include the operations, maintenance and control necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances has proven to lead to verifiable and measurable or estimable energy efficiency improvement and/or primary energy savings"

There is also a European standard created for *energy efficiency services (EES)*, EN 15900. In this thesis, *energy efficiency services* and *energy services* will refer to the same thing. The definition given by the ESD (2006/32/EC) for an energy service is basically the same as given for an energy efficiency service in EN 15900 (Duplessis, 2010)

The ESD and EN 15900 conclude that an *energy efficiency* improvement will result in an "increase in energy efficiency as a result of technological, behavioural, and/or economic changes". EN 15900 also gives some examples on EES: (Duplessis, 2010)

- "the intrinsic performance of buildings or equipments: building insulation, high efficient boilers, variable speed motors, energy efficient lighting, etc."

- “the operation and maintenance of installations : more efficient operation (building automation, logistic and layout optimization), improved maintenance, continuous optimization of technical installations operation “
- “the monitoring of the energy system: implementation of an energy management system”
- “the users behavior : training, awareness raising campaigns on energy efficiency opportunities.“

Figure 2.1 shows a value chain of some energy services ranging from simpler to more advanced services. The energy services can have a different scope from project to project so the position of the energy services on the value chain can be different in reality.

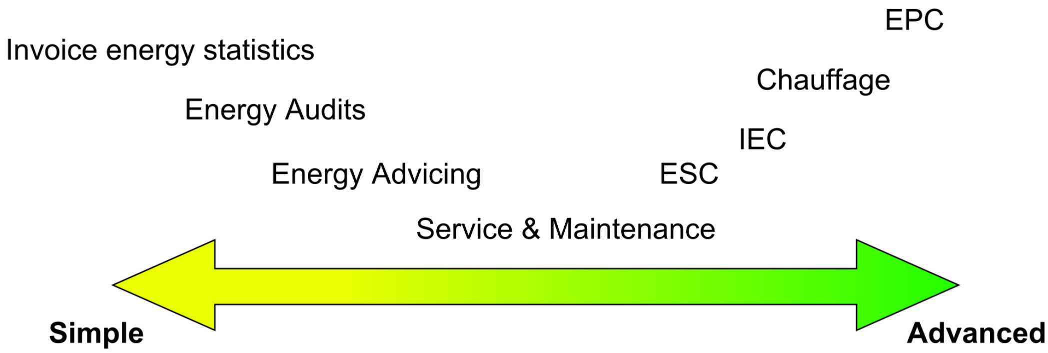

Figure 2.1. Value chain of energy services.

Looking at the more advanced energy services you will find some of the energy contract models that will be assessed in this thesis. The more advanced energy contracts bundles a number of energy efficiency measures into one package.

Grazer Energieagentur describes energy contracting as (Bleyl-Androschin, 2009(a)):

> “A comprehensive energy service concept to execute energy efficiency projects in buildings or production facilities according to minimized project cycle cost.”

There are a number of different contract forms in use on the market. In this thesis Energy Performance Contracting (EPC), Energy Supply Contracting (ESC), Integrated Energy Contracting (IEC), Chauffage and Facility Management (FM) are assessed.

Figure 2.2 shows a value chain of energy. To the left is the primary energy (such as crude oil etc) and to the right are the energy contracts which handle useful energy and energy savings. In reality the borders are not as clear but the figure illustrates areas where energy contracts might operate.

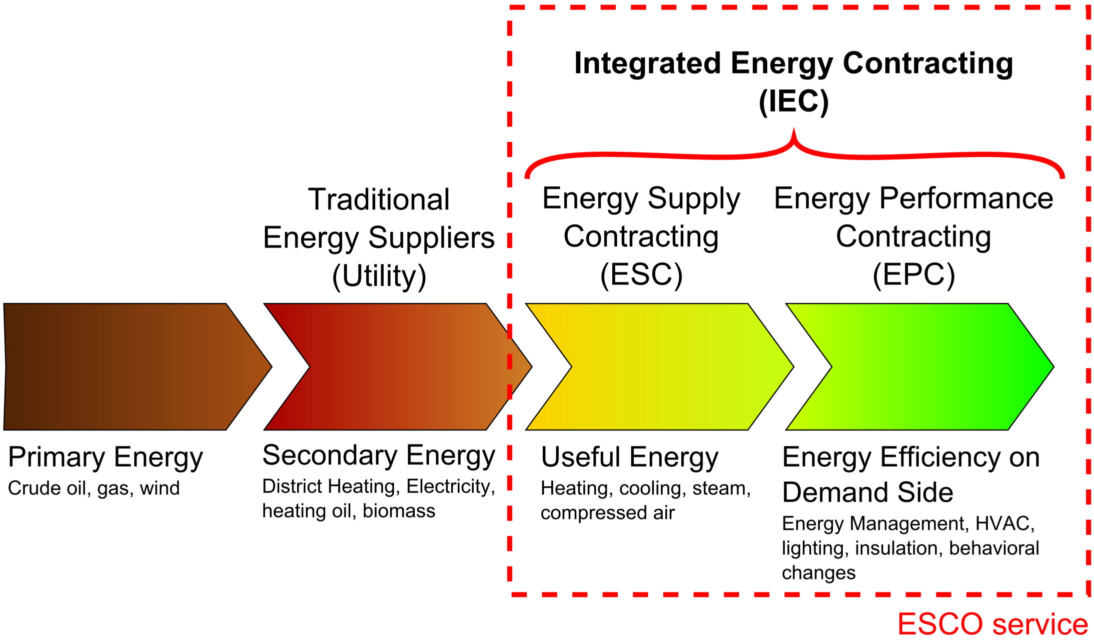

Figure 2.2, the energy value chain (Bleyl-Androschin, 2009(b))

2.1 ESCO

ESCO, or Energy Service Company, describes the company that delivers the energy service. An ESCO collects important resources in areas like: know-how, technology, energy, money, legislation etc (Bleyl-Androshin, 2009(a)), see *figure 2.3*. These resources are integrated into the services that the ESCO provides. An important role of the ESCO is that it takes on some risk from the customer. This is also described in the ESD (2006/32/EC) where an ESCO is defined as:

> "energy service company" (ESCO): an energy services provider that accepts some degree of financial risk in providing energy services, so that the payment for the services delivered is based wholly or in part on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria;

The service that the ESCO provides can be of different character. Some ESCOs are specialized within a certain field and have the competence and resources to carry out a certain type of project. A common scenario is that an ESCO either works on the supply side or the demand side. Supplying energy usually means selling *MWh* whilst saving energy on the demand side means selling *NWh*. NWh is a term that means *"Nega-Watt-hours"* and is used to try and illustrate and concretize the actual energy savings.

ESCOs often have a modular approach as to what services are delivered in a project. The "modularity" means that the ESCO can incorporate different kinds of services to tailor the project to meet the customer needs. For example, a customer who can finance the projects themselves will not need help with financing from the ESCO. Another example could be if the customer already has competent service personnel in their facilities, then it might be better to let them carry out a potential service and maintenance part of the contract instead of outsourcing this to the ESCO. (Bleyl-Androschin, 2009(a))

Figure 2.3. The properties of an ESCO (Bleyl-Androschin, 2009(a))

The ESCO can be a company that is focused just on energy services or it can be a company that also has other business fields. For example, many of the larger demand side driven ESCOs have started out as building controls, automation or control manufacturer companies and have then moved into selling energy services (eg. TAC/Schneider Electric, Siemens) (Lindgren Nilsson 2009). Many utilities have also added energy services to their existing service offerings.

In this thesis energy companies (utilities) which provide energy contracting will be discussed separately from ESCOs in order to clarify who is providing the services and how the services have evolved on the market.

2.2 Energy contracting in retrospect

The idea behind energy services is by no means new. The concept of energy contracting dates back hundreds of years.

> "We will leave a steam engine free of charge to you. We will install these and will take over the customer service for five years. We guarantee you that the coal for the machine costs less, than you must spend at present at fodder (energy) on the horses, which do the same work. And everything that we require of you, is that you give us a third of the money, which you save." [James Watt, 1736-1819] (Bleyl-Androschin, 2009(a))

Over a hundred years ago, Compagnie Générale de Chauffe, a French company started to offer energy contracting with focus on district heating efficiencies. This was the start of the "*Chauffage"* model (see the Chauffage section). During this time the measures were based on the supply side. Later, Royal Dutch Shell exported the ideas of this model to the UK and USA. The idea was developed to work on the demand side and the company would provide the customer conditioned space for 90% of their current cost. From this, the *shared savings* model was then developed, where the ESCO and the customer would share the cost savings from the energy efficiency measures. This concept was later to be known as Energy Performance Contracting (EPC). (Hansen 2006; Hansen 2009)

The oil crisis in 1973 raised the awareness of the importance of economizing the energy usage. It was during this time that different energy services really started to make an appearance in the US and the "modern" forms of energy services is often attributed to have been developed from here. Some energy services were introduced through the Demand Side Management program (DSM) where energy companies would engage in energy efficiency measures on the customer side (demand side). The measures would often include awareness-raising and beneficial loans to invest in energy efficient technology. (Bergmasth, Strid, 2004)

In the early 1980s the energy prices suddenly, and unexpectedly, dropped. This lowered the interest in energy services from the customers and many service providers. The utilities involved in the DSM program would lose money on their services (Bergmasth, Strid, 2004); and the ESCOs providing EPC with shared savings couldn't cover their investments when the payback times got longer (due to the lower remuneration from cost savings because of the lower energy price) than the contract time. Many ESCOs went bankrupt. However, the ESCOs that had given a savings guarantee often made good on those guarantees. From this realization, the EPC model developed, out came the *guaranteed savings* model where the customer would take on the financing of the project instead of the ESCO, and the ESCO would guarantee the savings in return. In the US, the guaranteed savings model has been the main form of EPC used since then. In Europe the shared savings is still common. (Hansen, 2006; Hansen, 2009) Shared and guaranteed savings will be discussed more in-depth in the EPC-section.

During the last fifteen years the interest in energy efficiency has increased. Energy prices have risen; worries about climate change have grown; worries about the security of energy supply is growing due to political worries and diminishing supplies of oil and gas. Many governments, especially in the EU, are actively working to promote energy services as a means of raising energy efficiency in order to mitigate climate change and raising the security of energy supply. Many energy contracting forms have also proven themselves as profitable business models on the market. Looking at the EU, the future for energy services is looking bright as the awareness of the energy efficiency and its economical and environmental benefits are spreading amongst policy makers, customers and service providers alike.

3 Assessment of Business models

3.1 Energy Performance Contracting

Energy Performance Contracting, EPC, is a widely recognized energy contracting model. It is a contract form that is especially useful for large scale projects. EPC is a turnkey solution and the ESCO provides a comprehensive set of energy efficiency measures. EPC projects typically generate energy savings in the range of 20-30% (sometimes up to 50%).

What defines an EPC contract is that it is performance based; the results are measured against a predetermined *baseline* (energy usage before the project implementation). This means that the energy usage after the project phase can be compared to the energy usage before the project implementation in a clear way. And the remuneration for the ESCO is based on the performance of the project.

The costs for the EPC project are financed by the energy savings it generates. So projects are basically self-funded. The initial investment can either be financed by the ESCO, customer or by a third party.

Typical measures include: more efficient building controls and automation (such as demand controlled lighting and ventilation), energy management systems, service and optimization of technical facilities, behavioral changes etc.

3.1.1 Customer motivation for EPC projects

There can be many reasons why a customer chooses an EPC-project. Below are some of the most common reasons (Energimyndigheten 2006)

- To save money/energy
- Refurbish old facilities
- Improve comfort, heating/cooling, ventilation, lighting
- Improve neglected maintenance
- Improve long-term competitiveness

3.1.2 Large scale projects

EPC is suited for large scale projects where a number of buildings are involved. Instead of looking at buildings one and one, they are often grouped into pools. Comprehensive energy efficiency measures would not be economically profitable for many building if they were looked at individually. By grouping buildings into pools the transaction costs for the individual buildings are lowered and buildings which have a greater potential for energy savings can compensate for those with less.

This way of thinking is also applied to the efficiency measures themselves. There are some measures that are easy and cheap to implement and generate large savings. These measures have a short payback time. One example can be optimizing existing installations.

Then there are other measures that can be more costly and have a much longer payback time. Examples of the latter can be building shell refurbishments, such as insulation improvements or new windows.

If EE measures are looked at one by one it can often result in only the most profitable measures being carried out (often referred to as "cherry picking", "cream skimming", "picking low hanging fruits"). If instead the measures are bundled together the ones with shorter payback time can help finance the ones with longer payback time, creating a more comprehensive set of measures. How many of the longer-termed investments are included in an EPC project varies from project to project. It can depend on how much money can be invested into the project (because of budgetary reasons or simply to be able cover the expenses etc.), how long payback times are accepted, how much risk is accepted etc.

3.1.3 Risk guarantees

One of the most important aspects of EPC is the risk guarantees that are incorporated into the projects. In an EPC project the ESCO takes on the *performance risk*. This means that the ESCO is responsible that the EPC project reaches the agreed energy savings level. The remuneration to the ESCO is based on the performance of the project.

Then there is also the *financial risk*. The party who takes on the financing of the project also takes on the financial risk. The investment needs to give return and if loans are taken they need to be paid back to the financial institution.

There are two predominant contract forms in use, *guaranteed savings* and *shared savings*. They will be described more in-depth.

3.1.3.1 Shared Savings

In the shared savings model the *ESCO finances* the EPC-project. The investment has to cover the costs of all the technical equipment, working hours (project development, documentation, customer-side optimizations etc.) and other relevant costs. The generated energy cost savings from the EE measures are then split between the ESCO and the customer according to a predetermined share. The model usually includes a savings guarantee. Shared savings can also be used in other forms of energy contracting, but savings guarantees are less common in those cases.

The savings guarantee is set at a level so that the payback from the energy savings during the contract period will cover the investment costs, including the cost of risk, and also profit for both customer and ESCO. If a savings guarantee is given, the ESCO is responsible towards the customer to reach this. If the guaranteed savings is not reached the ESCO will have to economically compensate the customer.

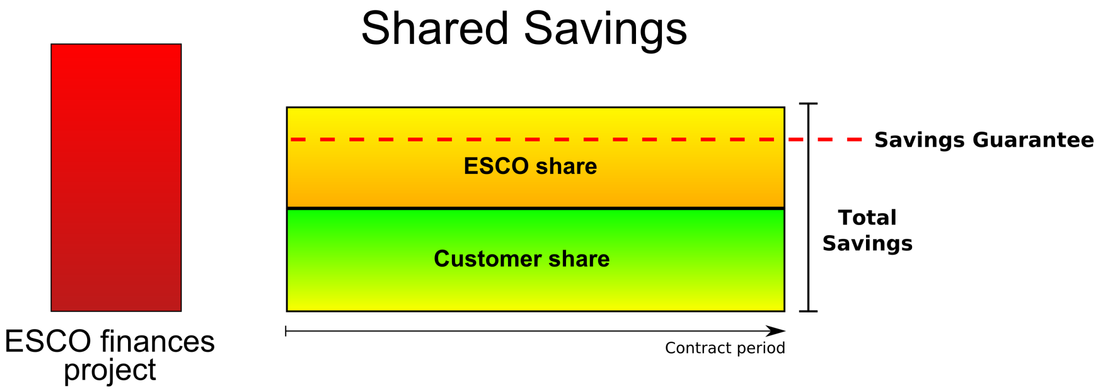

Figure 3.1.1. Overview of shared savings.

A problem with shared savings comes from the fact that the ESCO has to take on both the *performance risk* and the *financial risk*. Since this makes the risks higher the ESCO has to play it a bit more "safe" when implementing the project. Often, the ESCO will concentrate a bit more on the safe solutions which have shorter payback times. This can have the effect that the project might not be as comprehensive compared to using guaranteed savings. Shared savings projects more often tend to pick the "low-hanging-fruit".

Another important risk to take into consideration is the fact that a (private sector) customer could go bankrupt. In that case the energy savings will effectively stop paying back and will result in a loss for the ESCO.

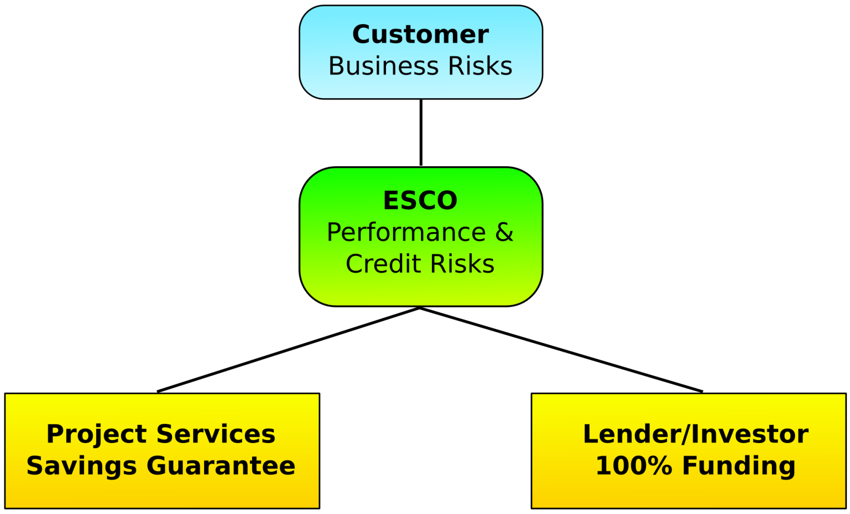

Figure 3.1.2. Cash flow and risk responsibilities, shared savings. (JRC EPC)

The shared savings model requires very financially strong ESCOs. EPC projects are generally large by nature so the initial investment can be high. If an ESCO commits to several EPC projects they will become highly leveraged before the projects have paid back, which typically can take 5-12 years. This can mean that the ESCOs in some cases are too highly leveraged to get new bank loans which means they can't take on further projects. It also makes it harder for smaller ESCOs to establish themselves on the market. (JRC EPC)

Since the customer does not have to provide the financing for the project it is well suited for markets where customers have lacking financial resources or where the awareness of EPC amongst the financial institutions is low. This is common on developing markets. (JRC EPC)

An important benefit for the customer with shared savings is that they will benefit from the savings from day one. This since they do not put in the initial investment but still save money from the energy savings as soon as the EE measures are done.

The shared savings model is more sensitive to energy price drops. Since the revenues for the ESCOs are based on the payback from the energy savings, a drop in energy prices will make the payback times longer and it can become hard for ESCOs to cover their debts (Hansen, 2006). It is however possible to stipulate a *single energy price* to limit this risk. This means that the ESCO and customer will agree on *value* of the service and neither party will gain from energy price changes (JRC EPC).

A shared savings model can result in longer contract times compared to guaranteed savings (for an identical project) because the ESCO does not get paid for its services at the start of the project but is instead remunerated during the course of the contract period. So to cover up their costs and profits they might need a longer contract time because the remuneration is slower.

3.1.3.2 Guaranteed Savings

With the guaranteed savings model the *customer provides the financing* for the EPC-project and thereby takes on the *financial risk*. In return the ESCO guarantees the savings and has the *performance risk*. If the guaranteed savings are not reached the ESCO will compensate the customer economically for the difference. This lowers the risk for the customer's investment. If the savings are higher than the guaranteed level, the surplus is usually shared between the ESCO and the customer according to a predetermined split. So the guaranteed savings model shares some properties of the shared savings model.

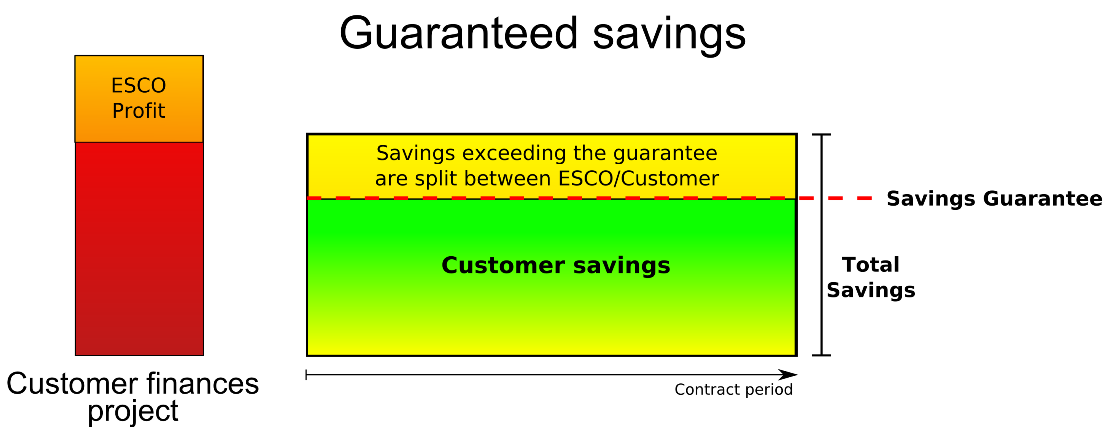

Figure 3.1.3. Overview of guaranteed savings.

The initial investment (made by the customer) will cover the costs of technical equipment, working hours (project development, documentation, customer-side optimizations etc.) but also the cost of risk as well as profit for the ESCO.

Since the projects are financed by the customer from the start the ESCO can in many cases provide more comprehensive long-term measures since they don't have to apply the same risk management (such as concentrating on "safe" measures with short payback times).

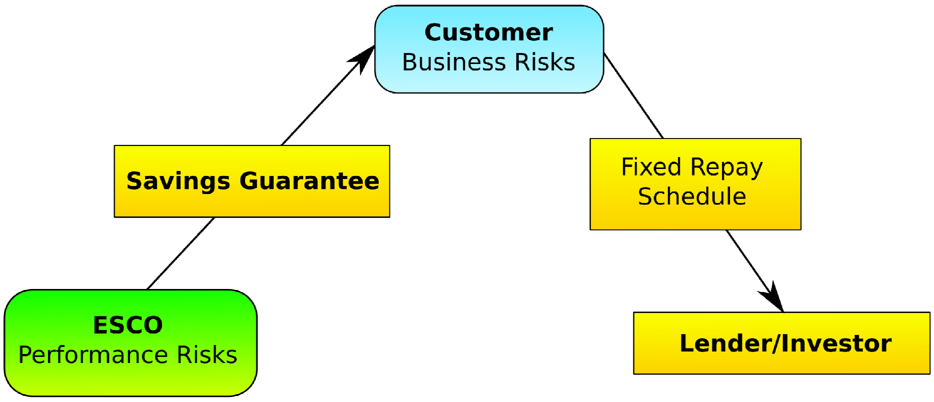

Figure 3.1.4. Cash flow and risk responsibilities, guaranteed savings (JRC EPC)

However, the guaranteed savings model needs a market with high awareness. Without this, customers will be less likely to trust the guarantees and financial institutions will be less likely to provide loans to the customer. So, guaranteed savings is generally more suited towards the mature market. The guaranteed savings model can however help build up a more aware and mature market in the long-term so in that sense it can be good for developing markets, assuming ESCOs can manage to use it successfully. (JRC EPC)

The guaranteed savings model requires financially strong customers which can be a problem.

3.1.4 Economy of EPC

Figure 3.1.5 illustrates the economic savings from an EPC. First the energy cost baseline (what the customer pays for energy) before the project can be seen. After the project has been realized the energy costs will be lower. This results in annual savings, part of this will be set off to pay for the project investment.

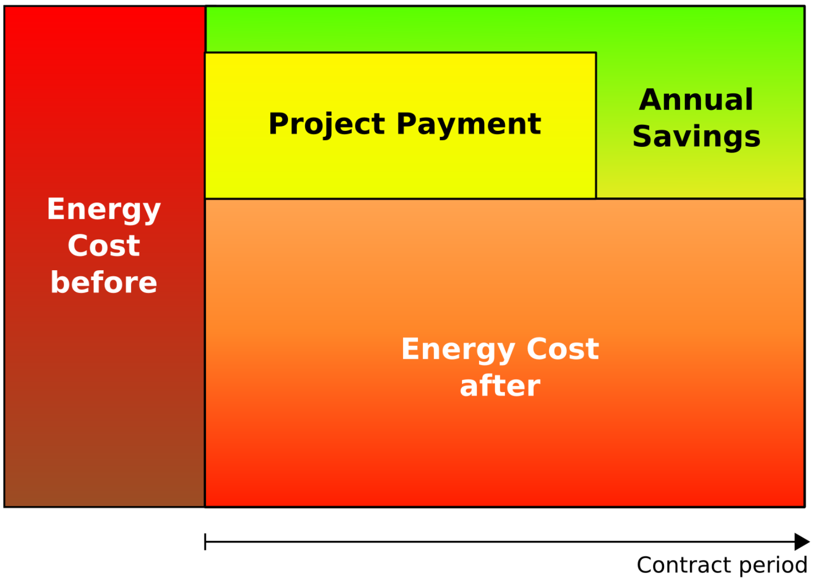

Fig 3.1.5. Economy of EPC

3.1.5 Structure of an EPC project

The basic structure of an EPC project is pretty simple. First, some sort of prestudy is made to determine the potential of the project. Based on this the procurement process follows and once this is completed the project is implemented. After the project implementation the results are followed up, measurement & verification. This is illustrated in *figure 3.1.6*

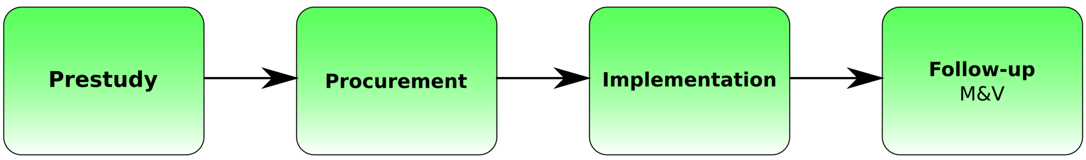

Figure 3.1.6. Basic structure of an EPC project

In reality, this procedure is a bit more complicated and the exact procedure varies between projects, ESCOs, countries etc. If a savings guarantee is to be given it can be based on the initial prestudy or on a dedicated in-depth analysis. The number of decision points (where the customer can choose to back out) for the customer can also vary between different structures. The two most common models is the *one-step* and *two-step* model. An EPC project will typically include characteristics of one of these models but they can also be somewhere in between, further extended and so on.

3.1.6 One-step process

In the one-step model there is only one analysis of the building stock on which the whole project is based. This analysis is done in the prestudy. Normally, only parts of the building stock is analyzed and from those results an estimate is made for the rest of the building stock that are involved in the EPC-project. The results from the prestudy is used in the procurement process and then also as a base for the project implementation and savings guarantee. Once the parties have reached an agreement there are no additional decision points for the customer where they can choose to back out. So once the project has been procured it is followed through. Also, once the procurement phase is over, the project scope cannot be increased. (Sjögren, Schulz, SE, 2011)

A prestudy gives a picture of the potentials of the savings but not as detailed as an in-depth analysis. When a savings guarantee is given based on a prestudy rather than an in-depth analysis the risks are considerably higher for the ESCO. Also taken into account that most EPC-projects are carried out in the public sector and the nature of public procurement in the EU: the prestudy might very well have been carried out by someone else than the ESCO who finally gets the contract. This further adds to the risks.

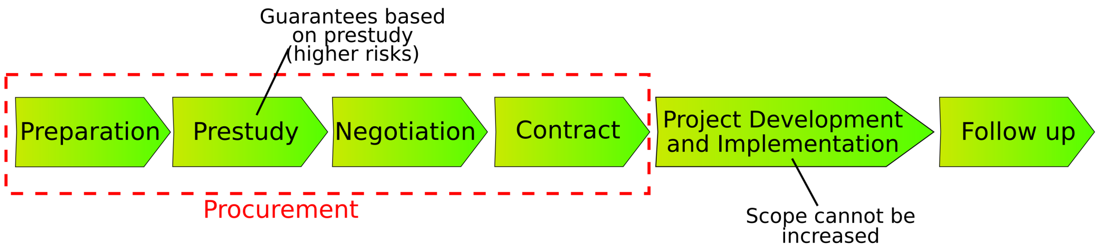

Figure 3.1.7. Illustration of the one-step model. (Sjögren, Schulz, SE, 2011)

Because of the high risks involved with the one-step model the ESCOs will often tend to focus more on the measures with shorter payback times. This can have the effect that projects using the one-step model can be less comprehensive than when using the two-step model.

On the other hand the one-step model is simpler and thereby cheaper and quicker. The transaction costs of the project will not be as high and this model is well suited for simpler projects where there is less need for comprehensive long-term measures; where there are a limited number of measures to be implemented (such as changing street-lighting) or where the energy baseline is lower and the transaction costs of a two-step model would make the EPC-project to expensive to be economically profitable. One-step projects does not per default mean less comprehensive projects, some projects are simply better suited towards using this model (such as in the street-lighting example).

3.1.7 Two-step process

In the two-step process there is a prestudy just as in the one-step model but then there is also a more in-depth analysis before the project implementation. The prestudy is used to give an estimate of the savings and gives a good basis for the procurement phase and decision making. The in-depth analysis gives more detailed and exact information about the complete building stock, the savings potential and the possible energy efficiency measures. This lowers the risks for the ESCO and a more accurate savings guarantee can generally be given to the customer. The scope of the project can also be changed during the in-depth analysis if there are additional EE measures that can be implemented that were not identified in the prestudy.

In the two-step model there is also an additional decision point for the customer where they can decide whether to go through with the project implementation or back out.

Variants of the two-step process can include additional decision points for the customer.

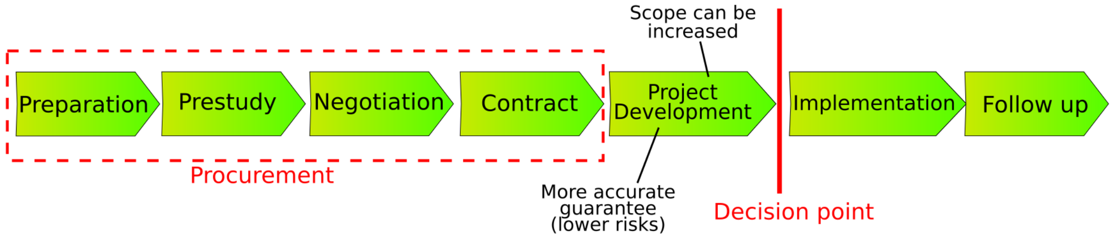

Figure 3.1.8. Illustration of the two-step model. (Sjögren, Schulz, SE, 2011)

3.1.8 Contract period

The contract length can vary between projects but is typically around 10-15 years long. During this period the ESCO will take on responsibility for the performance of the project. The performance will be measured and verified (see Measurement and verification section).

The payback times for the EE measures can run longer than the actual contractual period, at least with guaranteed savings. This, since the customer will continue to gain from the energy savings even after the actual contract period has ended and these savings can continue to pay back the initial investment (which in guaranteed savings was paid by the customer). The benefits of having a longer contract time might not be considered to be worth the added costs. There are however often opportunities to extend the ESCO services after the contract period has ended.

3.1.9 Financing

The EPC project can be financed directly by the ESCO, customer or through a third party, TPF (such as a bank/financing institution). If the customer finances the project or takes on the credit risk through a TPF then the EPC will follow the guaranteed savings model. If the ESCO finances the project either through own funds or through loans the EPC uses shared savings. (JRC EPC)

3.1.10 Measurement and verification

The process of measurement and verification (M&V) is one of the key concepts of EPC. EPC requires good knowledge of the energy usage prior and after the project implementation.

In the book "Performance Contracting – Expanding Horizons" (Hansen, 2006, page 65) M&V is described in the following way:

"Measurement and verification can be defined as the set of methodologies that are employed to validate and value changes in energy and water consumption patterns over a specified period of time, which result from an identified intervention or set of energy conservation measures"

In other words, M&V is the tool used to quantify the savings created from the energy efficiency measures that the ESCO has performed as part of the EPC project.

The M&V is done periodically to give feedback on the savings and the performance of the project. This feedback is then used to verify that the predetermined quality assurances are being met. Normally, energy savings is what is measured but also other aspects can be measured and compared against a baseline. These aspects can be things such as air quality, lighting level, worker productivity, water usage, CO_2 emissions etc. In theory a Performance Contract doesn't even have to do with energy at all.

The M&V can be done in many different ways. There are standard protocols (such as IPMVP) that ESCO can follow and these protocols usually provide different options for M&V (Hansen, 2006). An important factor to consider is how important M&V is in the specific project. Higher accuracy might mean higher costs and the importance of this can of course vary between different projects.

The M&V process can be done by the ESCO, which is the most common way, or it can be done by the customer or a third party. Basically, in whatever way the ESCO and the customer agree on.

A simplified explanation of the M&V process can be described as: (Hansen 2006)

$$ChangedResourceUse = \sum \{Post-InstallationUsages\} \pm \sum Adjustments - \sum BaselineUsages$$

Where *Baseline Usages* refers to the baseline prior to the EPC-measures, *Adjustments* refers to exceptional changes that aren't directly coupled with the EPC-measures, *Post-Installation Usages* refers to the energy usage after the EPC-measures.

3.1.11 Strengths

EPC is well-known model for comprehensive energy efficiency projects. It works very well for larger projects, usually including a pool of buildings. The large projects and the longer contracts and payback times makes EPC especially suitable for the public sector. It creates incentives for both the customer and the ESCO to save energy. The savings guarantees make the investment "safe" for the customer and is important to secure loans through TPF.

There are many EPC projects that have been implemented and thereby many reference projects that show the functioning of the business model.

3.1.12 Weaknesses

EPC is a very complex contract form, to be able to give a savings guarantee many steps have to be taken and there are certain risks involved. The transaction costs and the cost of the risk-taking can increase the overall costs of the project. This makes EPC less suited for smaller projects. The minimum energy cost baseline (annual cost for energy in the customer facilities prior to EPC) that is feasible with EPC, considering transaction costs etc., is around €100 000 (Bleyl-Androschin 2011). Usually EPC projects will be ten times larger or more.

The longer payback times might not be well suited for the private sector. Often, the private sector will not invest in projects that have a longer payback period than typically three years. This, since the private sector have added business risks, it is hard to know what the market will look like long term, therefore long term investments are risky. Then there is also the fact that there might be other investments that will give larger return of investment, pushing down the attractiveness of long term energy investments.

3.1.12.1 Baseline

Getting an exact value of the current energy baseline is very hard. If you start looking at the energy bill, can you be sure that the measured period is exactly the one that you want? If you measure the energy usage for a year, can you take into account if it's been a particularly cold or warm winter? *Figure 3.1.9* shows how the actual energy usage can vary.

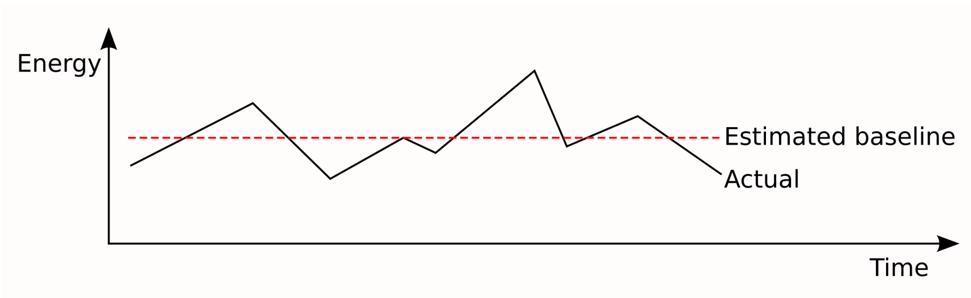

Figure 3.1.9. Actual energy usage vs. estimated baseline

There are many factors that can impede on the exactness of the baseline calculation or make it hard to compare later measurements (after project implementation) with baseline measures. Below are some examples. (Hansen 2006; Bleyl-Androschin 2011)

- An energy bill might not exist from the 1st of Jan to the 31st of Dec
- A certain year can be exceptionally warm or cold which gives the wrong value for the average year
- Level of maintenance, e.g. a ventilation system that has been cleaned will function much differently from that has not.
- The energy usage can be very different depending on the behavior of the residents, especially when it comes to electricity
- The occupation level may have looked different at the time of measurement. In a hospital the number of patients can vary, at a school the amount of pupils can vary etc

- Architectural changes can have a very large impact on the energy needs of a building. The difference it makes can be very hard to calculate and normally you can only do a qualified estimate

Factors like these can severely limit the exactness of a baseline measurement and the later measurements, this increases the risk for the ESCO that has guaranteed savings based on this baseline. With the added risk, the ESCO has to cover themselves by having a higher price on their services. The more exact the measurements are done the higher the transaction costs will be for the project.

3.1.12.2 Complexity

A big problem with EPC is its complexity. An EPC contract will generally be 30+ pages with the customer and on top of that there will be long contracts for all of the sub-contractors involved in the project. A reason for this is to manage the risks, decide who is responsible for what if certain situations occur. Eg. if the ESCO does not meet its savings guarantee they might not be economically responsible if for example the customer hasn't done the right service & maintenance that they might have agreed on; or if a sub-contractor has not delivered what they agreed on delivering etc. With the large scope of an EPC project the complexity rises. The complexity brings with it high transaction costs which will in the end have to be borne by the customer. The high transaction costs and bureaucracy makes EPC unsuitable for smaller projects. Customers and especially subcontractors will not like the added bureaucracy that takes time and energy away from their core business.

3.2 Energy Supply contracting

With an Energy Supply Contract, ESC, the ESCO provides the customer with *useful energy*, such as heating, cooling, steam, compressed air etc. The ESCO is responsible for the delivery of the useful energy and will take care of everything needed to make sure the customer gets the useful energy. This includes the planning, construction/installation of the power plant, operation and maintenance, fuel purchases etc. The customer does not have to worry about how the energy is produced and are guaranteed to get their useful energy (heat, steam etc.) which lets them focus on their core business. (euESCO 2010)

As illustrated in *figure 2.3* the ESCO will collect the expertise in: Know-how, technology, engineering, energy, money and legislation; making the ESCO a "one-stop shop" for the customer in order to get their heating (or cooling etc.).

Most commonly the ESCO will install a local heat-boiler (or cooler, CHP etc) at the customer facilities to provide the useful energy to the customer. The ESCO will usually own this plant during the contract period. The ESCO will take responsibility for the prospecting of the size of the energy plant so that it fulfills the customer needs; and all other preparatory needs (legal, technology, engineering etc).

During the contract period the ESCO will operate and maintain the plant and make sure that it runs as optimal as possible as well as taking care of fuel purchases. This means that the customer does not have to worry about the operational aspect of the plant since this is outsourced to the ESCO.

ESC does not have to be limited to a local power plant at a single customer facility. An ESC contract can be used to build up a local or district heating system. However, ESC contracts are generally more orientated towards *decentralized* (local) power supply rather than large *centralized* systems. In this thesis there will be a distinction between ESC and district heating. Unless otherwise stated, district heating will refer to the larger centralized systems.

An ESC contract will often contain some sort of price guarantee for the energy. Sometimes the customer has the opportunity to bind the energy price to a fixed level with the price depending on the binding time.

3.2.1 Financing

When it comes to financing, this can be done in many ways. In most cases ESCOs will provide the customer with the energy service *investment free*. This makes it easier for the customer to make the decision to sign a contract. The ESCO will of course be remunerated for their investments during the contract period. Contract lengths can vary; 10-15 years is typical, but the contracts can also be shorter or longer.

One model being used by some companies is that the customer signs up for a contract that is automatically renewed after a specified period of time (typically around 5 years) unless the customer chooses to end the contract after this period. If the customer decides to not renew the contract they will take over the operation of the plant and are obliged to buy out the power plant. This is especially common when it comes to more permanent solutions such as geothermal energy.

If more portable solutions are used, such as biomass heat boilers, it is easier for the ESCO to remove the installations from the customer facilities. In the case of industry customers, the ESCO can use a portable container or such for their boiler (or coolers etc.) so that it can be more easily removed later.

An ESC contract does not by any means have to be investment free for the customer. When it comes to larger installations or higher risk projects the customer might have to make an investment up front. The most common costs that the customers will bear covers the secondary systems, such as radiators and other "in-house" elements.

How to setup the economy around the ESC project can easily be tailored for the individual customer and the fees paid by the customer can be adjusted to compensate for higher risks or different contract lengths etc.

Many ESCOs will specialize in a certain customer type, such as industry or residential.

3.2.2 Energy efficiency

ESC doesn't have a direct energy efficiency goal like EPC does. The energy efficiency aspect comes a bit more indirect. The customer wants to pay as little as possible for the useful energy and most often a prerequisite for signing an ESC contract is to lower costs (other aspects such as reliability and operations & maintenance outsourcing are also important). A way of lowering costs is to use a more energy efficient technology.

From the ESCOs side there is a constant incentive for optimization the plant (eg. heat boiler) as is illustrated in *figure 3.2.1*. If the ESCO gets paid per sold energy unit (step 1 in the fig), part of that will be profit and the rest will be the cost of operation for the plant (including capital costs, fuel etc). If the ESCO can make the plant run more efficiently (step 2) the cost of operation can be lowered and thereby the profit will increase (step 3). So there is a built-in mechanism for the ESCO to always optimize the operation of the plant. The same mechanism provides incentives for any investments during the contract period that can make the plant run better. It could even provide grounds for switching technology all together if the technological development has created a more favorable technology that will be more cost effective. Typical energy savings for an ESC project is in the range of 10-20% (Bleyl-Androshin, 2011).

But what is important to note about the energy efficiency aspect is that all the efficiency measures stays on the production side. There are no incentives to actually lower the end-use in buildings.

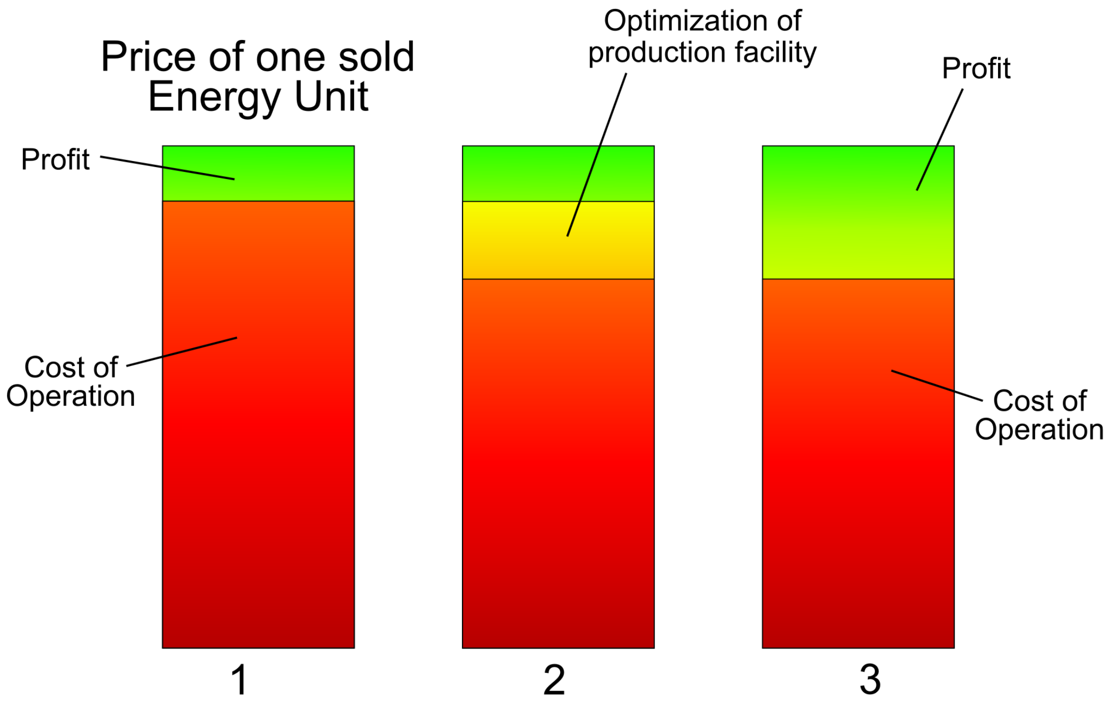

Figure 3.2.1. Energy efficiency incentive for ESCO

3.2.3 Renewable energy

Using renewable energy suits itself very well to ESC contracts. Since many of the contracts are local it is easier to use alternative solutions. Many ESCOs will use renewable energy as a sales argument, especially on markets where they are competing with large utilities providing district heating/cooling.

An ESC model lends itself very well to setting up solar power/heat supply. Since an ESC contract clearly defines the responsibilities of the ESCO and has a binding contract for the customer, it can help limit risks for both ESCO and customer when implementing projects such as this.

3.2.4 Risks

The ESCO will take on some risk during the contract. If for example an ESCO is working with an industry customer and the customer goes bankrupt during the contract period, then the ESCO might have invested in a power plant that they won't get cover for. To mitigate this risk the ESCO might make sure that the production plant is made portable so it can be removed from the customer facility, eg. having a heat-boiler in a portable container. If the project is of particularly high risk the price for the service will likely be higher.

Some ESCOs concentrate on working with the residential sector to mitigate risk because it is more stable than the industrial. The building is more likely to still be there in 10 years compared to a private industry.

Even in the residential sector, the ESCO will generally try and make the production plant easily removable. Depending on the laws in the specific country, this can be important as to make sure that the production plant is not considered as an integral part of the building which can therefore make it impossible to remove the plant.

3.2.5 Strengths

A customer is very aware about the need for heating (or cooling etc). It is something that the customer must have. An ESC provides this in an easy way where the customer does not need to have the know-how about different technologies or about the operation and maintenance part. The lowered costs and guaranteed reliability of energy delivery lets the customer focus on their core business and not worry about how the energy is provided or about costly (or comfort lowering) energy supply interruptions. The filling of such an obvious need makes ESC a very "easy" investment compared to doing more comprehensive demand side measures. For example, it might not be as obvious to the average customer that putting in new and better insulated windows might be a better alternative than getting a larger heat boiler.

With ESC there are normally no needs to do any large changes to the actual customer facilities, the changes stay in the boiler room. Compare this with comprehensive demand side measures where most of the changes are done in the customer facilities.

Comparing with EPC, the minimum profitable energy baseline for the customer is considerably lower with ESC. To cover up the transaction costs and needed investment the customer needs a yearly energy usage corresponding to about ~€20 000 (customer's annual energy cost) compared to ~€100 000 for EPC. This baseline corresponds to a thermal load of around 100 kW (Bleyl-Androschin, 2011). However, ESC projects with a lower thermal load are carried out, according to Cofely's (ESCO which provides ESC) website they provide ESC in the ranges of 30 kW – 20 000 kW (Cofely website). There is no upper limit.

3.2.6 Weaknesses

Although ESC does provide some energy efficiency aspects, these are limited to the production side. There can also be conflicting incentives if EE measures are taken on the demand side since the ESCO usually gets remunerated for every sold MWh and a lower energy end use will generate less profit for the ESCO.

In some circumstances, ESCOs will state a minimum delivered energy amount to the customer which means the customer has to buy at least that stated amount. This can effectively erase all incentive for the customer to do any EE measures on the demand side. The frequency of these types of contracts has not been investigated in this project but according to some of the interviewees it is something that is not uncommon in the UK.

Looking at the bigger picture: if ESC is used on a large scale it needs to be complemented with demand side EE measures to meet the challenge of limiting climate change and to meet many of the energy related targets.

3.3 Integrated Solutions

ESC and EPC are two of the most common contract forms and they illustrate energy services on the supply side and the demand side respectively. As mentioned in the corresponding sections, ESC has a typical energy savings potential of 15-20% and EPC a typical energy savings potential of 20-30%. It is easy to understand the benefits of not only working on one side but instead incorporate energy efficiency measures on both the supply side (production side) and the demand side. This makes sense in an environmental, economical, operational security aspect etc. In this master thesis *integrated solutions* refers to energy contracts that have energy efficiency measures on *both* the supply side and the demand side.

3.3.1 Which end to start at, supply side or demand side

When implementing an energy efficiency project of any sort it is important to start at the right end. Now, what is the right end?

Following is an example that one of the interview subjects had experience with. It clearly illustrates the importance of starting at the right end and it also shows the problem of the traditional ESC supply side approach compared to working on both the supply and demand side.

> The interviewee works for an energy company that has been working with energy services for many years. A customer was complaining about inadequate cooling of their building and approached the energy company to get help in installing a new cooler of appropriate dimensions. Whenever the temperature outside got to warm and when the sun was shining on the building, the inside temperature got to high and it affected the working environment.
>
> The energy company went to the customer location and prospected the building. What they found was large windows covering one of the walls where the sun would hit. Also, right outside was a large, heavy trafficked road that created a lot of noise that also affected the working environment. The windows were found to be double glazed windows.
>
> Instead of installing a larger cooler the energy company instead suggested that the customer switched the double glazed windows into triple glazed windows. The customer did this and as a result, the before under-dimensioned cooler now turned out to be over-dimensioned, so there was no need to install a new cooler. The working environment got much better due to the better cooling and less noise.

Examples like this can be found again and again, showing the importance of looking at the demand side before the supply side. The integrated approach, starting on the demand side, will lead to a lower energy consumption and therefore affect the supply. A smaller heat-boiler (or cooler etc) will also be less expensive (in most cases).

3.3.2 Conflicting incentives

A common issue that arises is the conflicting incentives for supply oriented companies (such as ESC or energy companies) when they start looking into also working on the demand side. If a company which normally gets paid for selling energy units now start to lower the need of these energy units, the credibility might not be that high from the customer stand-point. How this works in practice can depend on what type of company is providing the service and what type of business model they are using.

If the customer has trust in the service provider, this doesn't have to be a problem. A manager of energy services at a municipal energy company said:

> "It's like going to the dentist; you know that the dentist gets more money if he/she does more measures, but most people don't have any troubles going to the dentist anyway, it's a matter of trust"

In the same way, a supply oriented company (such as a utility or ESC provider) might get more money the more energy they sell, but if their demand side EE offerings are serious and they can communicate this to the customer, it does not have to be a problem. Comments from the same person said that in the cases where the customer has had any objections, these have quickly disappeared once they have talked to the customer and really explained their services. The same types of comments have been given by other people working in the same field. It is to a large degree a matter of trust and awareness.

However, not all energy providers who also provide energy efficiency services can measure up to this. Especially amongst companies that are new to energy services, the action of "selling bulks of energy" can be really incorporated into their thinking and the EE part might not really be integrated into their way of doing business. In these cases, the conflicting incentive of selling and saving energy can be a problem. In integrated business models where this might be a problem there are suggestions on how to solve this. Other integrated business models simply don't have this problem by design.

An example of the former is the IEC model that will be discussed, and of the latter there is EPC and Chauffage. This will be discussed more in detail in the different sections.

In many cases the fee for providing the energy service can be larger than the loss of remuneration from the selling of energy (that has instead been saved) when you take into account that a large portion of the energy price consists of energy tax, VAT and network charges. Especially if an "additional" remuneration method is given, such as using shared savings. (Bergmasth, Strid, 2004)

3.3.3 Integrated contract models

In this thesis several integrated models have been assessed. They will be presented in the following sections. First out is *Integrated EPC* which by itself is not a contract model but instead refers to the scenario when EPC projects are *integrated.* The contract models following this are *integrated* by design. The contract models are *Chauffage, Integrated Energy Contracting* and *Facility Management.*

3.3.4 "Integrated" EPC

The EPC model has been covered earlier. Although generally seen as demand side driven, EPC may very well contain supply side measures (in theory it could exist only of supply side measures as long as the savings are measured against a baseline). If the supply side is included into the EPC project and energy efficiency measures are therefore carried out on the supply side, it fits the definition for an integrated solution as used in this thesis. So, if the EPC project includes supply side measures it is in this thesis seen as an *integrated solution*.

Another point of including the supply side into an EPC project is that it creates an incentive to run the supply-facilities as optimized as possible, as long as the service and maintenance is carried out by the ESCO (which isn't always the case, see the country specific section on EPC) and the savings are incorporated into the total energy savings of the project. The more efficient the supply facilities work, the better performance the EPC will reach and the higher the remuneration will be (in the same way as with demand side measures).

The conflicting incentive of selling and saving energy is not a problem with *integrated* EPC. The energy is not measured and sold on the basis of how much is produced on the supply side. The energy consumption is instead measured against the baseline and the remuneration for the ESCO is based on the savings performance and not the amount of energy produced. This simply means that there is a strong incentive to run the supply side as efficient as possible and producing as *little* energy as possible.

3.4 Chauffage

Chauffage, *function contract* or *comfort contract,* is a contract form that revolves around the principle that the customer pays for a function rather than say MWh of delivered energy. This function can be: *keeping a room at 21 degrees* or *keeping an office space lit at 500 lumen*. Other functions can also be used, such as air quality etc.

The most common function however, is keeping a space conditioned at a certain temperature.

The chauffage model is often seen as a complicated model but it can be surprisingly simple (Hansen 2006). In Europe it is not uncommon with contract lengths of 20-30 years (JRC EPC) but contract lengths can also be significantly shorter, starting from 1 year and up.

A chauffage contract is usually setup in the way that the ESCO looks at what the customer pays to keep one square meter of space conditioned, say at a certain temperature. The cost will include energy costs, service & maintenance costs etc. The ESCO will then offer the customer a fixed fee that is lower than what the customer is currently paying, eg. 90% of what they are currently paying. This is illustrated in *figure 3.4.1*; if the customer pays €11.4 per square meter and year before the contract, the customer might pay €10.0 per square meter and year, fixed fee, after the contract to keep the space conditioned. Since the price is fixed the customer does not have to worry about price abnormalities, eg. due to extra-ordinary cold winters etc. Since the ESCO receives remuneration according to the performance of the EE and operational cost improvements, Chauffage is a performance based business model. However, it will in this thesis be treated separately from EPC.

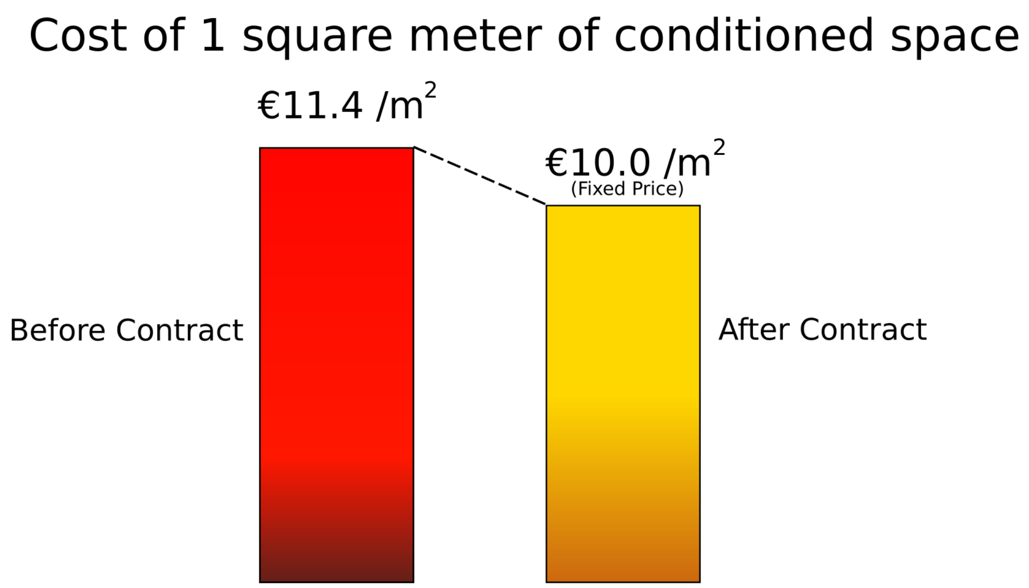

Figure 3.4.1. The cost of 1 square meter of conditioned space, before and after project implementation.

The ESCO will take responsibility for everything needed to keep the customers facilities at the predetermined temperature (or lighting level etc.), this includes everything from fuel purchasing, energy transformation, delivery, operations, service and maintenance of the customer side technical facilities.

Sometimes the ESCO will not by itself take care of the actual supply side and in that case they will outsource it but will still be responsible towards the customer. It is on the ESCOs responsibility to keep the price at the agreed level even if energy prices can of course vary in the supply chain for a number of reasons; eg. if the ESCO uses gas for the energy supply and the gas price rises sharply. Variations in the demand side energy use are also covered by the ESCO, so for example: an extra-ordinary cold winter might generate losses for the ESCO because of higher costs to provide the *function* (temperature).

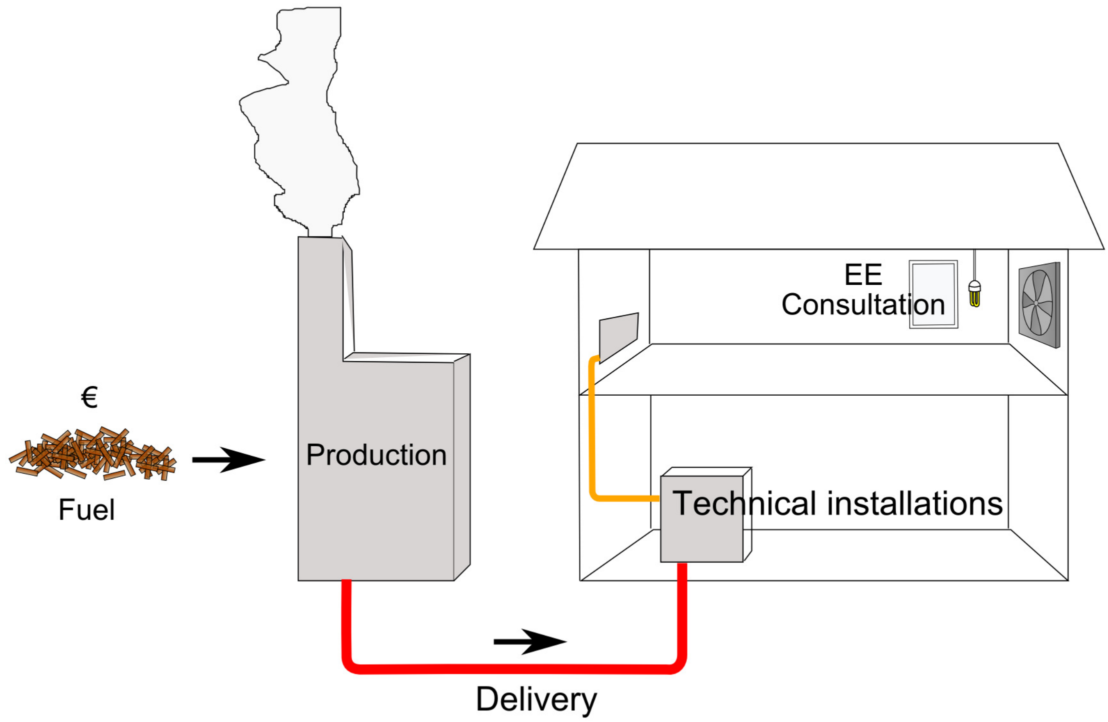

Figure 3.4.2. Scope of Chauffage

The above figure shows the scope of a typical chauffage contract. The ESCO takes care of the fuel purchases, production, delivery and user-side technical installations. The scope can of course vary between different companies, markets etc. When it comes to the demand side energy usage, the chauffage contract form is generally mostly geared towards the technical installations (customer side installations concerning heating, cooling, ventilation, electricity, water, sewerage), things that are not that "visible" to the customer. When it comes to demand side EE measures which demands more customer involvement ("building" measures), such as switching lighting technology, windows, insulation, user behavior etc. the ESCO might provide more of a consultation role, typically on a yearly basis. Again, the scope varies between different ESCOs.

3.4.1 Energy Efficiency

According to the European Commission Joint Research Centre, chauffage has the strongest incentive of all the common energy contracting models, for the *ESCO* to carry out EE measures in the customer facilities (JRC EPC). The reason for this is pretty simple. Since the ESCO will get paid a fixed fee per square meter instead of getting paid for the amount of energy delivered, the ESCO can increase their profits if they cut back on the *cost of operation*. If EE measures and optimizations (including measures that will lower costs for service & maintenance) are made to the customer facilities the costs of operation will decrease and a larger portion of the remuneration from the customer will be profit for the ESCO, as illustrated in *figure 3.4.3*. Step 1 shows an example of the cost/profit ratio prior to EE measures (during contract, price for customer is fixed), step 2 shows an example of savings and step 3 shows an example of the cost/profit ratio after the optimization and EE measures.

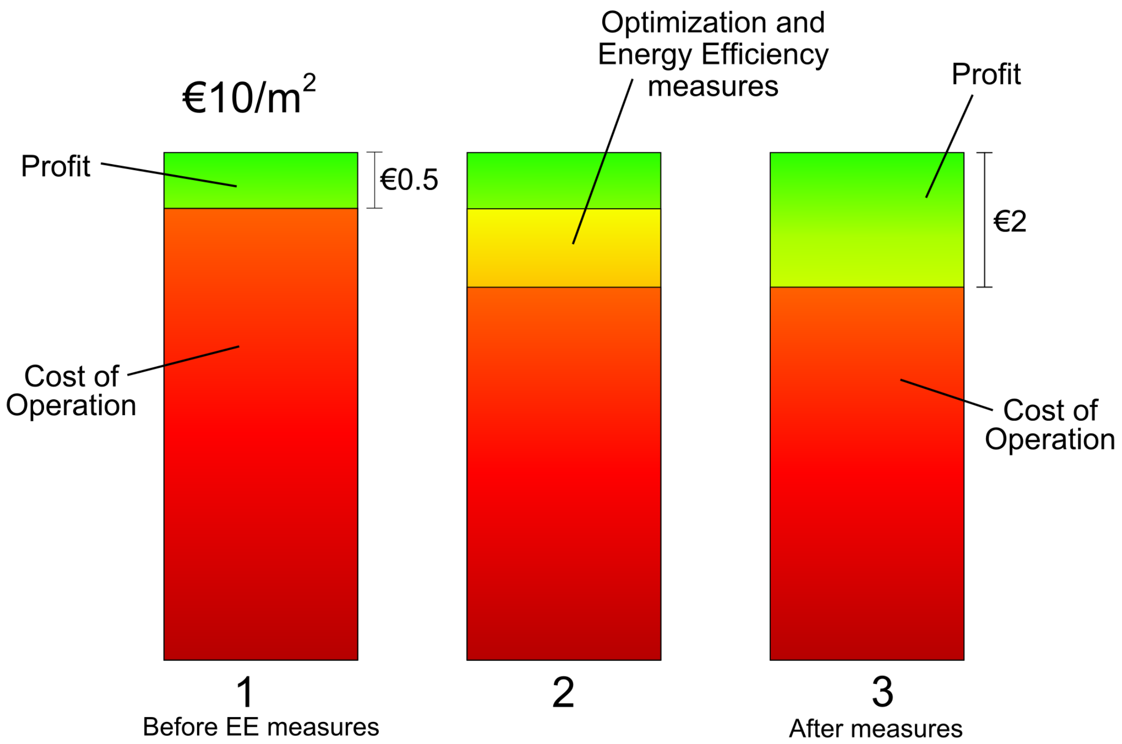

Figure 3.4.3. Cost/profit before and after EE measures and optimizations (during contract)

The concept is pretty similar to the EE aspect of ESC, but the EE incentive is larger because the measures can incorporate both supply side and demand side measures.

3.4.1.2 Customer incentive

If the incentive from the ESCOs point of view is very strong, it might be a bit weaker from the customer point of view, since the customer pays a fixed fee no matter how much energy is used. This can be one of the reasons why the demand side EE measures are geared towards the technical installations, since these measures can be done without the active involvement of the customer in the same way as many other demand side measures might. There is a possibility to use a shared savings model for a portion of the savings to create more incentive for the customer to save energy.

When it comes to demand side EE measures and investments that need more active customer involvement, the largest incentive from the customer point of view is to raise the value of their facilities by lowering the net operating cost of the building. The ESCO might be the one who will raise its profit from the energy savings due to the payment model, as shown in *figure 3.4.3*, but the lowered net cost of running the facility will increase the property value for the customer. According to an interviewee, the value increase is typically significantly higher than the investment for EE measures.

3.4.2 Financing

One of the strong points of the chauffage model is that it doesn't rely on single heavy investments from the customer and this makes the projects easier to realize from a financing perspective.

The customer (property owner) will instantly lower their costs since the fixed fee will be lower than what they are paying today. Most investments will be from the ESCO side in order to lower the cost of operation. Every EE investment will have a direct effect on the profit level made by the ESCO. The ESCO will try to make any investments as soon as possible in order to raise their profit level for the enduring contract period. If the contract period is longer they can make more long term investments. Generally, the customer will pay a lower fixed fee when there is a longer contract period and a higher fee when there is a shorter contract.

The ESCO can help the customer with financing when it comes to the user-side (demand side) EE measures that are not already covered by the ESCO (usually measures that are outside of the service & maintenance of "*technical installations*", such as lighting technology, building shell refurbishment etc.). These investments will raise the value of the customer property by further lowering the net operating cost but also increase the profits for the ESCO, so there is an incentive for both parts to go ahead with these investments. The ESCO can either help the customer with financing straight up, or they can make the investments themselves and simply add on a slightly higher fee to the existing fixed fee (eg. instead of paying €10 per square meter the customer will pay €10.5). If the customer has tenants in his properties he can then simply cover this extra cost by raising the rent for the tenants by the same amount. In this way, both the ESCO and the property owner will clearly benefit from the investment. If the tenants are paying for the energy they consume (which is common in commercial properties), they will benefit from a lower energy bill which will equalize the higher rent. In this way, the big problem of *split incentive*, where the property owner makes the EE investment and the tenants, not the owner, benefit from the savings, can be solved. This however requires that the laws and legislation permits this.

3.4.3 Strengths

As discussed in the previous section, a big strength is the absence of customer investment and that any ESCO side investment will have a direct effect on the revenue. This helps make the chauffage contract an "easier" investment for the customer than if they have to make a large investment up front.

As opposed to EPC, there is not the same need for an energy baseline to compare with since there is no savings guarantee (percentage level). An energy cost baseline will however need to be setup prior to project implementation to determine what the customer is paying prior to project implementation. The ESCO will look at what the customer is paying before the contract and then subtract a portion of this (eg. 10%, depends on risks, contract length etc.). After the project has been implemented you can simply remove any existing energy meters if you will, since the energy costs are fixed for the customer. Some measurements will be made to secure the function (such as temperature, light level etc.) but the need for costly measurement & verification does not exist with the chauffage model in the same way as with EPC.

The strong incentive for the ESCO to do EE measures is a big strength.

The chauffage contract doesn't require the same amount of cooperation between the customer and the ESCO as with some other contract forms such as EPC. This makes it more seamless for the customer since most of the measures are carried out in the "background" and does not affect their core business.

Fits certain customer types very well, especially property owners in the commercial buildings sector (such as owners of shopping malls). These customers have very high requirements for "*functions*" such as temperature levels (or lighting etc) because of the nature of their tenants: eg. shop owners who are dependent on their customers feeling "*comfort*" in their shops. Providing a good comfort level for the tenants is very important, especially in places where rents are high (where the energy portion might be a very small portion of the rent). Losing a tenant can mean significant losses for the property owner. According to an interviewee, losing a tenant generally means losing one year's rent due to the time it takes to find a new tenant and the time it takes to adapt the facilities to the new tenant (in the commercial sector). Providing a *function/comfort* for the tenants gives the chauffage contract a larger importance than "just" energy efficiency and lower operating costs.

3.4.4 Weaknesses

Since the ESCO has more of a consultant role when it comes to many of the demand side measures, the chauffage contract may not always be as comprehensive as say an EPC model, at least looking at the demand side.

Listed as a strength was the lower requirement for customer involvement but this can also be seen as a weakness. When the project is carried out as a larger cooperation it will make the customer more aware and educated in energy usage related areas and will have a higher likelihood to incorporate EE into their daily decision making.

The customer side incentive to save energy is a bit weaker compared to other contracting forms. The customer side incentive could perhaps be improved by using a shared savings model for some parts of the energy savings (if applicable).

3.5 Integrated Energy Contracting

Integrated Energy Contracting, IEC, is a contract form that combines the elements of ESC and EPC. The intent of the model is to try to create a model that can complement and extend ESC and EPC and try to solve some of the problems with these business models. ESC having the obvious weakness of being totally supply side centered and EPC the weakness of being too complicated and expensive for a lot of projects.

The IEC model has been developed as part of the IEA DSM Task XVI and has been driven by the work of Jan Bleyl-Androschin at the Grazer Energieagentur (IEAdsm.org).

The motivation to develop this model has been the need to go further "than the boiler-room". In the majority of energy contracting projects in Europe, the measures stay on the supply side, or in the "boiler-room". ESC and other supply services are used basically everywhere, the need is obvious (everyone needs heating), but working to lower the consumption is only done in the exceptional cases (at least in relation to supply services). The experiences from the people who have developed this model (first and foremost J Bleyl-Androschin) are mostly from Germany and Austria where ESC is the dominating contract model. It has therefore been natural to develop a model that expands the ESC model to include demand side measures rather than expanding the EPC model. This because of the dominating market share of ESC (see the country specific sections on EPC and ESC) but also to take advantage of the lower transaction costs associated with ESC (compared to EPC).

Some goals with the model have been to: lower the transaction costs compared to EPC; promote the use of renewable energy; have a clear model that is easy for the customer to understand; use an integrated approach to energy efficiency.

The IEC model also tries to focus on the importance of doing the demand side measures first; reducing the final consumption of energy before planning the supply side solution. The size of a heat-boiler (or cooler etc.) is largely dependent on the actual energy usage which will of course be affected by the energy efficiency measures on the demand side.

EPC is suited for large project in the public buildings sector but its costly M&V process and risks with the savings guarantee etc. can make it unsuitable for smaller projects, especially in the private sector. As discussed earlier, EPC requires an energy cost baseline of around €100 000 to be economically feasible (Bleyl-Androschin 2009), most EPC projects are around ten times this size. The IEC model on the other hand does not require such a high energy cost baseline. The practical limit has not yet been investigated but it should be closer to that of ESC (which is around €20 000) than EPC.

3.5.1 Scope of IEC

Where ESC is limited to just the supply side, the conversion of energy, IEC incorporates measures on the demand side as well. In this sense it reminds more of (integrated) EPC than ESC. IEC looks at the whole building or factory and includes typical measures such as: energy management, controls, HVAC, lighting, behavioral education. (Bleyl-Androschin, 2009(b)).

The savings potential of an IEC project should be closer to that of EPC, which is typically in the range of 20-30%.

The scope of IEC in relation to ESC and EPC (demand side centered) is illustrated in *figure 3.5.1*. IEC's place in the energy value chain is shown in figure 2.2.

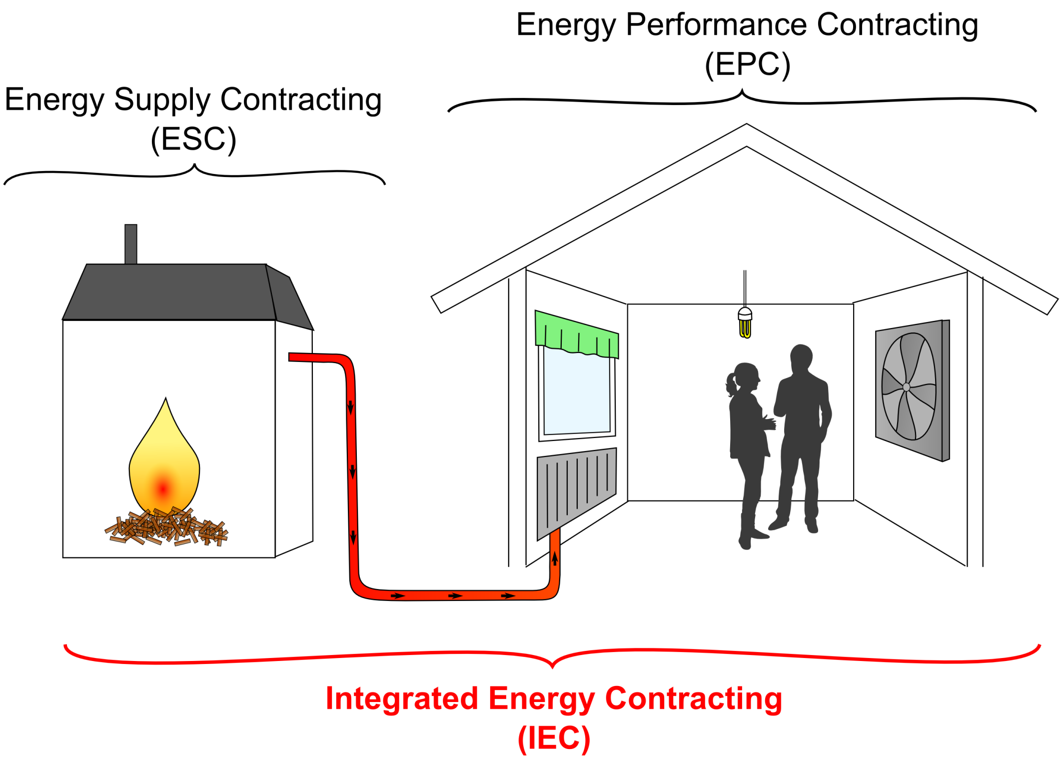

Figure 3.5.1. Scope of IEC. Source: (Bleyl-Androschin, 2009(b))

The responsibilities of the ESCO can of course be adapted to customer specifications but generally the ESCO will: audit the building; suggest and implement appropriate EE measures on the demand side; plan and build/install the supply facility (such as heat-boiler) dimensioned after the buildings estimated energy consumption; service, maintain and operate the supply side (including fuel-purchase), give quality guarantees (with *Quality Assurance Instruments*), follow-up.

Financing is an area where the ESCO can also provide help. Other areas can be: know-how about subsidies and grants etc. See *figure 2.3* for more examples of what the ESCO can typically provide.

3.5.2 Quality Assurance Instrument

To guarantee the quality of service to the customer and to reduce the cumbersome and costly measurement & verification process associated with EPC, the use of *Quality Assurance Instruments* (QAI) has been suggested. The quality assurance instruments is a simplified M&V procedure which does not focus on measuring the exact quantity of savings as in EPC, but rather guarantee the *function* and *performance* of the EE measures. For example, instead of measuring the exact energy usage before and after a certain EE measure (which can be costly and complicated), you can do calculations on how much energy is expected to be saved, so called "*deemed savings*". In many cases this will be enough. Eg. if you are to change the lighting technology, you may have information of how much more efficient the new technology will be and you know the number of light sources that will installed, from that information it is possible to calculate how much the technology will generate in terms of energy savings. With the help of simplified tools like this it is possible lower the transaction costs and still guarantee the function and performance of the EE measures.

By not focusing on the exact quantity of savings the projects will be less prone to situations where external factors can introduce complications. External factors can be any changes to the building, such as renovations or add-ons that will implicate the energy baseline. By not being dependent on a baseline as with EPC, the problems of determining such (see the EPC section) will not be prominent.

The most appropriate QAI used for a certain EE measure will have to be decided for the individual measures. Sometimes a one time performance measurement will suffice for eg. a street-lighting system, or a one-time thermographic analysis to verify the quality of measures including the building shell. The scope of the QAI can be of varying range, depending on what is agreed on by the customer and ESCO. To find the right balance between M&V and the related costs, the motto "as little effort as possible and as much as necessary in order to secure the general project savings goals" should be used. (Bleyl-Androschin, 2011)

In addition to the QAI that secures the function of the EE measures, some short and long-term measurements are advised to verify the performance over time. A suggested scheme for this is illustrated in *figure 3.5.2*.

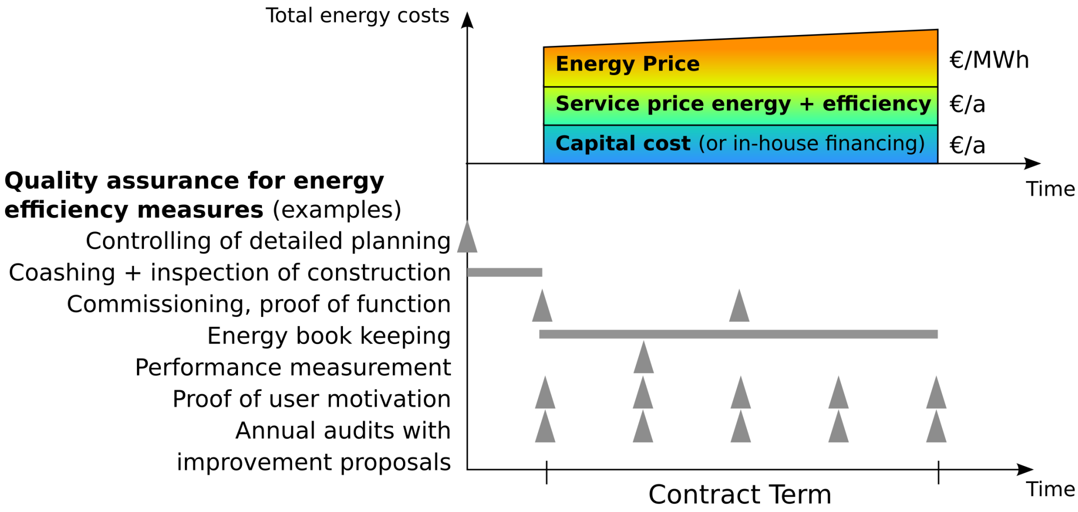

Figure 3.5.2. QAI examples as substitute for savings measurement. (Bleyl-Androschin, 2009(b))

An area that needs to be discussed is how to deal with situations where the ESCO does not fulfill its performance responsibilities in accordance with the QAI during the contract period. This could potentially be done with having a fine for the ESCO in the cases where they don't live up to their responsibilities.

3.5.3 Keeping the incentive for lower energy consumption

A problem with ESC-like models that includes demand side EE measures is the possible conflict of selling and saving energy that could arise. In order to meet this potential problem, a new price model has been suggested by the creators of the IEC model. The normal payment method for most ESC projects is that the ESCO is remunerated for every sold energy unit, €/MWh. The price per energy unit includes any capital costs, service costs, profit and the fuel costs (or any other cost that needs to be covered). Looking at the elements that are included in the price per energy unit, most of them are fixed, it is basically only the fuel cost that is variable. This is also known as the "marginal cost". With the ESC model the ESCO would be paid more money the more useful energy is sold to the customer.

A possible solution to solving this conflicting incentive is to use a different payment method where the fixed costs are paid separately from the variable, or marginal, cost. In this way the fixed costs would be decoupled from the amount of energy sold. The fixed costs would cover up the capital costs, service costs and profit for the ESCO, this could be adjusted on a yearly basis to make sure everything is covered. The remaining variable cost, the fuel cost, will be paid at a "*self-cost*" by the customer. In other words, the customer would only pay the direct cost of the actual fuel that is put into the heat-boiler (or cooler etc.) and the ESCO will not get any remuneration for this part. By doing this, there is no incentive for the ESCO to sell more energy units than required. This is illustrated in *figure 3.5.3*.

It has even been suggested that the customer could even pay a lower price than the "self-cost" for the fuel, subsidized by the ESCO to really rule out any remaining incentive for the ESCO to "sell" energy. It is discussible whether this is really needed. However, it could make sense on a market where the trust is particularly low towards ESCOs engaging in energy services on both the supply and demand side.

The supply side EE incentive which was discussed in the ESC section (where the ESCO can increase their profit by running the supply-facilities as optimal as possible) will still be there for the ESCO and the customer will also have an incentive to limit the final consumption of energy since they do pay the variable cost with this pricing model.

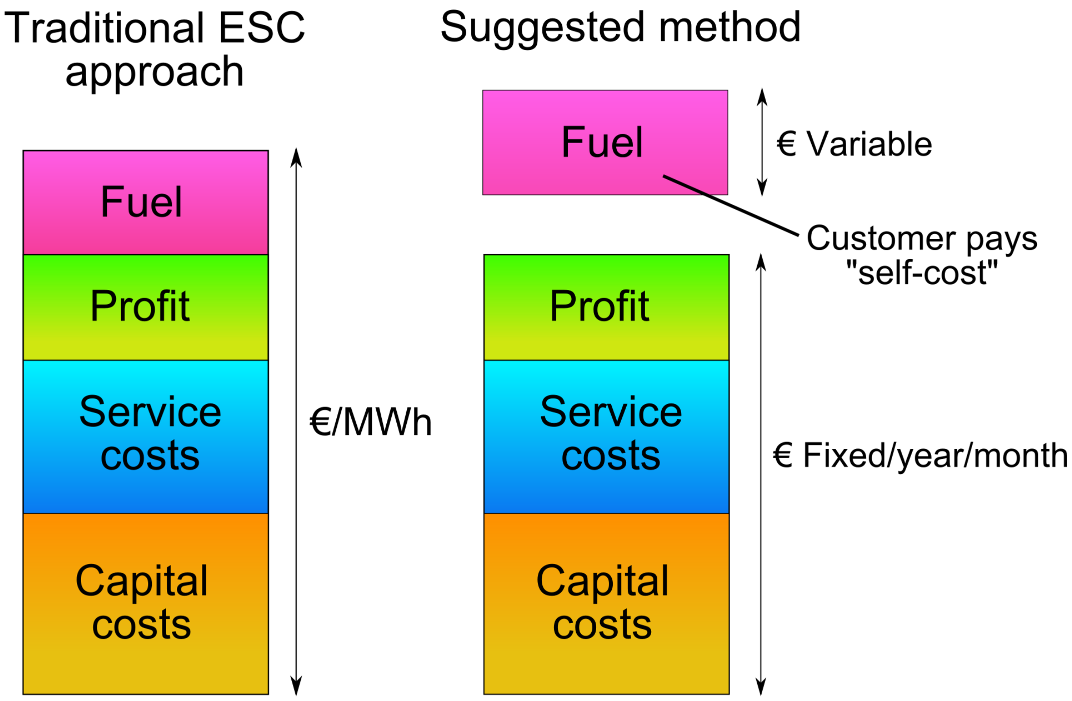

Figure 3.5.3. Suggested IEC price model (Bleyl-Androschin 2009(b))

3.5.3.1 Comments on the payment method

Some comments gathered on this subject from interviewees and other people spoken to during the research of this thesis, have had some different attitudes towards this payment method.

One ESC company working with localized, customer-side supply services (heat pumps, geo-thermal, would pellets heat-boilers etc.) in the residential sector, claimed that this payment method could very well work with their business model. They had a positive attitude towards the payment method, especially if their ESC offering were to be extended to include demand side EE measures.

Some municipal energy companies working with various demand side energy services including chauffage were more skeptical. They had a hard time understanding the model and the point of it. One person claimed that the reason for this is because they work with large *centralized* district heating systems and they don't really see the connection between the demand side measures and the fuel costs for the individual customer in the same way as they probably would with a *localized* supply-facility. It is worth noting that these companies did not see any conflicting incentives either with selling energy and doing demand side EE measures. Any objections they have had from customers have been erased after they have talked person to person. They see it as a non-problem.

Therefore a conclusion can be that this payment method would work well with smaller *localized* ESC type projects and to a lesser extent with projects working together with large-scale *centralized* district heating systems.

3.5.4 Renewable energy

The use of renewable energy is strongly encouraged with the IEC model. Considering the benefits of integrating supply and demand side EE measures in regards to the energy savings and the resulting lowering of CO2 emissions, the inclusion of renewable energy can take this one step further. In an IEC project (as well as an ESC) the supply side measures are often coupled with a technology switch, replacing an older energy conversion technology with a newer and more efficient one. Converting the supply technology is not something that the average customer does that often and it is wise to think through what technology to use. The increasing awareness about climate change and the negative impacts from CO2 emissions makes renewable energy an interesting option. Also from an energy security perspective renewables may be preferred instead of fossil fuels. According to interviewees, many customers are interested in converting from fossil to renewable fuels and are in many cases ready to pay an extra premium for it. And in many cases the conversion from an older inefficient oil heat-boiler to a newer more efficient heat-boiler using renewable energy will be profitable from an economical standpoint by itself (Energirådgivningen.se). There are also many governmental support programs to encourage the use of renewable energy throughout the EU. Especially for public institutions, the use of renewable energy is encouraged.

3.5.5 IEC development and results

IEC is a new business model for energy contracting and the experiences from the market are so far limited. There are however many energy efficiency projects that resemble IEC, for example when an ESC contract has been done together with a demand side contract (such as EPC) by the same company (or in a partnership). There are also 8 pilot projects that have been realized using the IEC model in Austria. The results from them are encouraging and show that the model works in a real market environment. The results show a high rate of energy savings and also a very high rate of CO2 emission reductions. Some projects lowered the CO2 emission with over 90%, the biggest factor being the conversion away from fossil fuels into renewable (Bleyl-Androschin, 2011).

Some areas where the IEC model can need development could be in how to deal with ESCOs not meeting the QAI targets. Also, more experience with what types of QAI to apply for certain measures will be beneficial. How to implement IEC with different types of customers and on different markets requires some more discussion and practice, not least when it comes to the payment method. It would also be interesting to find some (both calculated and empirical) results on the minimum customer energy cost baseline required to implement an IEC project. This would of course be different from project to project but it would be beneficial to have an estimate when comparing different energy contracting methods in order to find the best solution for a certain project.

3.5.6 Strengths

The IEC model has its strengths with its more comprehensive approach to energy efficiency compared to the more common ESC type models that are common on the market. Including the supply and demand side into an integrated solution will create larger energy savings than by only working on one side. The EE measures taken on both sides will add up but there are also synergy effects that can increase the effectiveness of the measures. Incentives for service and maintenance will be more integrated into the whole chain and encourage all aspects of the project to be run as optimized as possible. There are opportunities for the customer to save more money and new possibilities for ESCOs to reach a new market.

When working on the demand side the customer will usually become more involved in the project since measures are carried out in their facilities (as opposed to staying in the boiler-room). This can be a strength and weakness but the positive side is that the project will become more of a "partnership" and involve the customer more. In IEC projects, an important goal is to change the behavior of the customer to act in a more energy efficient manner, and this is easier to do the more involved the customer is in the project.

3.5.7 Weaknesses

Many customers might not be aware of the added benefits of working on the demand side. Everybody needs heating and choosing the route of an ESC-like solution is a simple and obvious decision for most.

Compared to ESC and other supply-services, IEC might create a larger requirement for customer involvement. With an ESC contract, the measures stay in the boiler-room and the customer doesn't need to engage in what happens there. When measures are done on the demand side, in the customer facilities, the customers will be more directly affected by the measures and some customer might see this as a barrier to invest in an IEC project, especially in the industry sector where their core business could potentially be affected.

The customer might also need to do investments in the IEC projects which is not typically the case with ESC (which normally is investment free for the customer). IEC could also be financed by the ESCO and use some form of shared savings model. But the added need for financing can of course be a factor to consider.

IEC might be suitable mostly for medium-sized projects, smaller projects having too high transaction costs to be feasible, and larger project (especially in the public sector) might be better suited towards EPC.

IEC might also be more suited towards markets that have a large share of ESC and to a lesser degree on other markets. For more discussion on this see the country specific section.

3.6 Facility Management

Facility Management, FM, is by itself not an energy service. FM is instead a way of managing facilities by incorporating various services into an integrated solution. The International Facility Management Association describes FM as: "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology". (ifma.org)

Another definition given by CEN, the European Committee for Standardisation, is:

"Facilities management is the integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of its primary activities". (BIFM.org)

Facility management works with a wide area of services such as: catering, security, cleaning, mailroom etc. FM companies can also incorporate energy related management, such as: service and maintenance of technical installations, energy optimization etc.

The key concept is to integrate several services and outsource these to an FM company. A facility manager could work with anything that is related to maintaining the efficient operation of the facility. The integration is meant to cut costs by rationalizing the services. For example, instead of having one person clean the floors and another person shoveling snow, the same person can do both these services and thereby costs will be cut.

Integrating energy services into FM contracts is becoming more common. Exactly how this is incorporated can vary between different companies and different contracts. Many FM companies have chosen to incorporate an EPC model where they will guarantee energy savings.

It is possible to use a more chauffage-like model as well, many FM companies are used to being remunerated per square meter and this could work very well with chauffage.

The services will usually include some form of service and maintenance of the technical installations in the facilities. The service can also go further and include delivery of energy. Some FM companies have experience with ESC.

3.6.1 Strengths

Many customers already rely on FM companies for services such as cleaning and other maintenance in their facilities. It would therefore be beneficial for many customers if the FM services are extended to also include energy related services. In that way they could either get rid of additional service and maintenance contracts that might be in use or they could get rid of their in-house organization. It would be easier for the customer to have a "one-stop-shop", one company that takes care of all of the facility related management rather than have several. The costs could be cut if the services are done properly.

Including energy services into FM can create an *integrated solution*, as defined in this thesis, to include both supply side and demand side EE measures. This would bring all the benefits that have been discussed about integrated solutions.

3.6.2 Weaknesses

FM contracts are often centered on the theses of “cutting costs” rather than “raising quality”. These two theses are in no way mutually exclusive but in many instances they can be contradictive. Raising quality can often cut costs, but cutting costs will not often raise quality (at least in energy contracting). In many ways FM services are designed to cut costs by integrating services. Eg. instead of having two people do two different services you might have one person doing two services. This may cut costs but it is unlikely that the one person can have the same expertise in the two different service areas as the two people would. In many cases this is not a problem, especially if the services are of a simpler character. However, energy management, especially under an EPC, requires highly skilled personnel. This can be a weakness with FM, that it is hard to find facility managers that are skilled in all the areas needed for successful facility management *including* the energy management which requires very high qualifications.

4. Energy Services in Sweden and Germany

4.1 Sweden

4.1.1 Some facts about Sweden*

Sweden has a population of 9.5 million (SCB.se). In 2009, the total consumption of final energy was: 376 TWh. Looking more specifically at the *residential* and *commercial* buildings (premises) sector (note: excluding industry), they consume around 130 TWh (climate adjusted). That is equivalent to 35% of the total Swedish final energy consumption. Around 60% of the energy in this sector is used for space heating and hot water. The space heating and hot water in the sector accounts for 82 TWh per year (climate adjusted).

District heating is the most common form of heating, reaching around 50% of the buildings in this sector. Looking at *apartments*, the share reaches 82%; and at *office space*, *commercial premises* and *public buildings*, the share is 68%.

So most of the larger buildings (multi-dwellings, office, commercial, public) use district heating as their main form of heating service. Single-household dwellings and smaller detached houses uses other combinations of heating where electricity is the most common. But since most energy contracting is done with larger buildings, the numbers concerning them are of a bigger interest.

Renewable energy provides for almost 45% of the energy use in Sweden. In district heating only 8% of the fuel is from fossil sources and the remainder consists mainly of biofuels, waste (contains some fossil fuel), peat and a small portion of heat pumps and waste heat. So the district heating can be considered to be generally clean (considering the low use of fossil fuels, high share of biofuels and taking advantage of "spill energy" such as waste etc.).

4.1.2 Energy services

During the last few years, the energy service market has grown considerably in Sweden. The energy prices have been rising for the last ten years which has been one driver. Growing climate concerns have also had an impact with several political incentives for energy services from the Swedish government as well as the EU. The price on electricity is expected to keep increasing in the future, not least as an effect of the increased electrical connectivity between EU countries which will raise Sweden's electricity price to be on pair with other European countries (especially Germany).

According to one of the interview subjects, the deregulation of the Swedish electricity market may also have increased the importance for energy companies to provide energy services in order to compete with other companies.

* All numbers are from (Energimyndigheten, 2010) unless otherwise stated.

The ESCO market in Sweden has seen a significant growth since the year 2000. It was earlier speculated that the energy companies would lead the development of energy service but instead it was the building and controls manufacturer companies that took on that role. An estimate of the turnover for energy services in 2008 is €85 million. This is however a low estimate and the real number is probably higher (Lindgren, Nilsson, 2009). Since 2008, the energy service market has continued to grow and any estimation of the current annual turnover for energy services should be significantly higher.

Up until recently, the energy companies (with a few exceptions) have not been that well represented in the amount of energy services provided. This has however changed recently and the energy companies are starting to show more interest in the field. According to one of the interviewees, working for an energy company, there are about 30 energy companies providing energy services today, five years ago there were about 5. This clearly indicates that energy services is a growing trend among the energy companies. There are about 10 energy companies that offer more comprehensive services where they will take a role in the management of the facilities. This is, according to the interviewee, a very strong growing trend.

According to Grontmij (2009), about 80% of the district heating companies offer energy services. This includes simpler types of indirect energy services such as invoice services (energy statistics) and energy advising. Of the companies, 25% claim to offer direct energy efficiency measures to the customers. Of the investigated companies, 63% are planning on offering more energy services in the future.

Utilities working with district heating have several reasons to work with energy service. They can improve their customer relations and retention which is a driver, but they can also get more direct benefits. By optimizing customer-side technical facilities that are related to the district heating systems, such as heat exchangers, they can lower the return temperature of the heat distribution medium (water) and thereby increase the overall efficiency of the district heating systems. There is thereby money to be saved for the utility by doing these optimizations. Another driver for the utilities is that if they lower the customer's energy consumption they can thereby raise the capacity of the district heating system in terms of connected subscribers. They can make more money from having more subscribers than from the excessive sold energy units. And to expand the capacity to contain more subscribers requires much larger investments than lowering the demand side consumption.

Comprehensive energy services from energy companies are likely to primarily come from *municipal* companies. The municipal companies have more involvement from local politicians and work for the common good. This influences how the companies work. Climate and economic issues are often raised and this is a driver for implementing energy services.

Comments from various people talked to in the research of this thesis claim that the large commercial energy companies are "stuck" in selling bulks of energy. The selling of energy is "built-in" in their sales culture and the whole energy efficiency thinking is lacking. Comments from an interviewee at a municipal energy company, which engages in energy services, claims that the large commercial energy companies will have "problems" later on because they are so late in adapting to the changing reality and not seeing the importance of working with energy efficiency. This is also backed up by literature, Bergmasth, Strid (2004) emphasizes that the energy companies that were early with implementing energy services have built up the competence and organization and done relevant investments in order to provide energy services. This makes it easier for them to develop their energy services further and gives them an advantage towards other energy companies who will have to start from scratch if they want to develop these services.

The larger energy companies do offer some energy services but they are generally not as comprehensive and often consist of simpler services such as energy advising. However, even though the larger energy companies may be providing simpler energy services, they have large PR budgets that can promote them. According to a person with insight into one of the largest energy companies, their media campaigns have lead to many new customers based on the "good-will" that their campaigns have generated. The "good reputation"/"positive image" that energy services can generate, can be very important in improving customer relations and this is also emphasized by Bergmasth, Strid (2004). Bergmasth, Strid (2004) also points out that many energy companies have introduced energy services only to *aid* in the *selling* of energy rather than providing energy efficiency services that can stand by themselves.

4.1.3 Potentials

The realized energy savings potential in Sweden can be considered low (Energimyndigheten, 2011).

The energy savings potential in the buildings sector has been estimated to 23%, or 34 TWh per year to 2016, according to governmental investigations (SOU 2008:110, 2ndNEEAP Sweden 2011).

Naturskyddsföreningen (national environmental NGO) and SWECO (consulting firm) did an investigation of their own and found that Sweden could halve their energy usage by 2030. Their estimations found that the buildings sector could save 55-80 TWh. (Naturskyddsföreningen 2011).

According to calculations made by Schneider Electric (ESCO operating in Sweden), 3.7 billion SEK (~€400 million), or 4.9 TWh, could be saved every year in the public sector alone by implementing energy savings measures. (Schneider, 2011(b))

Many of the calculations made for the potentials for energy services in Sweden have been concentrated on EPC and some of these are presented in the EPC-section. Calculations for other types of energy services are hard to come by since many earlier reports and investigations on energy services have often been focused on EPC. Other energy services are gaining acknowledgement in newer reports such as Energimyndigheten (2011), Grontmij (2009). However, calculations of potentials for other energy services are still something that needs further research.

There are certain sectors where energy contracting can play an important role. During the 60s and 70s a large project was carried out to build affordable housing for the growing population and increasing urbanization. These municipal housing complexes were built during a time when oil and electricity was cheap and building them in an energy efficient manner was not of high priority. The average energy consumption for these buildings are 210 kWh per square meter, which can be compared to the requirements for new houses of 110-150 kWh per square meter (Energimyndigheten, 2011). The money needed for the renovations, around 650 billion SEK (~ €70billion) (Tällberg, 2011), does not exist today and there are discussions if some financing can come from energy contracting. It's a very complex task that needs new innovative business solutions and the potential for energy contracting is enormous and will probably play an important role in the refurbishments.

The energy price has been exceptionally high during the very recent years partly due to problems with the nuclear power plants. Several larger upgrades have lead to problems and since about half of Sweden's electricity is produced from nuclear power, this has had an effect on the energy price. The higher energy price creates a larger *potential* for energy services but it is worth noting that high prices are likely to be lowered when the problems are sorted out. This will likely happen within a few years (SVT, 2011). This can be important to keep in mind when providing or developing energy services that may be sensitive to energy price drops and it can potentially create a short-term *decline* in the interest for energy services.

However, as mentioned, looking at the long-term trend, the electricity prices are expected to rise, not least as a result of the merging of the European electricity markets.

4.1.4 Policy

There are several policies that affect the energy services market. Some are EU-based and some are national.

Sweden has, in accordance with the EU energy service directive, ESD (2006/32/EC), adopted an *indicative* target of reaching a 9% improvement in energy efficiency to 2016 based on a lowering of end-use consumption from the average level of 2001-2005. According to the National Energy Efficiency Action Plan (2ndNEEAP Sweden 2011) Sweden expects to reach this target according to their calculation method. The ESD has had some effect on the energy service market, especially amongst the energy companies.

The EU has put up 2020 targets addressing climate change, the so called 20/20/20 targets. They address a 20% CO_2-emission (equivalents) reduction from 1990 levels, 20% energy from renewables and a 20% increase in energy efficiency. The energy efficiency target is stated as "saving 20% of primary energy consumption compared to projections". As opposed to the other 2020 targets, the EE target is currently *not legally binding*. It has been proposed that in a first stage, member states will set national targets and programmes to reach the *indicative* target of 20%. This will be evaluated in 2013 and if the measures are not seen as adequate by the Commission, a legally binding target might come into play in a second stage. The Commission estimates that only half of the 20% target is likely to be reached with the current measures. (Energy Efficiency Plan 2011)

Sweden has defined its 2020 target as *decreasing (primary) energy intensity in relation to GDP by 20% from 2008 years baseline*. Another 2020 national target is to phase out fossil fuels from the buildings sector. (2ndNEEAP Sweden 2011)

According to a Swedish long-term prognosis (Energimyndigheten, 2009, page 11) the primary energy usage is estimated to *increase* with 34 TWh, or 5%, to 2020 from 2005 years level. This is *not* in line with the (currently non-binding) EU *indicative* target of saving 20% of primary energy consumption.

Sweden has put up national targets of decreasing CO_2-emission (non-trading sector, outside ETS) with 40% to 2020 from 1990 levels. Of these 40%, one third will be made in other countries through flexible mechanisms (CDM, JI) and two thirds within Sweden

(Energimyndigheten, 2011b). Since energy efficiency measures are some of the most important mitigation measures (World Energy Outlook 2009), it is likely that EE will play an increasingly important role in realizing the national climate goals.

Another political target comes from the *National program for energy efficiency and energy conserving building construction*, which states that the energy usage per heated floor space should be decreased by 20% to 2020 and by 50% to 2050 compared to 1995 years baseline. (Energimyndigheten, 2011)

It is clear that energy efficiency and energy services have climbed on the political agenda. The result is a political framework that increasingly helps to promote energy efficiency. Not only are politicians on the national level showing increased interest in energy services, but also on a regional. Regional politicians are active in making decisions to incorporate energy services into different projects in municipalities and other public institutions. The trust and awareness is growing, not least as a result of the growing amount of good practice examples from realized energy contracts.

4.1.5 Renewable Energy

Sweden has a very large share of renewable energy in its energy system. The share is almost 45% (Energimyndigheten 2010). According to EU based targets, Sweden should reach 49% to 2020 but the government has decided to set the target at 50% (Energimyndigheten 2010).

Even though this is a very high share compared to other countries, it is questionable if the current policies can be seen as "ambitious" in promoting further use. Sweden will reach its target without any further active measures (REPAP2020.eu). The large share of renewables in the Swedish energy system can largely be attributed to the carbon dioxide tax that was introduced in 1991 which affected the large scale district heating systems and made it profitable to use renewables.

Therefore, it can be argued that renewable energy will *not* be a driver for the energy service market, at least from a *political* standpoint. And at least not in the same way as in Germany where the renewable energy related policies have a more direct effect and integration with the energy efficiency related policies.

4.1.6 ESC

Energy Supply Contracting is not a well-known concept in Sweden. An important reason for this is the well built-out district heating system. Because of this, the need for ESC is not as obvious as in other countries. One of the interview subjects, working for an energy company, said that his company used to offer ESC but has then stopped delivering the service since almost all their customer were using district heating.

The term that is usually used for ESC in Sweden is "*färdig värme*" (for heating), which translated would be along the lines of "*useful heat*". Some energy companies have offered this to customers, especially in the industry sector. Eg. Neova offers industrial customers like sawmills ESC services where they will install heat boilers on the site and run and operate these (Neova website). Vattenfall has also had this service for industrial customers with energy deliveries in the TWh range (Grontmij, 2009).

Some ESCOs are starting to provide ESC to residential property owners. The risks can be seen as lower in this sector compared to the industrial since the residential properties are more likely to still be there in 10 years time compared to an industry customer that could potentially go bankrupt in that time span.

ESC is also available on the electricity side, eg. Vattenfall has had services such as "*useful electricity", "useful lighting"* where the company installs, operates and maintains customer side facilities during a contract period of typically 5-10 years (Grontmij, 2009).

A more common service which is closely related is *service and maintenance* contracts where usually an energy company will take over responsibilities of the service and maintenance of an existing customer supply facility. However, they are not involved with the planning or installation of the plant. And more importantly, there are no real incentives to run the plant as optimized as possible since this is not how they typically are remunerated. So an ESC contract (which includes service and maintenance) will generally provide larger energy savings because of its built-in incentive for energy optimizing as discussed in the ESC section.

One potential problem in Sweden can be the somewhat unclear legal situation when it comes to removing heat-boilers that are installed in the buildings. There is a risk that the heat-boilers can in some cases be considered as an "integral" part of the building and can therefore *not* be removed by the ESCO after the contract period. However, according to one of the interviewees, a professor of real estate law (Ulf Jensen, Lunds Universitet) has made investigations into this and come to the conclusion that there should *not* be a problem with removing the heat-boiler after the contract period. This, under the circumstances that the boiler can be "easily" removed, thereby not being considered as an integral part of the actual building (eg. compare with plumbing which cannot be easily removed).

4.1.6.1 Opportunities

The district heating grid in an area is owned by a company (public or private) and they have a monopoly on the district heating services in the grid. In some areas the monopoly situation has lead to district heating companies (usually non-municipal) having high prices on the heating. This can lead to opportunities for ESC companies who can then, in some areas, provide the customers with a service with a lower price than what the utilities can offer. In

Sweden there are ESCOs that are starting up businesses to compete with the district heating utilities in the regions where the prices on district heating are the highest (such as Eco2 Energy).

The ESCOs may also try to compete by providing an eco-friendly approach, choosing fuels and technologies that are more environmentally friendly. Especially with solar or wind energy, this might be an area where the eco approach can be more important than just the price.

There are areas where the district heating is not built out where ESC might be a good option, eg. in newly built residential or commercial areas. ESC, maybe in the form of a local district heating system could be very interesting in such areas.

As buildings are constructed in a more energy efficient way (not least as an effect of rules and legislation) the need for heating will decrease. It will come to a point where it may no longer be profitable to expand district heating to newly built areas. District heating needs a certain *subscriber density* or *demand for energy* to be profitable. Smaller scale ESC projects might be better suited for these areas and this could prove to be an interesting opportunity for ESC in the future.

Of the buildings not using district heating, heating is often provided through electricity, heat pumps, wood pellets and oil boilers. Of these, the buildings using oil are of very high interest to ESC. Of the others (excluding electricity) some sort of measure has commonly already been made to convert from other energy supply and the customer might therefore not be as interested in ESC.

According to *table 4.1.1* there are about 10 000 oil boilers still in operation in Sweden in the sizes of 60-500kW. These will need to be converted within the next few years because of the target to phase out fossil fuels in the building sector to 2020, and this could very well be an area where ESC could play a role. Since the oil boilers in the table are in the sizes of 60-500kW, especially in the higher ranges ESC would be very feasible. Even though the vast majority of oil boilers have already been converted in Sweden, this number can still be considered as very high (according to comments from employees at a large ESCO).

The regional distributions shows that especially in south Sweden there are still many oil boilers in operation. Perhaps it could be a good opportunity to direct ESC efforts to these areas.

Region	Number of municipalities	Participating municipalities (in the survey)	Number of oil heat boilers
Dalarna, Gävleborg	25	25	523
Gotland	1	1	172
Jämtland	8	8	464
Norrbotten	14	7	17
Skåne	33	27	1324
Småland, Blekinge	35	28	3057
Stockholm	26	14	279
Uppsala	8	7	308
Värmland	16	15	600
Västernorrland	7	7	550
Västra Götaland	49	43	2140
Örebro, Östergötland	25	25	574
Sum	247	207	10008

Table 4.1.1. Survey of oil heat boilers, 60-500kW. (2ndNEEAP Sweden)

4.1.6.2 Threats

As mentioned, ESC is not very well-known and a big threat to the business model is the low awareness, especially in the non-industrial sectors.

The district heating utilities are likely to meet competition from ESC companies in the ways they can. An ESCO helped a customer in Bjuv, Sweden, with lowering their energy costs by "threatening" the utility with installing localized heat boilers at the customer facilities. The utility lowered their price in response to this. If ESC grows in areas where district heating is expensive and the utilities lower their prices, it will become very hard for the ESC companies to continue to compete in these areas.

In municipalities where municipal energy companies operate, prices tend to be lower than where private utilities operate. It will be hard for ESC companies to compete in these areas.

4.1.7 EPC

ESCOs started to provide EPC services in the late 70s and 80s as a result of the oil crisis and the referendum to phase out nuclear power in Sweden. These early attempts of EPC did not turn out to well and this severely damaged the reputation of the EPC concept and the distrust that this generated from the customer side can still be heard to this day. A telling quotation from the early EPC days is still remembered by some: "freezing in the dark". When energy prices later dropped the early EPC market in Sweden died out (Lindgren, Nilsson, 2009).

It wasn't until around 2000 that EPC started to emerge in Sweden again. This time around it has reached far more success. Thanks to good services provided by the ESCOs, a supportive political framework, higher awareness, climate change concerns and an increasing energy price the EPC market has grown to a mature market. Sweden is even seen as something of a role model in how EPC can be introduced to a new market. (Lindgren, Nilsson, 2009)

The EPC market in Sweden has matured significantly over the past 5 years and has now established itself on the market as one of the most known energy contract forms. There are several companies operating on the market. Most notable are: Schneider Electric, YIT and Siemens.

Of these, especially one company has a significantly large market share. The competition between the EPC companies is getting tougher, just a few years ago the company with the largest market share dominated the market almost completely. Since then, the other companies have gained larger market shares. There is also competition coming from companies that have just started to provide EPC-like services, not least from FM companies such as Dalkia.

In Sweden, a combination of guaranteed savings and the two-step model is by far the most used. This leads to less risk for the EPC companies compared to the one-step model and shared savings which could generally result in more comprehensive projects. As discussed in the EPC section, the guaranteed savings approach is good for building up a long-term mature EPC market. Shared savings EPC projects do occur but can be said to be more the exception rather than norm.

Most EPC have a contract length of around 10 years. The average payback time for EPC projects in Sweden is 10-12 years (Energimyndigheten, 2011). But there are indications that customers are willing to accept even longer payback times since the EPC model has gained more recognition and trust. Several projects have payback times that are over 15 years which can be seen as a very good thing since it will lead to more comprehensive projects with larger energy savings.

Table 4.1.2 shows the building area of the realized EPC projects in Sweden between 1998 and 2011.

Year	Number of EPC-projects	Area, m^2
1998	1	134000
1999	2	85000
2000	-	-
2001	2	75000
2002	4	491000
2003	4	219000
2004	9	962000
2005	11	893000*
2006	12	2115000
2007	7	2478000
2008	13	4175000
2009	12	2148000
2010	2	229000
2011	7	1575000
Sum	86	14686000

Table 4.1.2 Source: Energimyndigheten2011; *Data missing from 6 of the 11 projects

As seen in the above table, the EPC development has really gained momentum from 2005 and forward (note that data is missing from 6 of 11 projects in 2005).

4.1.7.1 Potentials

Looking at the potential for EPC in Sweden, calculations vary. According to WSP (2007) there is a potential of saving 12 TWh to the year 2016. According to IVL (2007) the potential is lower, 4 TWh to 2016 (Energimyndigheten, 2007). An even lower estimate is given by some of the background material to the energy service directive (ER 2010:32), claiming a 1 TWh saving to 2016. (Energimyndigheten, 2011)

It is difficult to calculate the potentials, which the variation in the above numbers indicates. Even if the lower numbers are realized it is still a significant saving.

How much energy that is saved in EPC projects can of course vary. There are no good official numbers but data from the largest EPC ESCO in Sweden can *indicate* the savings level. According to the ESCO they have saved 21% on average in their projects that were active in 2010. The ESCO had 43 active EPC projects covering 3.1 million square meters.

4.1.7.2 EPC in the public sector

Almost all EPC projects are carried out in the public sector, especially in municipalities. Some hospital projects have been realized but there is still a large potential for further projects to be developed here.

There are several points worth noting that are related to the large portion of public projects. In Sweden, the municipalities generally have good economy. The economy has been managed responsibly and this has lead to very good credit worthiness amongst the municipalities. Therefore, municipalities can easily get beneficial, low rate loans. This means that the municipalities can finance energy efficiency projects themselves. This is a reason why guaranteed savings is used so often. The savings guarantee is generally very important to the municipalities, especially since it is the tax-payers money that is being invested. Because of the public customer's ability to self-finance, there is no need for other financing solutions. The ESCOs cannot get loans that are as beneficial as the ones that the municipalities can get themselves. This is an area where Sweden is different from many other markets.

When public institutions procure services like EPC they are bound to the rules of public procurement. The public procurement process can be complicated and some see this as a barrier for EPC. An EPC project in the municipality of Stockholm was cancelled in 2009 after some legal experts claimed the EPC procurement was in violation with the public procurement laws. The Swedish Energy Agency (Energimyndigheten) and Miljöstyrningsrådet (the Swedish government's expert organization for environmental and sustainable procurement) has since then concluded that EPC is in line with the Swedish public procurement laws and that there is no hindrance to proceed with EPC projects in the public sector (pedersen.se).

The uncertainty about the legal situation had the effect that new EPC projects were put somewhat on hold during 2010 (as can be seen in table 4.1.2) but the market has since then recovered (Energimyndigheten, 2011).

4.1.7.3 Outsourcing

Another characteristic of the Swedish EPC market is that the service and maintenance organization usually resides on the customer side. Because most EPC-projects are carried out in the public sector and most larger public institutions already have their service and maintenance organization or have existing service and maintenance contracts with other companies, there is a lower reason for the ESCO to provide the customer with this service. Some of the largest ESCOs in Sweden operating in the EPC-market do not offer this service at all to the customer which is something that is more common in other countries like Germany. There are actually only very few ESCOs operating on the EPC market that have the capacity to provide this service at all. The ESCOs are however very involved in the customer's service and maintenance organization since they hold a very big role in creating successful EPC projects. The involvement means education and close follow-ups.

Including the service and maintenance part into the EPC project could perhaps create higher energy savings since there is arguably a larger incentive for optimization if it is done as an integral part of the ESCO's services. This, since the ESCO has a more direct gain from any energy savings. At least compared to outsourcing just the service and maintenance to a third-party company, which is not uncommon.

If EPC becomes more common in the private sector maybe it will also be more important that the ESCO provides service and maintenance as a more integral part of the EPC contract.

4.1.7.4 Integrated EPC

In Sweden, most EPC projects do not include the supply side. Again, the biggest reason being the well built-out district heating. If district heating is already used then there are seldom any economical incentives to convert to other supply types. The cases where the supply side is incorporated into EPC in Sweden are typically when there are oil heat-boilers in the facilities. In these cases it makes good sense to convert to a cleaner and more efficient supply technology. The savings made from the conversion will then be incorporated into the EPC savings. It is not typical for the ESCO to take over the service and operations of the supply facility, usually it is left to the customer's service organization or if the customer has outsourced this through a separate service and maintenance contract. As with the discussions in the previous section, if the service and maintenance of any supply facility is carried out by the ESCO there will be a larger incentive for optimizing the operation since they have a more direct gain from any energy savings made.

However, including supply is a growing trend, especially when it comes to renewable energy. Many customers are interested in solar or wind power and this is something that can be used even if there is district heating available. Solar and wind power gives the customer a concrete and visual environmental profile that can be of interest even if there might be other options that makes more economical sense (such as district heating). The fuel used in district heating can sometimes be gas or peat and in these circumstances conversion to solar, wind or wood pellets can also make additional environmental sense.

4.1.7.5 Opportunities

The growing awareness about energy services and EPC in particular, will have a positive effect on the market. Today, there are many good practice examples that can be shown to potential customers. The EPC companies have gotten more experience and the quality of the projects is generally getting better. If you look at some of the earlier EPC projects carried out by a certain ESCO and then compare it to an EPC project they are doing today, it is obvious that the gained experience has lead to higher quality projects and more accurate set baselines.

The raised awareness and trust in the model can have the effect that customers will sign up for contracts with measures that have longer payback times, such as building shell refurbishment. This is something that will give larger energy savings over time and also needed to meet the long-term climate targets (World Energy Outlook 2009).

Public procurement can be complex, but since the legal situation of EPC has been clarified there shouldn't be the same problems in the future as the ones that arose in Stockholm.

Incorporating the supply side in EPC projects can be an opportunity for ESCOs to develop their business models. The growing use of wind power and solar energy suits itself very well to be included. Of course, in the cases where there already exist local heat-boilers, the ESCO participation in installing more efficient technology can be developed. A larger responsibility in the service, maintenance and operations of the supply side could lead to a bigger interest from customers to actually incorporate it into the projects.

A larger involvement in service and maintenance could also lead to EPC projects with higher savings due to the raised incentive (from the ESCO side) to optimize the technical facilities, especially in the cases where the supply side (such as heat boilers) is incorporated.

In some sectors, especially commercial facility sector, the outsourcing of the service and maintenance organization can be a driver for engaging in energy contracting (see the chauffage section). Incorporating larger use of service and maintenance could perhaps be a bridge over to this market.

The two-step model is good for complex projects but for simpler projects a one-step model might be a better choice. Using the one-step model to for example change street-lighting, or for homogeneous non-complex building pools might provide an opportunity to use EPC where it might today be considered too costly. And worth noting is that EPC does not by any means have to strictly follow the one-step or the two-step model, it could just as well be something in between, or beyond.

In the Swedish market, the EPC projects so far have been a bit more individualized and adapted to suit the particular customer compared to Germany. It is not as standardized as it is in Germany. This can be a good thing, making the projects more tailored for the customer and thereby probably creating a more suitable solution. On the other hand, having a more standardized approach can lead to easier project implementation, more standardized procurement procedures etc. leading to lower transaction costs and a probability of more EPC projects being implemented as a result. A reason for this can be that up until now, the ESCO has played a larger role in the procurement process. However, a very clear trend is actually that the EPC procurements are becoming much more standardized then what they have been before. This can be a sign of a more mature market. The customer knows a lot more about EPC today than just a few years ago and takes on a bigger role in the procurement process resulting in the procurements following a more standardized protocol. Customers do also often take help of external consultants in this process. EPC is becoming more of a commodity, an "off-the-shelf" solution, and it is very likely that it will become more like the German market in this sense.

The private sector is a more or less untouched market. If ESCOs can find a good way of working with EPC in the private sector there are large potentials.

4.1.7.6 Threats

Listed in the opportunities section was the fact that existing EPC companies are getting better and learning from their experiences. On the other hand, a growing market will introduce new ESCOs to the EPC market and these will of course need to learn and build up their own experience. That means that new companies might not be able to deliver as good projects as the established companies and this could lower the trustworthiness of the EPC-model. There have already been examples of this with FM companies that are incorporating EPC (see the FM section).

The quality of the EPC projects will depend on the competence of the staff that is available to the ESCOs. But a problem in the Swedish market (as well as in other countries) is a shortage of qualified people. This is a large barrier to the whole energy service market, and especially to EPC due to its complexity. The shortage of qualified people is seen as one of the major barriers both in the short-term and the long-term. Looking at how many people are being educated in the energy field and comparing with the projected needs, it is obvious that there will be a long-term shortage of educated personnel.

The public procurement process is complex and costly and is a barrier for all energy contracting. EPC is one of the more complex energy contracts and it means that the procurement process will generally also be more complex compared than for other contracting models. This makes EPC vulnerable to competition from other less complex business models. One problem with EPC is that the customer binds itself to one supplier for a very long time which can in some cases be a problem with the procurement rules (this will be more apparent the longer the contracts are) and also with the decision making in the customer organization. Since EPC is mainly aimed at the public sector, the large customer organizations can be a problem when it comes to making a decision on EPC. Many people have to be involved and the number steps from the energy competent people up to the final decision makers can be very long. This is especially a problem in the larger municipalities and less so in the smaller.

4.1.8 IEC

Integrated Energy Contracting resembling the form that has been discussed in this thesis is not common in Sweden. Energy efficiency has traditionally had a strong polarization to either demand side or supply side measures. There are ESCOs working in the industry that may work with some integration principles but they seldom include service and operations of the supply facilities. There are examples of ESC-like contracts in the industry sector where the provider (usually an energy company) has also done some work on the demand side. These contracts are usually also without any savings guarantees. Energy consultants are also active on this market.

There are demand side projects where the supply side has been added, usually without service and operation. Then there are also examples where energy contracts have included the supply side but in the "opposite way". Many industries don't have a problem with getting heat, they have a problem with getting rid of heat. In industries which have processes that create a lot of waste heat, taking care of this waste heat can create large savings. One benefit with having a well built out district heating system in this case is that it makes it possible to use this waste heat and put it into the district heating system. Many projects aim to make this possible by building connections to the district heating system. However, this requires agreements between the industry and the local district heating company since there are legal barriers for a third party to connect to the district heating grid. Using waste heat in the district heating systems is a very interesting integrated approach that deserves some attention.

As with ESC, the vast use of district heating (and cooling) lowers the need for local energy supply in many cases. But in the cases where there are needs for a local supply, then IEC could be a very good idea.

4.1.8.1 Opportunities

Because of the close relationship with ESC, the opportunities for ESC can indicate the opportunities for IEC. As shown in *table 4.1.1*, there are about 10 000 oil heat-boilers in the range of 60-500kW which need to be converted within the coming years. Looking into the possibility of incorporating demand side measures in these conversions could be very interesting, especially at the facilities using boilers of the larger sizes.

For ESCOs working with ESC in areas where they compete with district heating, IEC could be a way to expand their model and give them an advantage on the market. If these ESCOs start to pose a threat to the established utilities in the region (which might have higher prices) the utilities are likely to lower their prices in order to meet the competition. Being able to provide IEC can then be an important advantage to the ESCO. Providing demand side EE measures could also be a way for ESC companies to gain more trustworthiness. ESC is a "new" concept, at least in the residential buildings sector, and trust can be an important barrier to overcome. Providing demand side EE measures could emphasize the *value* of the *energy service* and perhaps overcome some of the reluctance from the customers as focus is moved away from "just selling energy".

One area where IEC might be a very good complement to the available business models currently used on the Swedish market is in the private sector. EPC has had a very hard time reaching this market and perhaps the simpler approach of IEC (with lesser transaction costs etc.) can be more attractive. Especially if projects are done with shorter payback times, something that is important to large parts of the private sector. It is also in the private sector where most ESC are done today.

Mentioned as a threat is the wide use of district heating that could make the IEC model less useful on the Swedish market compared to the German. However, utilities working with district heating could apply elements from IEC when developing their energy services. Looking at the trends of energy companies (especially municipal) providing more demand side services, it would be interesting to apply the use of QAI (Quality Assurance Instruments) on the demand side EE measures. This could very well lead to a development of more comprehensive demand side measures from the energy companies. Today, most of the utilities offers are limited to the technical facilities; using more of an IEC approach could be a way to expand this.

4.1.8.2 Threats

The Swedish market does not use ESC in the same way as on the German market. Therefore the potential customer base is not as clear as in Germany. Efforts need to be made to identify customer types that would especially benefit from IEC.

The large use of district heating makes the market for IEC (as with ESC) a lot smaller compared to Germany. If IEC elements were to be incorporated into energy services using district heating it is likely that the supply side will not "feel" as integrated into the project as if using a localized supply; projects might tend to resemble more of a demand side "add-on" project than an integrated project. The IEC suggested payment method is less likely to work well with district heating as well (as discussed in the IEC section).

4.1.9 Chauffage

Chauffage, or *comfort contracts* as they are referred to in Sweden, is a growing business model. The use of the business model has been lead by Göteborg Energi, a pioneer among energy companies when it comes to providing energy services in Sweden. Göteborg Energi is a municipal utility (municipality of Gothenburg) and has been working with energy services since the early 90s. The company offers a range of energy services and their *comfort contract* is one of their top-of-the-line offering (the other being the "green partnership" which aims to make buildings completely carbon neutral).

The energy service portfolio that Göteborg Energi uses has been spread to some other municipal energy companies and today there are three energy companies in Sweden who are using the chauffage model and a fourth that is starting up. The companies are shown in *table 4.1.3*, note that data is for all of their energy services and not only chauffage. The fourth company, Lunds Energi, have just started up their energy services and will not provide comfort contracts in the starting phase.

Energy Company	Turnover 2010 (million €)	Employees (energy services)	Comments
Göteborg Energi	20	70	Target 2014: 33 million €/year
Mälarenergi	4,62		Started in 2007
Öresundskraft	2,2	26	Active for 2 years
Lunds Energi	-	-	Comfort contract not implemented yet

Table 4.1.3. Energy companies involved with chauffage in Sweden. (Energimyndigheten 2011, interviews)

These energy companies have in common that they all deliver district heating and electricity as their main business area. They mainly use their own district heating for the energy supply but in theory they are not bound to it. Because of municipal regulations they have to buy the energy at a market price, even when they buy it from themselves, they are not allowed to subsidize it. However, because of the nature of municipal district heating utilities, few other companies can compete with their prices and availability in these regions.

The demand side measures that are performed are mainly limited to the technical installations of the facilities. On a yearly basis the energy company will go through the customer facility and give advice on additional EE measures, this can include lighting, building shell measures etc. The energy company will take on a consultant role. The suggested measures can then be financed through the energy company and paid back through raising the yearly fixed fee per square meter.

Many customers come from the commercial sector for which the chauffage model is especially beneficial. About 25% of Sweden's building space consists of commercial properties (Energimyndigheten, 2011) which indicate a big potential for the business model.

It seems only energy companies have shown interest in the chauffage model in Sweden so far. Since the model has been started at an energy company and they have shown success in using it, it is natural for other energy companies to follow. It also seems that it is mainly municipal utilities showing interest in the model. A reason for this can be because they are generally a lot more serious about energy service than the large utilities. Göteborg Energi even has an owner directive that says: "they are not allowed to sell energy to the customer that they don't need" (Mats Mårtensson, Göteborg Energi). You will not find this kind of owner directive from non-municipal large energy companies in Sweden (in theory, state owned companies such as Vattenfall could have owner directives such as this but it is not very likely in this specific context).

Another thing that makes the chauffage model, as used in Sweden, very advantages for an energy company compared to a pure ESCO is that some of the risks involved with having a fixed price for the energy usage are leveled by the company's other business activities. For example if there is an exceptionally cold winter, the heating demand will increase and this could mean that the contract provider will experience a loss because of the fixed price level which is calculated from a normal year. An energy company which also sells heating will then make more money from their other customers because their demand for more energy and thereby compensate the losses from the fixed price models. This has been the case during the past two years in Sweden with colder than normal winters.

The energy companies also have another very strong competitive advantage towards the pure ESCOs, they already have a business relation with their customer (in most cases). Especially energy companies which offer some optimization of the customer's technical facilities in their default district heating service, have a big advantage since they are already in the customer's facilities. They have a relation with the customer, the customer knows who they are and the energy company is already accustomed to the customer's facilities. The next step, to provide additional energy services is thereby small. ESCOs operating in the Gothenburg region have commented that they are having a very tough time competing with Göteborg Energi (GE) when it comes to demand side services, at least with non-EPC contracts, contracts that do not offer a savings guarantee, because of the relationship that GE already has with the customer.

A strong driver from the customer side to sign up for a chauffage contract is to outsource their service and maintenance organization. This is a growing trend and the customer typically expects to save around 10% by doing this, according to an interviewee.

4.1.9.1 Opportunities

The outlook for the chauffage model is looking very good in Sweden. It is likely to continue spreading amongst the municipal energy companies first and foremost. It is a business model that is very easy to understand for the customer and the economical benefits are very clear. The chauffage contract, as used in Sweden, is usually only about 4 pages long. Compare this to EPC where the contract is usually 30+ pages and includes a lot of commitments from the customer to facilitate the responsibilities involved from the ESCO versus the customer. In an EPC contract there are also a lot of obligations for any subcontractor, because of the need to mitigate any risks that could affect the baseline (for which the ESCO is economically responsible for). The contract period in the comfort contracts is also very flexible and can range from a couple of years and upwards. The longer the contract period the customer agrees on the lower the fixed fee will usually be.

It is a very strong trend that the municipal energy companies are providing more and more energy services and the comfort contract has positioned itself as the top-of-the-line energy service for utilities.

However, the model is not only for energy companies. In other parts of Europe many ESCOs are working with the chauffage model. It is likely that the municipal energy companies will be the front runners in Sweden in the next few years, but there is nothing that excludes other ESCOs to also start using this model. This could open up some interesting opportunities; private ESCOs can also do business in the whole country and are not bound by law to only act inside of a region (see next section). Some of the FM companies have a similar pricing model of being remunerated per square meter and a chauffage model can thereby be beneficial for them.

A big problem in Sweden is the *split incentive* (as discussed in the chauffage section) when heating is not included in the tenant's rent. This is very common in the Swedish commercial buildings sector. Even though there are some uncertainties about the landlord/tenant situation (see section 4.2.7.9), experiences from using the chauffage model have shown that it can solve the problems of *split incentive*.

It is very likely that the chauffage model will provide a very strong competition in the future on the Swedish energy contracting market, especially in the commercial property sector. Other countries should also keep their eyes open, not only are several Swedish energy companies in discussion to incorporate the model, but also many international companies. Several companies in Norway, Denmark, Portugal, Japan and USA have shown interest in implementing Göteborg Energi's model.

4.1.9.2 Threats

In large energy saving projects in the public sector and hospitals, the chauffage model is likely to meet tough competition from EPC-models or in-house solutions. In these sectors there are normally existing service and maintenance organization and the trend of outsourcing this is not as strong as in the commercial sector. However, there are indications that this is growing in these sectors as well, but it is not as prominent as in the commercial sector. EPC-models can often provide more comprehensive projects where the ESCO do not only act as consultants in the demand side measures but provides more of a turnkey solution. This, together with the savings guarantee can be very important for many public institutions.

A big problem for growth amongst the municipal energy companies is that they are forbidden by law to sell services outside of their region. Even though there is a customer demand to use chauffage services they can’t because the existing providers today are municipal companies which might not be available in their regions. This is a strong barrier to the expansion of comfort contracts. It has lead to a very regional availability of the service (especially considering how few companies are offering the service today). It is likely that the model would have been much more wide-spread in Sweden if it wasn’t for this municipal law.

Comfort contracts are an easy way for a property owner to lower their net operating cost of their building. However, there are other investments that typically will raise the property value a lot more than energy related investments. One interviewee claimed that the property sector is under-valued in Sweden since it is still not profitable enough to invest in value-raising energy related projects. However, other sources indicate that the long-term outlook on property value will move in the opposite direction. There are opinions that the Swedish property market is in fact one of the most over-valued in the world (DN.se(b)). A lowered value on properties would be a threat to the chauffage model.

Many large private property owners in Sweden are speculators who own residential areas for a few years and then sell them off at a higher price. The problem with these property owners is that they are very reluctant to do any investments in the buildings, especially longer-termed. This is a very big problem in many aspects, not least to energy contracts such as chauffage. Chauffage providers see a threat if property owners continue to speculate on properties in such a short term.

4.1.10 FM

Facility Management that includes energy services is a growing trend in Sweden. There are no reports on the extent of energy related services that are offered as of now; this is an area where future investigation is needed (Energimyndigheten 2011).

Many customers are requesting energy services from FM companies. These customers are generally already using FM companies for other services. Some FM companies have started to offer an EPC model with guaranteed savings.

However, so far many customers have been disappointed with the outcome of the projects. One of the interviewees, working at an energy company, stated that if there is one thing their customers have been disappointed in, it's the FM companies. Statements like this have been collected from several people when researching this thesis.

There are several reasons for this. One being that the companies are simply new to this. It can take some time and experience before the companies learn how to provide energy service in a good way. Another is related to what was discussed in the FM-section; there is a shortage of qualified people in the facilities. FM might be a good way to manage people who carry out services in a facility, but in order to manage people who take care of energy optimizing etc., you need highly skilled personnel in the facilities. There seems to be a problem with how FM companies are *used* to work and how they will *have to* work in order to provide high quality energy services. Some former employees at FM companies have stated that they have the "wrong" approach; that it's to a large degree a (business) "cultural" issue; that they don't acknowledge the high qualification needed from the people who are actually working with the energy related problems *in* the facilities (this can in some ways be compared to the "culture" in the large commercial energy companies when it comes to selling versus saving energy). The FM companies need to learn from their experiences and maybe adapt to doing things a bit different from what they are used to in order to improve their offerings.

Several FM companies have chosen to partner with ESCOs that have more experience with energy services in order to provide their customers with a high quality service.

4.1.10.1 Opportunities

There is a clear customer demand for energy service integration into FM. So the opportunities are looking very good. Especially for customers who are already using FM services it makes sense to also integrate energy services.

The use of energy service integrated FM is likely to grow and this is an opportunity for the "traditional" ESCOs to expand their offerings. Several ESCOs working with EPC have already started to include some services that have traditionally been associated with FM services such as security, fire protection etc. We are also seeing ESCOs partnering up with FM companies for certain projects and it is likely that there will be further cooperation or merging of FM companies and ESCOs in the future.

Looking into using chauffage like services might be more natural to FM companies than incorporating an EPC model.

4.1.10.2 Threats

A big threat is that the FM companies will get a bad reputation because of disappointed customers. This needs to be taken serious since a bad reputation can live on for many years and affect the market possibilities in the future. EPC had this problem in Sweden and other countries because of some bad first attempts which have had implications on the market even 10-20 years later (Lindgren, Nilsson 2009).

The FM companies also have very tough competition from the established ESCOs on the market, especially on the EPC side. It is hard to enter a highly competitive, mature EPC market for any company. The Swedish EPC market has matured a lot over the last few years and it has become a highly competitive market.

All ESCOs on the market are having problems finding skilled people to hire, this is large barrier, and the FM companies also face this problem. ESCOs which have been specializing in energy services for a longer time might have a somewhat easier time recruiting the right people than the FM companies which are newer to the market and may not be as specialized in the energy efficiency field. Comments from interviewees and others (including former employees) have indicated this.

Another problem is that procurement processes usually focus on the price of the service and not the quality. Many customers may not be as willing to pay extra for the inclusion of energy services. However, this can be an awareness problem. According to comments from interviewees and former employees of FM companies, the FM companies have been prone to compete with bidding low and in several cases offered a price that wouldn't really cover quality energy services. This will of course affect the services they then provide to the customers in a negative way.

4.2 Germany

4.2.1 Some facts about Germany

Germany has a population of 81.8 million (Destatis.de). The total final energy consumption is 2614 TWh (NEEAP Germany 2007). About 60% of the final energy use is for space and water heating.

District heating covers 14% of the occupied accommodations. 46% of the district heating is distributed to private homes; 36% to public buildings, commercial and trade sector; 18% to industry. Geographically, the use of district heating is much more common in the eastern parts of Germany. In western Germany the market share for district heating is around 9% and in eastern Germany the share reaches 30%. (cospp.com; ecoheat4.eu)

4.2.2 Energy Services

The German energy service market is one of the most mature in Europe. Energy efficiency services started to emerge in the early 90s and have since grown. The estimated number of ESCO or ESCO-like companies working with energy services are about 500 (S. Hansen, 2009). Of the ESCOs that are involved with energy contracting (such as ESC and EPC) the number is around 280 (BEA 2011).

The energy services can be divided into different categories. There are the more informational; these were the earliest services to emerge on the German market. Services include information, communication, consulting services. These services are often provided by utilities and an important driver is the improvement in customer relations and retention. (Bunse, Irrek, Siraki, Renner, 2010).

Then there are services connected to industry, commerce and public sector that are connected to energy delivery contracts. These services are more of add-on services to the energy delivery contracts and the main driver for providing the services is customer retention. (Bunse, Irrek, Siraki, Renner, 2010).

Thirdly, there are the more comprehensive energy services which are by themselves profitable and not just a tool for customer retention and relations as the other categories tend to lean towards. Energy contracting is in this category.

Of the energy contracts in Germany, ESC is the most common and has a market share of around 80-85%. EPC has a market share of about 10-15%. Maintenance and administration of technical installations has about 5% of the market. (Bunse, Irrek, Siraki, Renner, 2010; T Miller 2010; S Hansen 2009)

Even though energy services are widely used in Germany, there still exists some suspicion from many customers towards energy contracts, according to interview subjects. The trust issue is of very big importance in Germany. This can in some cases lead to advantages for local ESCOs and utilities which are known to the customers in the region. It can also make it hard for newcomers on the market to establish themselves, having good reference projects to show can be very important.

4.2.2.1 Energy agencies

The use of third parties such as energy agencies to aid in project facilitation is very common in Germany. Most customers are not experts in energy or legislation and it can be very beneficial for them to work with a "neutral" third party as an intermediate between the customer and the ESCO. The energy agencies are experts in procurement processes and have good know-how about legislation.

4.2.3 Potentials

Energy services in Germany have a relatively long history and a lot of energy savings have been realized. Still there is a large potential for the market to grow. According to reports, Germany has the largest economic savings potential in the EU (Klobut, Tuominen, 2010). The reason for this is mostly because of the large building stock (compared to other EU countries) rather than the relative savings from each building.

There is a general consensus amongst energy experts that the market will continuously grow, not least as a result of the expansion of combined heat and power usage (S Hansen 2009; Bunse, Irrek, Siraki, Renner, 2010). The growing use of renewable energy can also raise the potential for energy services. Another important fact to consider is the role that energy services will take in the future in realizing the phase out of nuclear power. This might very well help raise the potential of the market making more projects economically feasible.

An estimate done in 2005 estimated a total potential of 1.3 million ESCO projects, the number of running contracts are estimated to 50 000 (S Hansen 2009). According to the (first) German national energy efficiency action plan (NEEAP Germany 2007) Germany has an *economic potential* of saving 13.2% of its final energy consumption to 2016, 346 TWh.

Looking at some specific sectors (transport/traffic and manufacturing excluded) the numbers are (to 2016):
Private households: 98 TWh, (corresponding to 12.5% economic savings potential within sector).
Trade, industry and service: 41 TWh (10.7%).

The public service sector is included in the "Trade, industry and service" sector, looking at it specifically the numbers are:
Public service sector: 11 TWh (17.5%).

4.2.4 Policy

There are several policies that have an effect on the energy service market. As with Sweden, some are EU-based and some are national.

The Energy Service Directive, ESD (2006/32/EC), has an *indicative* target of reaching 9% energy efficiency to 2016. According to a German energy expert, Germany has reached about 45% of this target already.

The ESD was implemented in Germany very late, not until 2010, 2 years after it should have been implemented. According to several interviewees, the implementation was very "soft", meaning that it didn't contain any measures that have had any direct impact on the energy service market.

Germany has setup several 2020 targets. The oldest is to *double the energy productivity* to 2020 from 1990 years level (Lehr, Lutz, Pehnt, Lambrecht, Seefeldt, Wünsch, Schlomann, Fleiter 2011). This is an *energy intensity* target which is related to the *primary energy usage in relation to GDP*. Doubling the *energy productivity* is the same this as lowering the *energy intensity* with 50%. According to an energy expert, Germany is far from reaching this target.

In the *Energy concept for an environmentally sound, reliable and affordable energy supply* (Energy Concept 2010) several targets related to energy efficiency are presented:
20% lower primary energy consumption to 2020 and 50% lower to 2050, from 2008 years baseline. Reduce electricity consumption with around 10% to 2020 and 25% to 2050. Reduce heating requirements of buildings by around 20% to 2020 and have a building stock which is almost climate neutral to 2050.

In addition to this there are the German climate targets of mitigating CO2 emissions with 40% to 2020 and 80% to 2050 (non-trading sector, 1990 years baseline). (UBA 2007)

Germany has decided to phase out nuclear power and to be able to do this and still meet the climate goals, renewable energy and energy efficiency will play a big role. (Matthes, 2011)

4.2.5 Renewable Energy

A large part of Germany's energy production comes from fossil fuels. The interest in using renewable energy is however growing in Germany, both from customers and policy makers. There are also targets set by the EU. German targets for renewable energy include a share of 18% to 2020 and 60% to 2050 (BEA 2011). Germany had a share of 10.9% renewable energy in the total final energy consumption in 2010 (BMU 2011)

The Renewable Energy Heat Law promotes the use of renewable energy but also EE services. The combination of doing EE measures together with using renewables go hand in hand and it is an important tool in reaching the energy and climate targets. For example, conversion of renewable energy has lower losses compared to thermal combustion. Thereby, the extended use of renewable energy can promote primary energy savings in the energy system.

The inclusion of renewable energy into energy contracting will become more important. ESCOs who can combine these two into a "package" will probably gain advantages on the market. (Bunse, Irrek, Siraki, Renner, 2010)

From the customer's point of view, the interest in using renewable energy has grown. Many customers choose renewable over fossil energy sources and many are also ready to pay a little bit more for this. As stated by an interviewee: "The market is ready".

4.2.6 ESC

Energy Supply Contracting can be considered the most important energy contracting form in Germany, having a market share of around 85%. The majority of the companies that are active on the energy contracting market do offer ESC. The large district heating systems are not as prominent in Germany as in Sweden; they are most common in larger cities and eastern Germany. The heating system is more dependent on decentralized solutions and many buildings use more localized supply, either in direct relation to the building or as part of a local district heating system. In Germany, only 13% of the residential buildings (Ecoheat4.eu) are connected to district heating (compared to around 50% in Sweden) and many buildings rely on ESC instead.

4.2.6.1 Renewable energy

As discussed in the country overview, being able to provide renewable energy as part of a "package" is becoming more important. ESC is very well suited for this since it is neutral to the energy technology. In one sense it can be easier to use renewable energy in smaller localized power plants than in the large centralized systems because the latter are more dependent on strong political incentives to make the technology switch. This because the large district heating systems are more sensitive to the economical aspects and are more likely to choose the most cost effective solution whereas smaller systems might choose renewable energy for other reasons. If there is a lack of strong political incentives, such as a carbon dioxide tax, it can be argued that smaller systems are more likely to convert to renewable energy. In Sweden for example, it wasn't until a carbon dioxide tax was introduced that the large district heating systems started to convert away from oil.

4.2.6.2 CHP

The use of combined heat and power (CHP) is becoming more important in Germany and it is a very good way of increasing the effectiveness on the supply side. Incorporating both electricity and heat production can create conversion efficiencies of over 90%. The German government is actively working to promote the use of CHP and have instated laws such as the "Kraft-Wärme-Kopplungs-Gesetz KWKG". The use of CHP has gone up in the recent years. (Bunse, Irrek, Siraki, Renner, 2010)

4.2.6.3 ESC characteristics

Most commonly the ESCO will own the heating or cooling systems during the contract period. Around 70% of the supply facilities are owned by the ESCO (Bunse, Irrek, Siraki, Renner, 2010)

ESC contracts are used through all sectors. According to one of the interviewees, about 50% of the ESC market is in the public sector where buildings are often put into pools (as with EPC following ESP, see next section). The public sector is then followed by private residential building sector and then by hospitals.

Typically, the ESC contracts are investment free for the customer. According to one of the interviewees, about 95% of all the ESC contracts are done without customer financing. Customer costs that may arise are more connected with secondary technical installations in their facilities.

The contract lengths are typically around 10-15 years.

Many older heat-boilers use oil and when they are replaced it is most common to choose gas.

4.2.6.4 Opportunities

ESC is a very well established energy contracting model in Germany. Customers will always need heating (and cooling etc.) and the future place for ESC on the market can be seen as very stable. The growing use of CHP will likely create new opportunities for ESC. The targets to use more renewable energy will also create possibilities for further use of ESC.

4.2.6.5 Threats

The pure ESC contracts will likely meet more competition from integrated models in the coming years. However, the integrated contracts are not likely to replace ESC as the dominating energy contract in the near future.

Larger expansions of the district heating networks can have an impact on ESC market and lead to utilities taking over more of the heating (and cooling) delivery services.

4.2.7 EPC

EPC emerged in the German market in the early 90s. During this time there were no standard contracts and only a handful of projects were carried out. There existed a lot of mistrust of ESCOs and the reliability of their services. EPC had a haltering start and it wasn't until 1995 that the EPC market really opened up. (JRC 2007)

In 1995 the Berliner Energiagentur GmbH (BEA) started their Energy Saving Partnership (ESP) which has been a very important milestone in the German EPC history. The ESP triggered a growth of EPC in the public sector and has been used in many projects. In the ESP, houses are grouped into pools which are then subjected to an EPC contract. So far, 24 pools have been contracted and they include over 1400 buildings (BEA 2011).

The ESP model has in many cases made it easier to implement EPC since it is standardized and follows a simpler model. The projects follow a one-step model and shared savings is used[1]. The combination of the one-step model together with shared savings may have lead to many projects not being as comprehensive as they might have been with a two-step model and guaranteed savings because of the higher risks and absence of an in-depth analysis (see the general EPC section). As discussed in the EPC section, for simpler projects the one-step model can be desirable, but many of the projects that have used the Berliner Energieagentur ESP model have in fact been very complex. Using a one-step model and shared savings in a complex project will lead to higher risks for the ESCOs and to limit risk the ESCO will focus on "safe" solutions with shorter payback time. This has had an effect that many projects are somewhat focused on the "low-hanging fruit". On the plus side, the ESP model has made it easier to implement the EPC projects and thereby helped to realize projects that would otherwise probably not have been carried out. The model has also helped to spread awareness and built up a larger base of good reference projects and raised the trust in the EPC model. It has also helped in creating a more standardized procurement process.

The standardization is something that is characteristic for the German EPC-market compared to other markets such as the Swedish. It has good sides and bad sides. On the plus side, as mentioned, it helps create an easier procurement process. It is in many cases also easier to initiate and realize EPC projects when they follow a more standardized process. It is easier for third parties such as energy agencies to aid in the procurement. On the down side, the standardization might lead to "stiffer" projects, less adaptation to customer needs which can lead to less effective projects in some cases.

Energy agencies are often involved with facilitating EPC projects. Some ESCOs, such as Siemens, will only work with customers through energy agencies when it comes to EPC. So, if a customer interested in an EPC project would contact Siemens they would be referred to an energy agency instead. The energy agency would then setup the project and include Siemens (alongside other companies) in the procurement bidding phase.

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[1] In many documents it is actually implied that ESP uses "*guaranteed savings*". The "*guaranteed savings*" refers to the *savings guarantee* that is given. However, the projects are financed by the *ESCO* (or TPF) and *not* by the *customer*, the savings are split between the customer and the ESCO, thereby it clearly fits the definition used for *shared savings,* as defined in this thesis. From BEA's homepage: "At its own economic risk, the energy service provider as the contractor makes all investments which are necessary and gives an energy saving guarantee. The partners then share the cost savings." (BEA homepage)

Since EPC is such a complex contract form, especially counting in the procurement process, it can be very beneficial for the customer to work with an energy agency to facilitate EPC projects. Since the energy agencies are experts in the procurement process and have good know-how about legislation and the overall EPC process they can make the process much easier especially for the customer. The use of energy agencies are by many seen as an important driver for the EPC-market. The energy agencies helps create trustworthy projects and thereby helps develop the EPC-market in a long-term perspective. On the downside they can arguably help promote the standardization of the EPC projects which might not always be positive (see above discussion). Some comments from people working at ESCOs not on the German market (Sweden, Denmark), can see the use of energy agencies as somewhat intrusive and feel they might create a barrier.

4.2.7.1 EPC geography

EPC contracts are more common in some parts of Germany compared to others. The eastern regions for example have not carried out as many EPC projects as in other places. There can be many reasons for the differentiated occurrence of EPC contracts. Each Bundesland have their own legislations and policies and some Bundesländer have worked more pro-active to support energy services. It is likely that the awareness and trust issue plays a major role in the geographical differences. In the more frequent EPC regions there exists a better infrastructure for EPC projects as well, with more active energy agencies to help facilitate projects.

In regions such as Berlin, EPC has been done for many years and has gained trust amongst the customers and the awareness is high. In some places such as North Rhine Westphalia (NRW) the housing structures may have worked as a driver. According to one of the interviewees, there are many buildings in NRW that have problems like: having old plumbing that cannot be renovated and need total replacement. This is a costly process and by including measures like changing the plumbing into an EPC project, it becomes easier to finance the measures. This can act as a driver for EPC. The same reason can however work as a barrier in other places where customers will be less likely to invest in an EPC project because the scope of the project will become too big because of expensive and complex measures such as this. If the customer is not convinced about the benefits of EPC, reasons like this can be a tipping point in choosing not to invest in EPC.

4.2.7.2 EPC characteristics

Looking at Germany in a larger perspective, the one-step model is very common as a result of the well known and wide spread ESP model. But the two-step model does also exist. The shared savings model is the most used in Germany but guaranteed savings is also used. There are no studies of the ratio between them as far as the author of this report has found.

In the shared savings model used in Germany, a savings guarantee is given. The savings guarantee is very important in the public sector. What really defines shared vs guaranteed savings in Germany is how the project is financed with guaranteed savings being customer financed and shared savings being financed by the ESCO (or TPF, but the ESCO takes on the credit risk). Forfeiting is also a commonly used financing form.

A big driver for using shared savings in Germany is for financing reasons. The municipalities in Germany are generally high leveraged and can not get beneficial loans as easily as in

Sweden (Sjögren, Schulz, 2011). By using shared savings they do not have to make the upfront investment which makes it easier to engage in an EPC project. According to an interviewee, many of the larger public institutions already have in-house competence on energy and would perhaps want to do the EE measures themselves but don't have the finances, the ability to get help with the financing is therefore a driver to hire an ESCO.

Another driver for using shared savings is the fact that the customer gets benefits from the savings, basically from day one. Because they haven't made the upfront investment they don't have to worry about the payback time in the same way, but still get revenue from their part of the savings. This makes it attractive for the customers. On the other hand, the customer maybe would have gotten a more comprehensive contract if they chose guaranteed savings instead, because of the lower risks for the ESCO.

When it comes to contract length it can vary between 5-15 years. The Shared savings model will usually demand a somewhat longer-termed contract in order to remunerate the ESCO compared to a guaranteed savings contract (given the *same* measures/*identical* project, as discussed in the general EPC section). The use of shared savings and the one step model creates higher risk projects which can lead to *choosing* measures with shorter payback time being implemented to limit risk.[*]

When it comes to realized savings, a good indicator can be the results from the ESP projects, this can be seen in *table 4.2.1*. The average savings guarantee of 26% is high, especially some type of buildings raises this number and it is likely that the inclusion of supply side measures also contributes to the high number (see Integrated EPC section below for discussion). This number is actually higher than the Swedish number of 21% (which as discussed is not necessarily representative for Sweden but should be a good indication) even though it is for projects using shared savings and the one-step model, a potential reason for this (in addition to including supply side measures) can be that the energy prices are higher in Germany and this means that more measures will be economically feasible.

Total number of pools	24
Number of buildings	Over 1400
Guaranteed savings[**] in total:	26%
Annual plus to the public household	€2.7 million
Total CO_2 reduction (1996-2010)	Approx. 450 000 t
Total net investment	€49.20 million

Table 4.2.1. Results from the BEA ESP project. (BEA 2011)

[*] Clarification: the risk affects the *chosen* measures, note that the discussion on contract time in shared vs guaranteed savings is based on *identical* measures being *chosen.* Also remember, contract length is not necessarily the same thing as payback time;

[**] As mentioned in a previous footnote, a *savings guarantee* is given in the *ESP* model but the model still follows a *shared savings* scheme as defined in this thesis.

4.2.7.3 Potentials

Even though EPC has been done for a relatively long time in Germany, there is still a big potential for new projects. The potential in the public sector is estimated to be around €2 billion (including turnover from energy sales). The annual savings potential from energy savings is estimated to be around €200 million (Bunse, Irrek, Siraki, Renner, 2010). There is a minimum of 20 000 buildings that are suitable for EPC in the public sector (BEA 2010). *Table 4.2.2* contains some numbers on the savings potential for EPC.

	Savings (Mill. €/year)	CO2 eq (t/year)
Public authorities	210	1,141,026
Hospitals	360	1,956,044
Industry (excl. Trade, Commerce, Services)	140	778,841
Street lighting	130	739,200
Total	840	4,615,111

Table 4.2.2. EPC Potential. (Bunse, Irrek, Siraki, Renner, 2010, BEA 2007)

It is estimated that the German EPC market will have an annual growth of about 7% (Sjögren, Schulz, 2011).

There are also many running EPC contracts that will end in a near future and that opens up potentials for new projects, these will have to be more comprehensive than the former to really add new savings.

4.2.7.4 Contract development

The Berliner Energieagentur GmbH has developed a new model they call ESP+ which aims to create more comprehensive projects. With ESP+ longer termed measures can be implemented, such as including the building shell and other building refurbishments.

A problem with including building shell refurbishments is that can create some complications with the public procurement laws making the procurement process a bit more tedious. As stated in Johnson Controls (2010):

> "It is noteworthy that the development of such models is complicated by EU public procurement laws, which place limits on the ability of public and private authorities to procure significant construction works, which are often required for building envelope refurbishments, due to the "nature of or risks associated with the delivery of [construction] services." This prevents building owners from negotiating the terms of a building envelope performance contract with bidders in the kind of ongoing, multi-step negotiated procedure that ESCO s prefer"

ESP+ also provides instruments to share the investment between the customer and the ESCO.

4.2.7.5 ESCOs

The EPC market is a highly competitive market and although there are many EPC projects that have been done, there are only about 10 ESCOs that are active on a regular basis in the EPC-market (Bunse, Irrek, Siraki, Renner, 2010). The most active companies are: Siemens, Hochtief, YIT, MVV AG, Johnson Controls, Evonik New Energies, Cofely, Sauter, Imtech Contracting, Getec AG (Sjögren, Schulz, 2011).

These companies are characterized by their large size and credit-worthiness. Smaller companies working with EPC, such as municipal utilities, usually work on a local level and do not engage in numerous EPC projects (Bunse, Irrek, Siraki, Renner, 2010).

4.2.7.6 Outsourcing

The outsourcing of the service and maintenance organization is something that is much more common in Germany than in Sweden in EPC projects. It is expected that the ESCO can provide this service. This does not mean that customers always want to outsource, in many cases especially larger public institutions will have their own service and maintenance organizations and in those cases it is usually a good idea to work together with them instead of replacing them. But the ESCO still has a larger responsibility for the service and maintenance than in Sweden (generally speaking) and most of the ESCOs working with EPC have the capacity to provide the service (as opposed to Sweden).

4.2.7.7 Integrated EPC

The integration of the supply side is very common in Germany. It is in fact the typical scenario. Since Germany does not have district heating in the same way as in Sweden, the facilities are more dependent on other supply sources. Looking at the importance of ESC it is not surprising that the supply side is important also in EPC. The inclusion of the supply side has the benefits of raising the typical savings from EPC contracts and this gives a larger economic and environmental gain. It also makes it more important that ESCOs have competence on the supply side and not only on the demand side.

4.2.7.8 Opportunities

The German market has been successful for the EPC model. The awareness is high and the infrastructure of supporting energy agencies etc. is very good, especially in some regions. This together with the good results from the projects strongly indicates success. Especially when considering the savings potentials that still exist. There are many parts of Germany where very little of the potential has been realized (especially in eastern Germany)

From a policy perspective, EPC is likely to gain future promotion considering the targets set by EU and the German government. This is further reinforced by the decision to phase out nuclear power and the strong position that EPC has on the energy services market.

If EPC manages to grow in the industry sector, there are also large potentials there. Some obstacles need to be overcome, such as the unwillingness for longer-termed investments and the unwillingness to go through with energy projects that might infringe on the core business or production. Also, the awareness needs to be raised.

As mentioned in the *Potentials* section, many running EPC contracts will end in the near future. This opens up possibilities to startup new EPC projects. However, since many energy saving measures have already been implemented in the former contract, it is important that the new contract will include more comprehensive measures. This opens up opportunities for using models such as the two-step model and ESP+ (which also tries to incorporate building shell measures) etc.

4.2.7.9 Threats

The German EPC market is very competitive and it is very hard for smaller or new ESCOs to establish themselves on the market. There is potential for growth on the EPC market but during the last few years the market has not been moving much in either direction.

Some experts have indicated that the amount of demand side EPC projects have somewhat gone down in favor of integrated contracts that extend supply-oriented services. The growing use of CHP is expected to further boost this trend. (Hansen 2009).

The competition from simpler contract models that extend the supply side with demand side EE measures (like IEC) is likely to grow. Because of the vast amount of ESC projects being carried out and the need to improve energy efficiency throughout society, this will very likely be a growing threat to EPC.

The complexity of EPC is a barrier and one of the big reasons why customers will choose a simpler contract form. The transaction cost associated with EPC make it unsuited for many projects and with growing competition from other contract models it is likely that EPC will see threats especially among smaller projects.

The complexity of EPC makes the procurement process cumbersome and this can be a barrier, especially if measures are extended to include building shell refurbishment.

FM-companies are gaining interest in the EPC market and this could affect the market (see the FM-section).

Contract forms such as Chauffage could potentially become a competitor to EPC, especially in the commercial property sector.

EPC has not really gained a strong foothold in the private sector; the short payback times often required do not work well with EPC. In the private sector energy efficiency investments could also be of lower priority compared to other investments.

An unsolved problem is the landlord/tenant problem which denies landlords to include EPC costs in the tenant rents in the private residential sector. So if a building owner (landlord) wants to invest in an EPC project, he/she can't cover the costs by raising the rent for the tenants, even in the cases where tenants pay for the energy used, meaning they will be the ones saving money from the EE measures. There have been efforts to solve this problem on numerous occasions but unfortunately no solution has been found so far.

The somewhat bad economy of the municipalities (at least compared to Sweden) can on one side be a driver for EPC since they might want to save money; on the other hand it makes the customers less able to finance energy efficiency projects. This induces the use of the shared savings model which might not be the best model for developing the market long-term (as discussed in the EPC-section; JRC EPC). It might be a better solution if municipalities had the ability to take beneficial loans when investing in EPC projects with a savings guarantee. Using guaranteed savings would lower the risks for the ESCOS which could create more comprehensive projects and could perhaps help drive the market forward.

4.2.8 IEC

IEC is a very interesting model on the German market. It is clear that it has been developed with the German and Austrian market in mind. The vast use of ESC and the need to improve energy efficiency throughout society makes IEC the perfect candidate to meet the challenge.

Projects that have been implemented using IEC have been done in Austria, but the experiences from them can be directly translated to the German market.

4.2.8.1 Opportunities

Experts have indicated that supply side oriented contracts with added demand side measures are becoming more common (Hansen, 2009). This shows that there is interest for IEC-like models and that the market is ready. The decision to phase out nuclear power can further boost the opportunities for energy contracting in general and IEC in particular (because it fits so well with wide use of ESC).

There are examples where ESCOs will provide an EPC and an ESC contract to the same company, creating a sort of integrated solution. However, in many cases it would make more sense to keep these two in a single integrated contract. There is also mistrust from customers toward companies that sell energy when they add demand side measures to their services. The IEC payment model could help solve this.

IEC may have a larger chance of bridging the difficulties that EPC has faced when trying to reach the private sector. Because of its simpler approach, IEC could potentially have a greater success in the sector.

The German contracting market can be said to be more or less divided into ESC and EPC (with other contract forms having a very small market share) and looking at the huge potential to expand the ESC model, the ESCOs that succeeds in implementing an integrated contract model such as IEC on a larger scale would be able to reach a very big market. Having a clear and uniformed integrated contracting model would really help in spreading the awareness about this to customers and energy agencies etc. and IEC is a good candidate for this. The market potential for IEC or IEC-like models is huge in Germany; it is almost surprising that so few ESCOs have tried to seize this opportunity.

4.2.8.2 Threats

IEC is a new model that has only been used in around eight projects so far (Bleyl-Androschin, 2011). There are areas where the model may need some more development and more projects need to be implemented to be able to learn from the experiences. There will be a lot of work that needs to be done to spread awareness about the model in order to make it used on a larger scale. The involvement of several energy agencies and the work in IEA DSM Task XVI are however very good channels to help spread the awareness. And the more projects that are implemented, the more the awareness will spread.

Even though IEC aims to extend the ESC model, ESC will still be simpler for the customer to choose. The demand side measures included in IEC will have a larger impact on the customer's core business and this can be a barrier. It is important to communicate to the customer the importance of doing demand side measures before implementing a supply side solution. There is a lot of money that could be saved by most customers by doing this. Eg.

customers could invest in smaller heat-boilers (or coolers etc) if the consumption would be lowered first (which saves money on top of the energy savings).

A threat to IEC in particular is that other integrated models might become more widespread and thereby somewhat erase the need for yet another contract model.

There are also areas where EPC or other models will still be a better solution, in very large projects for example.

4.2.9 Chauffage

The chauffage model is not common in Germany. Several of the interviewees did however point to another model that is being developed that has some resemblance to chauffage. This model is called *Naerco* and is developed by several organizations including two universities. The Naerco model goes beyond the scope of this thesis but it does show that there is a growing interest in chauffage or chauffage-like models (and integrated models in general) on the German market. It also indicates that there exists potential on the market for these types of *integrated solutions*.

4.2.9.1 Opportunities

The opportunities for chauffage can be seen as good in Germany. There is a need for models that go beyond the supply side and that is simpler than EPC. Chauffage could be a very good candidate, at least in certain sectors and it could also benefit certain types of ESCOs. As in Sweden, chauffage could be very well suited for municipal energy companies willing to extend their energy services. They would have an advantage in many cases because of their pre-established relations with the customer. As discussed earlier, trust is very important in Germany and local companies can thereby have an advantage.

If chauffage would follow the same trend as in Sweden, maybe it would fit energy companies that provide district heating. This would also help limit their risks (as discussed in the Sweden Chauffage section). Considering the higher amount of district heating and lower competition from EPC in eastern Germany, perhaps this could be a good place to start providing the service.

The commercial property sector is especially suited towards chauffage and there should be a large potential here since most contracting offers today in this sector is ESC. Because the tenants in this sector are usually very dependant on the "comfort" level, chauffage, or "*comfort contracting*", can be seen as having a very high potential. Chauffage would provide a higher level of service than what ESC can provide. The inclusion of the customer-side technical facilities and the fixed price model should make it very appealing to many customers.

Even if the problem of the tenant/landlord problem can't be solved, chauffage can still be attractive. For example, if rents are very high (~€300 per square meter/year) in a commercial building, the cost of loosing a tenant due to inadequate *comfort* level outweighs the potential loss of saved energy (which would in this case be attributed to the tenant) with a magnitude of up to 100 times (considering typical energy savings per square meter/year).

4.2.9.2 Threats

The biggest threat to chauffage in Germany is probably the low awareness about the model. It may not suit all market sectors but there are many where it would be very advantageous for the customer and the probable reason that it isn't used more is the low awareness from both customers and ESCOs.

The flexibility of contract lengths might be less flexible in Germany than Sweden because of the lower level of district heating used. If customers are using district heating it would be easier to have a shorter contract time since the customers will likely be using the district heating with or without the chauffage contract. If the service on the other hand demands the construction and installation (investment) of a local supply facility the contract lengths would likely have to resemble that of typical ESC.

The tenant/landlord problem could of course create a problem.

4.2.10 FM

The experiences from Germany closely resemble those from Sweden. There is a strong growing interest in using FM companies to work with energy efficiency. According to an interviewee, ESCOs often have a higher chance of getting an EPC contract if they cooperate with an FM company or even merge.

However, few FM companies take energy efficiency seriously even though there is a growing customer demand. As in Sweden, some of the early attempts to include EPC have not turned out as successful as expected. But with the raising interest in providing energy efficiency together with FM there will likely be a growth in the market, especially considering that experienced ESCOs are merging or cooperating with FM companies.

4.2.10.1 Opportunities

As stated, there is a growing demand for FM with energy services. The development of energy related FM-services will be very interesting to follow and it will bring new opportunities for both ESCOs and FM companies.

4.2.10.2 Threats

Since the German EPC-market is so competitive, probably the most competitive in Europe, it will be tough for new companies to establish themselves on the market, this of course includes the FM companies.

As with Sweden it is important to carry out good quality projects as to make sure that the customers can trust the quality of the projects. If not, this can have far-reaching consequences on the market.

5. Discussion

What business models are used on specific markets depends on several factors. Firstly there is the underlying "infrastructure" of energy. For example, are buildings dependent on local energy supply or

on larger area-wide networks. Here, we can compare Sweden and Germany. Germany uses district heating to a lesser degree which has created the need for energy contracting models such as ESC. The opposite can be said of Sweden, the high use of district heating has made energy contracting models such as ESC less needed. This factor needs to be taken into consideration when adapting models to a certain market.

Another important factor lies on the policy level, there must be an environment that allows for energy contracting. The energy contracting models that are used should be able to stand on their own as working business models on the market, without subsidies or other support. However, they need the right framework to be able to exist. Energy efficiency is becoming more and more recognized by the Swedish and German government, not least as an effect of targets set by the EU. This will hopefully lead to a long-term work in providing the best possible framework for energy contracting. Some of the problems apparent today involves the public procurement rules. It is often very complex to procure larger and long-term energy efficiency projects today and the focus often lays on economy rather than quality when choosing an ESCO. Public institutions need to learn how the procurement process should be laid out to secure high quality projects and policy makers need to work in making this process easier. In Germany energy agencies often take on the role of helping customers and in Sweden the customers are gaining better knowledge in this, often with the help of consultants. Even so there have been incidents like the one in Stockholm 2010 where the whole national EPC market was put more or less on hold due to uncertainties about the legal situation of the procurement. Work to improve this situation can very well help move the market forward.

Then there is the trust and awareness issue. Essential for reaching market success is to ensure that the customer trusts the energy contracting model and the service provider. ESCOs need to be able to prove that it works. This is one of the major reasons EPC has gained so much success in today's market, the awareness of the model can be considered as high and there are many successful projects to prove its value. This has not always been the case. There have been several attempts to roll out EPC on the Swedish market and it is only last time around that it has reached success. The early attempts contained some less successful projects that gave EPC a very bad reputation which has been an important reason why it took so long to gain a strong position on the market. This clearly shows the importance of serious ESCOs providing good services to build up a long term market. This is especially true for new business models and concepts. However, there is a learning curve to everything and introducing new business models (or companies) to a market may contain some trial and error. Even with contracting models that have proven their value on the market it is important that ESCOs continuously strive to keep their quality as high as possible, it does not take much too erase the good reputation build up over many years. In this light, it will be interesting to see how FM companies that are starting with energy services will perform in the coming years. The same goes for energy companies that often have a long history of trying to sell as much energy as possible, how will they manage to transition into comprehensive and trustful energy services.

With an established energy service market it may be easier to introduce new services since the concept of energy efficiency is more known and accepted by the market. Germany has had an established energy service market for 15-20 years and Sweden for 5-10 years. Still, the awareness of energy efficiency as a concept can be very regional. For example, EPC projects are more numerous in some parts of Germany than others.

An established energy service market will not only be of good when introducing new business models. There may be conservatism and the established models might push away other initiatives. For example, looking at literature (especially from governmental agencies) about the Swedish energy service market from just a couple of years ago, one might come to the conclusion that EPC is more or less the only energy contracting model of existence. Fortunately, a more diversified description can be found in the most recent publications and this also better reflects the real market situation.

Another issue on established markets is that public customers may have learned how to procure a certain model in a standardized way and are somewhat unwilling to change this in order to introduce a new model. This could also potentially hinder the development of existing models. When contracts become too standardized, too much of an "off the shelf" solution it may be harder to tailor individual projects to create the best solution. Especially if this adjustment means an approach that has not been common practice.

Another form of "conservatism" can be seen on the German EPC market where shared savings is the most used model even though guaranteed savings could (arguably) help build up a better long-term market with more comprehensive projects because of the lower risks. The large use of the one-step model, even in very complex projects, is another example where the "standardization" may impact the outcome of (complex) projects in a negative way. On the other hand, the standardized approach may very well be an important reason to the high establishment of EPC overall in Germany.

Since EPC has been around for quite some time in Germany there are a number of projects that will need to be renewed. These new projects will need to result in further energy savings and it is therefore important to focus on creating even more comprehensive energy savings projects. A possible way to help with this would be to focus more on two-step models and perhaps also more on the guaranteed savings model.

In order to promote the guaranteed savings model on the German market the financing situation has to be solved. The need for external financing is a driver for many ESCO driven projects in general and for shared savings in particular. The municipalities in Germany are highly leveraged and have a hard time getting loans. Given the large number of successful energy savings projects, investments could generally be considered "safe", especially for EPC. Therefore, a solution could be if the municipalities in Germany could get more easily approved and beneficial loans for EPC projects (and other "proven" business models), perhaps from state level.

Looking at the development of new business models in Germany it is likely there will be more integrated models developed. EPC works well in many projects but may be too complex in many cases. ESC is completely supply side centered and there is a need to extend this model to the demand side. The growing interest of including renewable energy should also be considered. Taking these factors into account, models such as IEC would be very suitable on the German market. Chauffage like models could also work well. There is a large untapped market in this segment and it may only be a matter of time before ESCOs start to fully realize this. There are already projects being done that take these factors into account but having a more unified and defined business model that covers this would be beneficial, not least in spreading the awareness amongst customers, energy agencies and ESCOs.

The growing use of FM will most likely also continue, especially together with the EPC model. Further cooperation and merging of ESCOs and FM companies can be anticipated.

In Sweden the EPC market is becoming more standardized and this development will likely continue. The integration of non-energy related services is also a growing trend. For example fire protection and security is often incorporated into the projects. Services such as these have traditionally more been associated with FM. Just like in Germany, the interest for FM is growing in Sweden.

So far, outsourcing of service and maintenance has not been a driver for EPC. Instead, the customer usually have their own service and maintenance organization or the they have a separate third-party service. One development that could take place is that EPC ESCOs start to provide these services more integrated into the EPC project. In the EPC projects where there have been problems, it is usually because the service and maintenance organization has not been succeeding with their task in a satisfactory way. This can especially be a problem when a third-party is responsible for the service and maintenance. Having this integrated into the EPC project could very well be a development that will happen. It is interesting to look at the chauffage model in Sweden where the outsourcing is in fact a driving factor. Since many of the customers are of the same type as those who have chosen EPC, it is very likely that many customers would want to have service and maintenance incorporated into the EPC contracts. Another direction where EPC might be heading is to include more supply side measures. In the cases where supply facilities are installed (usually where there are existing oil heat boilers) the ESCO typically does not take over the operation of the facility during the contract time. This could, just like the service and maintenance organization, be something that ESCOs will start to provide in the future in EPC projects. The inclusion of supply side measures could also come with the growing interest for using renewable energy. Customers who have a strong environmental profile might want to have wind power or solar power/heating to display their commitment, even in the cases where they are currently using renewable energy through their district heating provider (which is hard to display).

There is clearly a growing trend of energy companies providing energy services, especially amongst the municipal companies. Several are offering comprehensive energy services and the chauffage model, or comfort contracting as it is referred to in Sweden, has become something of the "top-of-the-line" offering. It will be interesting to see how this model will spread in the coming years. The growth of the model has been somewhat hindered by the municipal laws so far. If a larger energy company (or ESCO) that works on a national level would pick up the model it could perhaps spread quicker. However, so far the larger energy companies have shown little interest in serious energy services so this may be somewhat unlikely in the next few years.

The energy service market is constantly changing. It is important that energy service providers keep their business models dynamic and adapt to customer needs and develop new ways of approaching energy efficiency to be able to meet today's and tomorrow's challenges. Understanding how business models for energy efficiency can work on a market is pivotal in doing this. Hopefully this thesis has introduced the reader to some new concepts and ideas that can lay grounds to further discussions.

The interest and awareness of energy efficiency and its benefits are growing among policy makers as well as among customers and service providers. The climate challenge and need for energy security will also affect the future interest for energy services. It will indeed be very interesting to follow this exciting market over the coming years.

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