Energy services in Swedish industrial firms
A multidisciplinary analysis of an emerging market

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Abstract

The European commission highlight the energy service market as an important means to improve energy efficiency. Both the Energy service directive and the new suggested Energy Efficiency Directive urge member states to facilitate market development for energy services. The industrial sector is estimated to have large energy efficiency potential. The aim of this multidisciplinary report is to investigate the state of the Swedish energy service market 2011, both from the supply side and from the industrial demand side in order to contribute with knowledge to the discussion of energy services as a way to improve industrial energy efficiency. Economic market theory and Socio-technical theory (the theory of economization presented by Caliskan and Callon) is used to analyse different aspects of the emerging market. The results show that the market for industrial energy services in Sweden is more extensive than previous reports have assessed. Our study describes how energy service collaborations can be complex and how calculations and measurements of expected energy savings lead to controversies and power imbalances.
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List of abbreviations

ANT – Actor Network Theory
D- Demand
EC-European Commission
EED- Energy efficiency directive
EPC- Energy performance contracting
ESCO – Energy service company
ESD- Energy service directive
ESP - Energy service provider
LPG – Liquid petrol gas
MC- Marginal costs
PFE- Program for energy efficiency
SEA- Swedish Energy Agency
STA – Socio-technical Agancements
1 Introduction

As the debate about how to reach a sustainable energy system in the EU continues and increases in intensity one word keeps recurring, decoupling. Decoupling, to reduce, even abolish, the environmental impact of human activity while retaining economic growth has become an important political goal and one step to reach it is through increased energy efficiency. (Van der Voet et al. 2005) In social science studies, the field of ecological modernization has aimed to shown how environmental concern can support economic growth. (Mol and Sonnenfeld, 2000; Mol, 2001) Furthermore, other studies argue similarly that there is an untapped reservoir of cost -effective technologies, which could improve energy efficiency, which is not being employed. (Jaffe and Stavins, 1994) Despite political efforts and elevating energy prices, energy saving potentials are not being reached. (Linares and Labandeira 2010) In other words, studies from different disciplines show that there is a need, and belief, in developing energy efficiency further to reduce human impact on the environment while still supporting a growing economy.

One instrument that has been raised as a tool to tap these energy saving potentials, mainly in sectors whose core activity is not related to energy, is energy services. Energy services, the concept of outsourcing energy management, have been stressed as a way of overcoming some of the barriers that hold back increased energy efficiency. In the EU, the emerging energy service industry has mainly targeted the public- and residential sector, although the industrial sector is estimated to have large energy saving potentials. (EC 2011)

The aim of this report is to investigate the state of the Swedish energy service market today, both from the supply side and from the industrial demand side in order to contribute with knowledge to the discussion of energy services as a way to improve industrial energy efficiency. The report examines which actors offer energy services to industrial customers today, and explores how collaborations between energy service providers and industrial customers have worked in the past. The report is guided by the following research questions:

Which are the main actors providing energy services to industrial firms in Sweden today and what kind of services are they providing?

How do industrial firms perceive energy service collaborations and the energy service market?

What challenges and opportunities do the current energy service market actors forecast?

1.1 A perspective on perspectives

By integrating economic and socio-technical analysis in the discussion of the energy service market we analyze different features of the market with perspectives that simultaneously complement and contradict each other. Economic theory is useful when describing the system of a market and the market interactions but it relies on simplified assumptions. In socio-technical theory, objects and events that are hard to value in monetary terms are made visible. The often black boxed behaviors of actors in a market are investigated. Socio-technical theory can be used to study aspects and black boxes that economic theory sometimes takes for
granted. By performing a joint analysis we aim to show that both economic and socio-technical theory can be used to study the market of energy services.

Multidisciplinary research studies phenomenon from two, or more, different disciplinary perspectives. A problem is placed in the center and is studied from different angles to reach a fuller understanding of it. This differs from interdisciplinary research that aims to integrate specific disciplines theories, methods and results on an equal basis. (Berner, 2010) This study is conducted with two different perspectives, an economic and a socio-technical. The design of the study as well as the choice of theories is guided by the two standpoints. The objective is to use these different perspectives, which in many ways are conflicting, to broaden the analysis of the energy service market. By combining the different outcomes of our empirical investigations and analytical discussions, we provide the reader with the opportunity to see two ways how the Swedish energy service market can be studied.

The intent of this project is not to fully integrate the two perspectives since their aim and ontologies are so heterogeneous. However, there are research questions that both perspectives find interesting and by analyzing these simultaneously we hope to find areas where the perspectives can enrich each other.

1.2 Disposition

We start this report by describing the context of the energy service market, to give the reader background and knowledge of the studied field. In the theoretical chapter we introduce economic and socio-technical theory that later will be used in the analysis. The following chapter describes our chosen methods and how the empirical study has been conducted. This is followed by a presentation of the results where we answer the first research question. In the final chapter economic- and socio-technical theory is used to analyse the results in order to better understand the Swedish market for energy services and to answer the two last research questions.
2 Background

As a background we present common terms used to describe energy service markets and its aspects. An international and a brief historical perspective of energy services is presented as well as current political objectives regarding energy efficiency both in the EU and Sweden.

2.1 Glossary

*Energy services* has been stressed as a tool to overcome barriers to energy efficiency (EC 2006; EC 2011; Hansen et al 2009, Lindgren, Nilsson 2009). An energy service is a service that based on contractual arrangements aims to measurably improve energy efficiency. This may include implementation, auditing, maintenance and even financing of energy efficiency projects. Simply put, energy services are a way of outsourcing energy management.

Often the terms of energy services are formulated in an *energy performance contract* (EPC), a contractual arrangement where the remuneration for the energy service is related to the performance, the savings or the energy efficiency improvement, of the service.

Companies that offer energy services in EPC are referred to as *energy service companies* (ESCOs). Since the payment is based on the performance of the service an ESCO share the risk with the beneficiary of the service. Companies that offer energy services of some kind but charge a fixed remuneration are called *energy service providers* (ESP). Since their remuneration is fixed, they do not share the risk with their customers.

2.2 European and Swedish policies for industrial energy efficiency

One of the main targets in the Europe 2020 strategy “for smart sustainable and inclusive growth” is to reduce the primary energy utilization by 20 %\(^1\) (EC 2010). In June 2011 the European commission (EC) released a proposal for the new Directive on energy efficiency (EED) (EC 2011) that is supposed to replace the Directive on energy end-use efficiency and energy services (ESD) (EC 2006) as well as the Directive on promotion of cogeneration based on a useful heat demand in the internal energy market (CHP) (EC 2004).

The EED states that the current directives are insufficient tools to tap the existing energy saving potential that is necessary to reach the 20 % savings target. Therefore the EED establishes a framework for all member states to promote energy efficiency. It presents rules to overcome barriers to energy efficiency and policy recommendations. One of the recommendations that also were highlighted in the ESD as an important tool to overcome barriers to increased energy efficiency is energy services. The EED states that:

“It is necessary to continue developing the market for energy services to ensure the availability of both the demand and the supply of energy services.”

The EED specifies the importance of developing both the demand and the supply side of energy services. To implement this, the directive urges member states to increase the market transparency. One suggestion to accomplish this is to put together a list of ESPs and ESCOs.

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\(^1\) From 2005 years level
The importance of encouraging energy supply companies and utilities is underlined. Another means that is suggested is for member states to provide model contracts and procurement guidelines, mainly for complex energy services and EPC.

The EED also states that small and medium sized industries represent an enormous saving potential in the EU and that member states shall establish favorable frameworks providing this sector with technical assistance and information.

Increased energy efficiency is to be accomplished by identifying and removing regulatory and non-regulatory barriers for energy services. Member states are also urged to promote availability of energy audits, carried out in an independent manner by qualified or accredited experts, households and small and medium sized industries are highlighted. (EC 2011) In the EED the consideration of introducing tradable white certificates is mentioned but so far the idea has been rejected due to difficulties to harmonize such a system.

However, Swedish policies for energy efficiency are based on the ESD and the CHP in the government bill on energy and climate (Bill 2008). Instruments and measures for energy efficiency in industries are based on subsidies and information. For the energy intense industry a program for energy efficiency (PFE) was introduced in 2004. The program offers tax relief for industries that participate in the program and improve energy efficiency by performing an energy audit and implementation of an energy management system.

Small and medium sized industries that utilize more than 500 MWh per year (or agricultural plants with more than 100 animal units) can apply for financial support to conduct an energy audit. The Energy Audit Program entitles industries to 50 % of the cost to perform the audit, maximum 30 000 SEK. The program was introduced in 2010 and in May 2011 309 industries had applied for the subsidy (SEA 2011).

In addition to this, according to the second national energy plan (Gov. 2011), the Swedish Energy Agency (SEA) has put out a manual for industrial energy efficiency for small and medium sized industries and work actively to promote networks to exchange information and experience.

The SEA is also responsible for the promotion of the energy service market in Sweden, both indirect energy services such as statistics and energy audits as well as complex energy services such as EPC. This is mainly done by spreading information and improving the competence and knowledge on the demand side. (Gov. 2011)

In the ESD (EC 2006) an accreditation system for ESCOs is advocated as well as standardized contracts for energy services. This has also been recommended in several studies of the European ESCO market (Vine 2005, Bertoldi et al. 2005) However, the Swedish government have concluded that there is no need for such a system in Sweden since the market is well functioning without licenses or standardized contracts. (Ministry investigation, 2009)
2.3 Energy services - an international overview

Describing the international market for energy services is difficult because there is no real consensus about what an energy service is and who provides it. The descriptions differ not only between national markets but also within countries. However, despite the weak terminology that complicates market reports, the energy services industry is growing in many countries around the world, but the development differs depending on national conditions. (Hansen et al. 2011)

The North American market is considered one of the most developed markets for energy service and EPC. The North American market for energy services started to develop in the 1970’s when energy prices increased dramatically due to the oil crisis. The climbing energy prices raised the demand for energy efficiency but many sectors lacked both knowledge and financial means to implement efficiency measures. Performance based energy service contracts spread quickly. In the US today, EPC and other performance based contracts accounts for 69 % of the total revenues in the energy service market. However, the main market activity is aimed at the public sector and only around six percent of the energy service contracts are with industrial partners. One of the explanatory factors for the large EPC market in the US is explained by ambitious energy saving targets for the public sector and EPC is a way of reaching the goals without having to make large investments. (Satchwell et al. 2010)

The European market for energy services is judged as being far from reaching its full potential despite the European Union’s urge for increased energy service activities. Market conditions vary significantly between different member states but in most countries, the markets are growing slowly. (Hansen et al. 2011, Marino et al. 2011) One of the main obstacles to the diffusion of energy services in recent years has been lack of financing, something that can partly be explained by the financial crisis in 2008 but other hindering factors in some countries have been ambiguities in the regulatory frameworks and a lack of knowledge and experience. The lack of awareness of and information about energy efficiency and energy services is not only on the client side but also, in some member states, on the governmental side. Energy service activities in Europe have mainly targeted public buildings and involved heating, ventilation and air conditioning systems. Most member states have only a few energy service companies registered but Germany, Italy and France all have a large energy service industry (>100 ESPs). (Marino et al 2011)

The German market is often mentioned as the most mature European market for energy services. (Vine 2005, Bertoldi et al. 2006) There are more than 500 companies in Germany that offer energy services but only small fractions of the projects have performance based remuneration. The main activity is energy supply and heat delivery services and most projects are towards buildings in the public sector. One of the main growth factors in the German energy service market is the Energy Saving Partnership, a scheme where buildings are bundled together in pools in order to decrease transaction costs. (Hansen et al 2011)

2.3.1 Energy services in Sweden

In an article published about the European energy service market Sweden is mentioned as one of the few member states that have had a strong market growth between 2007 and 2010
A public investigation in 2008 (SOU 2008) judged the Swedish market as being fragmented and immature but with a potential for growth and development. The demand for energy services is growing in Sweden as the demand for energy efficiency is increasing, a trend correlated with elevating prices for energy. Since the definition of energy services is so vague, the supply side of the energy service market contains actors from varying sectors.

The investigation towards a more energy efficient Sweden (SOU 2008) analyzed what implications the ESD have for the Swedish market. The ESD urges member states to remove barriers and promote the market for energy services but in order to do so the market needs to be defined. The SOU 2008 categorized the supply side in four different segments, depending on their core business: companies that deliver or sell building related products, companies that work with operation and maintenance, technical consultants and energy companies. One conclusion is that energy services are mainly targeting public and private buildings. For industries and smaller premises, the main energy service is just energy inspections and energy audits, mainly provided by technical consultants. The investigation did not identify any regulatory barriers.

The varying characteristics of the supply side make estimations of market size difficult. However, some attempts have been made. The general opinion is that the energy service market has grown as the interest for energy efficiency has increased with elevating energy prices in the last decade. In 2003 an international study of the ESCO market identified 6-12 ESCOs in Sweden, with a total turnover around 482 million SEK (Vine 2003).

A study in 2008 identified 27 Swedish ESCOs and eight of these companies (answering for about 50-70% of the market) provided financial information in a survey; their total turnover was 781 million SEK. The 2008 survey applied a vague definition of ESCO and included both companies with performance based remuneration and companies who charged a fixed fee for energy efficiency projects. Their valuation was that excluding companies who did not provide EPC would be to underestimate the market for energy services and the actors involved. The research focused on energy services towards the housing and service sector (i.e. buildings) (Lindgren, Nilsson 2010).

2011 the SEA published an analysis of the Swedish market for energy services (SEA 2011). The analysis broadens the categorization of services and providers compared to the SOU 2008. The SEA then adds three different categories to the list provided by the SOU 2008: companies that work with installations, companies that work with facilities management and companies that provide internal energy services (i.e. companies that provide energy services in house). The SEA makes a distinction between indirect and direct energy services. Indirect energy services are services that offer information and advice without executing the changes or implement any technology such as offering energy statistics, do an energy audit or offer energy counseling. Indirect energy services often function as pre studies for direct energy services that actually execute changes. In addition, the SEA analysis assumes the demand side of energy services to be private and public facilities. Regarding the size of the market, the
SEA does not make any overall estimation but assumes that energy services towards industries counts for less than 10%. (SEA 2011)
3 Theory
In this chapter we will present economic theory and socio-technical theory. The theoretical assumptions will later be used to analyze the market for energy services.

3.1 Economic theory
This part of the theoretical chapter gives a brief overview of how economic theory can help explain the market for energy services. Energy services is a tool to increase energy efficiency, the utilization of energy, and therefore the energy service market effect and is affected by the energy market and vice versa. By applying economic theory we put the demand and supply of energy services in the context of demand for energy. Neoclassical theory and applied barrier theory are used to describe and discuss the economic context of energy services.

3.1.1 Market failures on the market for energy efficiency
In the explanatory memorandum of the EED there are numerous reasons explaining the benefits of energy efficiency. With rising imports, energy prices in the EU are expected to elevate, something that can threat the economic growth in the union. Also improved energy efficiency is argued as the most cost-effective way to increase security of supply. The third main reason, one that is often mentioned, is that energy savings is an effective way to reduce greenhouse gas emissions. (EC 2011) This reason can however be questioned since the energy sector (e.g. combustion plants and refineries) is included in the emissions trading system (EU ETS). Given that all emissions are utilized, a reduction of emissions in the energy sector will only be transferred to some other sector, therefore improving energy efficiency in the European Union does not mitigate climate change. (Brännlund, 2010)

From an economic point of view, talking about a market for energy efficiency can seem irrelevant. Resources will be used efficiently on a perfect market in a market economy. Energy is a good and the demand for a good on a competitive market is decided by demand and supply, marginal willingness to pay and marginal cost of production. When marginal costs equal the marginal benefit of an investment the resources are used efficiently. On a perfect market, the price will equal the marginal cost. A perfect market contains: rational actors, no barriers to enter or exit the market, homogenous products, an infinite number of actors and sellers, perfect information, perfect factor mobility, constant returns to scale and costless transactions. If any of these criteria’s does not hold, there is a market failure. If market failures exist on a market, interventions are justified if feasible, low-cost policies are available to eliminate or compensate for a market failure, as long as the benefits exceed the cost. The only justifiable reason for public policy to intervene on a free market is if there are market failures. (Hepburn 2010)

The energy market might not be a perfect market; for example, many analysts claim that there are externalities that are not included in the price. If externalities are not included, the price of a good is to low and too much will be produced. Another market failure that is often mentioned when describing the energy market is informational asymmetries. Inadequate information can lead to actors not making optimal decisions. (Linares 2010) One assumption that is often discussed is the assumption of rational actors. The slow diffusion of energy efficiency technologies is an empirical challenge to the conventional theory of rational actors.
Production theory and neoclassical economics assume that rational firms make all investments with a positive net present value. However, numerous bottom up studies have revealed that the return rate from investments in energy efficiency is often higher than the discount rates for other types of investments, with comparable risk. (DeCanio 1998)

### 3.1.2 Market barriers to energy efficiency

When the EC promote energy efficiency it applies a wider term than market failures; the directive describes how to overcome market barriers to energy efficiency. The barrier theory goes beyond neoclassical economics and explains why seemingly cost effective measures to energy efficiency are not being implemented (i.e. why the demand for energy is larger than it “should” be). The barriers can be divided into economic barriers, organizational barriers and behavioral barriers. (Sorrell 2004) Table I is an attempt to briefly summarize the barrier theory.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Claim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk and uncertainty</strong></td>
<td>Risk and uncertainty has been recognized as one of the most important barriers to energy efficiency in industries. Both economic risk such as volatile energy prices and technological risk such as production disruptions and impacts on product quality prevents investments in energy efficiency.</td>
</tr>
<tr>
<td><strong>Imperfect information</strong></td>
<td>Imperfect information is often at the center of the debate on barriers to energy efficiency. Actors who lack adequate information cannot make optimal decisions and numerous studies have illustrated that there is a lack of information about energy utilization and energy efficiency opportunities amongst firms.</td>
</tr>
<tr>
<td><strong>Hidden costs</strong></td>
<td>Hidden costs are the costs that are not included in the bottom-up studies but that prevent investments in energy efficiency. They include the overhead costs of energy management, transaction costs, search costs and the opportunity cost of investment in energy efficiency.</td>
</tr>
<tr>
<td><strong>Access to capital</strong></td>
<td>Limited access to capital concerns both internal and external capital. Investments in energy efficiency are often viewed as maintenance projects and therefore have lower priority than investments related to the core production process. Therefore, investments in energy efficiency are harder to finance.</td>
</tr>
</tbody>
</table>
### Split incentives

Split incentives have been observed as a barrier both between different market actors and in different units of a single firm. If the actor who accounts for the costs for increased energy efficiency cannot benefit from its benefits, the measures are unlikely to be taken.

### Bounded rationality

Bounded rationality is one of the more controversial barriers. It is argued that business decision-making is often made on assumptions and rules of time rather than rational, informed decisions.

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**Table I (Sorrell et al 2004, Fleiter et al 2011)**

The existence of barriers to energy efficiency has been proven numerous of times in bottom-up studies. Bottom-up studies of energy efficiency, often based on energy audits, show that there is great potential for increasing energy efficiency and the calculations are based on practical economic potential, the technical potential. Nevertheless, what is an efficient investment and what the potential for energy efficiency really is, is arguable. According to orthodox economic theory bottom up studies do not account for all costs and that is why the technical potential is greater than the economic potential. (Jaffe and Stavins 1994) The obstacles that the barrier theory refers to as barriers could be translated to just cost. Risk raises the discount rate of an investment, lack of information increases the search costs and shortage of capital increases the interest rates. If not all costs are accounted for in the bottom up studies, then maybe the actors on the energy market really are rational. (Brännlund 2010)

#### 3.1.3 The demand for energy efficiency and energy services

Rational actors make decisions to maximize their utility; therefore all actions where the benefits exceed the costs should be taken. The benefit, return of investment, for an investment in energy efficiency is the savings that the efficiency measure will generate by reducing the variable energy costs. The demand for energy efficiency therefore depends on the price of energy in relation to the price of energy efficiency. If energy prices are high, then the economic savings from an improvement in efficiency will be large. A price increase on energy will therefore augment the demand for energy efficiency. Energy efficiency will be demanded to the point where the marginal cost for energy efficiency equal the marginal cost for energy. This is illustrated in figure I.
The costs for energy efficiency are all the costs related to the action. This does not only include the investment cost and capital costs but also the costs for acquiring information, making the decision, accounting for technical risks and economic risk. Making informed decisions about energy efficiency requires knowledge about energy and technology. Information about energy efficiency and efficient energy management is available but acquiring it and keeping updated takes time. For organizations whose core business\(^2\), is not related to energy, these costs can become high relative to the cost savings in energy. In addition, the second hand value of energy investments can be low or close to zero when the investments are not asset based. Investments in energy efficiency are often incorporated into buildings or non-asset based which makes them difficult to resell. Energy efficiency is often not accounted for in the price of buildings or factories even though they affect the lifecycle cost and that makes them riskier than other asset based investments. (Sorrell 2007)

To employ energy services is a way to outsource energy management. Energy services will only be demanded if they can improve energy efficiency at a lower cost than undertaking the same action in-house.

3.1.4 The economics of energy services

The following question is why an ESP could improve energy efficiency at a lower cost than doing the same measures in-house. The advantage of ESP is often explained by knowledge

\(^2\) Core business is defined as “the set of products, capabilities, customers, channels, and geographies that defines the essence of what the company is or aspires to be to grow its revenue sustainably and profitably.” (Zook et Allen 2001)
and scale advantage. Since ESPs core business or at least part of it is energy and energy management, they have a scale advantage. ESPs can stay updated about technical and economical energy management solutions since they apply the information in many different settings. This reduces the cost of knowledge per kWh and this cost advantage is, up to a certain point, inversely related to scale. This is how ESPs overcome the barriers of imperfect information. (Sorrell 2007, Goldman et al 2005)

The scale advantage is why ESPs often are specialized in generic technologies such as lightening, heating, ventilation and cooling (HVAC), support processes. (Goldman et al 2005) An ESP specialized in more specific technologies, such as machining and distillation for example, have a more limited market. This reduces the scale advantage and can make the ESP vulnerable to the demand side. If the market is limited, in other terms the ESP loose market power. The ESP can become a price taker or the obtained knowledge becomes a sunk cost. (Sorrell 2007) This advantage in generic technologies is often used to explain why energy services markets have mainly targeted public sector and other buildings. However case studies have shown that, in average, almost 90 % of the cost efficient energy – investments in Swedish small and medium sized industries may be found among the generic support processes (Thollander et al., 2007).

The Swedish industrial sector answers for roughly one third of the nation’s total energy use. In 2009 that meant 134 TWh. There are roughly 59 200 individual industrial companies, 600 categorized as energy-intensive industries and the remaining 58 600 as non-intensive. Three quarters of the industrial energy use goes to the energy-intensive sector (pulp and paper, iron and steel etc.) and the rest is used by the manufacturing, non-energy intensive industry, industries that usual fall in to the category of SMEs (SEA, 2010). The EU has concluded that the savings potential for energy efficiency in the European industrial sector is at least 25 %. The potential for energy efficiency in the Swedish non-energy intensive industry has been differently evaluated. The estimations vary between 50 % (Trygg and Karlsson, 2005) and 15-20 %, 2-3 TWh/ yrs (Thollander et al., 2007).

When energy services are provided in performance based contracts, i.e. by an ESCO, the costs are further reduced since the ESCO share the project risk, which brings down the discount rates. Nevertheless, consulting an external part to manage something as complex as energy also generate costs. What an ESP or an ESCO gain in scale advantage and reduced risk must compensate for the extra costs generated from transferring some or all of the responsibility for energy management to an external part. (Vine, 2005; Lindgren and Nilsson 2010; Sorrell 2007)

An organization consulting an ESP or an ESCO reduces the in-house needs for energy management but requires costs for identifying a partner (the ESP or ESCO), negotiation contracts, monitoring the performance and execution of the energy service etc. These increased costs, transaction costs, may include search costs, legal costs etc. Transaction costs are partly a consequence of lack of trust and the risk of opportunistic behavior from both parts and they are not necessarily related to the size of the contract at least not in terms of kWh,
even though operations that are more complex demand more specific contracts. (Williamson 1985)

The theoretical term for these trust issues is *moral hazard*. (Sorrell 2004) Detailed contracts are necessary for complex energy services but it reduces the profitability of energy efficiency projects for both the ESCO (this problem is mainly concerning contracts with shared or guaranteed savings) and for the client. Detailed contracts are necessary to avoid post contractual opportunism and behavior under contract that is inefficient. Often there is asymmetric information since both parties of an EPC are lacking information about parts of the project. The client of the energy service does not have full understanding about the technology installed and how the savings potentials are calculated. The ESCO on the other hand does not have all the information on how the technology will be utilized once it is installed. The actions of the ESCO are to some extent unobservable to the client and vice versa. The principal problem is to make sure that both parties act efficiently and to the project benefit. If the terms are not negotiated and specialized beforehand, the ESCO or the client may act to their own advantage. Therefore contracts need to make sure that the energy service is provided adequately and specify monitoring and verification of the utilization. (Sorrell 2004)

To measure the performance of an improvement in energy efficiency can be difficult since energy utilization is related to many varying factors such as weather and occupancy, changes in production because of different product lines or fluctuations in demand. If the energy service is to be implemented this needs to be done at a feasible cost. Varying factors mean that it can be hard to with certainty establish the effects of an energy efficiency improvement and therefore clauses and terms must be carefully negotiated in contracts, especially if the remuneration is performance based. (Goldman et al 2005)

3.2 Socio-technical theory
This chapter will presents socio technical theory that will be used to analyze the Swedish energy service market mostly from the firm’s perspective. A socio-technical perspective studies technology, human interaction with technology and their place in society. This field of study includes a range of different theories and the chosen theory for this study takes a different view of what a market is and how it is constructed compared to economic theory. The aim is to better understand the processes that make up the market by studying both human and nonhuman agents in equal terms. This theoretical perspective that gives equal status to both human and nonhuman actors comes from Actor Network Theory (ANT) which was groundbreaking within science and technology studies. By attributing equal status to all entities in a network artifacts and their effect on the network are made visible. (Sismondo 2010) To be able to study the market for energy services with this perspective we have chosen to analyze our material with the help from Caliskan and Callon and their theory of markets. This theory can help understand how actors affect the market regardless if they are human or nonhuman actors. The theory of economization has not been used to study energy markets and therefore applications of the theory will only be done in the analysis.
The term *economization* was identified by Callon (1998), by describing economics in an active way he implies that the economy is acted rather than discovered. The essence in his theory about markets is that we cannot study the market like a pre-existing reality since we are a part of the process that creates and maintains it. Caliskan and Callon (2009, pg. 370) explains:

“This term [economization] is used to denote the processes that constitute behaviors, organizations, institutions and, more generally, the objects in a particular society which are tentatively and often controversially qualified by scholars and/or lay people, as economic.”

An important part of economization is the process of valuation. The process of valuation is a complex process to determine how high we hold something, what we believe has a value for us. This is a broader process than price setting, but price setting is a part of a valuation process. What is recognized as valuable is not a result of a value regime, instead Caliskan and Callon speaks of modalities of values. A modality of value is a group of ways to value what we prefer over other ways to do valuations. They believe the definition of value is different in different situations and the reason why one modality of value is preferred over another lies in the situation. A scarf can be seen as a highly valued gift in the eyes of the donor, but when the birthday child is on her own it becomes a useless piece of fabric. Even the piece of fabric is responsible for its representation of worth. It carries a history and sets up boundaries for its use which affect how it is valued. Therefore, in the spirit of Actor Network Theory (ANT), Caliskan and Callon (2009), involve material artifacts in the study of valuation. They do not think that objects have an intrinsic value or meaning, the value of things is created in a process where the identities of things and humans are enacted. It is neither the rational actions of individuals nor the society that is in focus, but rather the realities that connects them. This is studied by covering the network that connects actors, things and their modalities of value.

The process of economization can be studied by investigating the activities, fields and behaviors that are defined as economic. By doing this we can understand how markets take shape and understand (economic) actions in the context of the Swedish industrial firm. We will study “how economics is done” and how economic actions are defined which can be fruitful in our quest to understand how the markets of energy services are constituted.

The study of creation of markets is one aspect of economization. Markets are socially constructed and produced by the actions that we perceive as economical actors. At the same time, Caliskan and Callon recognize that social constructivism is not sufficient to study markets since the specificity of the arrangements, as well as its material aspects, are lost. A market can have various forms and actors but each market has its set of significations, realities and practices that are generally agreed upon. Caliskan and Callon (2010) define them as socio-technical arrangements or assemblages.

Caliskan and Callon name the study of markets *marketization* which includes the study of the shape, constitution and dynamics of a market’s socio-technical arrangement. The most interesting study objects that frame the market are:
• the processes of pacifying goods
• the marketizing agencies
• market encounters
• price-setting
• market design and maintenance.

We will look deeper into these five study objects in order to understand how we can study the market for energy services in Sweden.

3.2.1 Pacifying goods
An important feature in the market is the distinction between things that are subject of valuation and agents that can perform the valuation. According to ANT, things and people are treated as equals and they are seen as actors within a network. In a market things are objectified as predictable goods and thus provide a stable entity that can be compared and traded. To be able to keep agents and thing separate, things has to be disentangled from its networks of connections. According to Callon and Caliskan, the process of turning things from entangled beings into passive goods is a critical process that needs to be studied. In the service market actions are turned in to passive goods:

“Services are framed with a view to objectifying and transforming them into packages, ‘things’, which can be valued. Like other goods, they must be made describable and predictable, with built-in safeguards to warn of unexpected overflows.”

(Caliskan and Callon 2010, pg. 7)

A service is many times presented to us as a good with a complete package, for example renting a car. It comes with a package of rental services which include different pick-up locations, repair service, insurance and legal agreements. “Hiring a car” becomes packaged so that it can be traded and compared in a market. In the same way, energy services can be compared if they are qualified and packaged as a tradable good.

Another important aspect of pacifying goods is ownership. After a good have been traded in a market, it is important to be able to tell the nature of its property rights. This process can be seen in the use of leasing deals where the change of ownership is regulated as a part of an energy service contract. Ownership has been disentangled from the user and the object’s location and is only regulated by a contract. Standardization is furthermore a help in the disentanglement process. A good that has undergone a process of identification in abstract and precise terms becomes more independent from its surrounding network.

3.3.2 Marketizing agencies
Every market has its own set of important actors and it is impossible to make a priori definition of the forces that affect a market. Of course there are well-known actors that have a great influence in many different markets but an important step in the analysis of a market is to make visible who can impose change in the studied market. (Caliskan and Callon 2010) To be able to study actions connected to their context, Caliskan and Callon uses the term socio-
technical agencement (STA). This term refers to the arrangements of human and non-human entities that are engaged in an action. A pilot flying a plane can be such an action, the plane and all its material components together with the pilot are important to make the action real. The term also stress the fact that agencies and arrangements are not separate, one could not exist without the other. A pilot cannot be a pilot without the plane, their meaning in the specific context is created by their actions. This also implies that the meaning of the agencement lies in its own construction:

“An STA eventually includes the statement(s) pointing to it and interpreting it, just as creating instructions are a part of a device that participates in making it work.”

(Caliskan and Callon 2010, pg. 9)

The study of STAs is an indefinite project since it includes everything that is part of an arrangement but it provides an opportunity to create new ways to analyze processes. We are able to create new forms of agencies to better fit the studied case and we do not have to stick to conventional divides between categories of agencies. In this view, what is called an entity depends on its possibility to be perceived as acting as one. An organization, a football team or an individual can all be studied as entities if they are considered to be the source of an action. Collective actions can be shared between the members of an organization or attributed to one member, in the first case the organization can be studied as an entity just as the individual is seen as an entity in the latter case.

Technology does not have to do with actual artifacts; a calculation can be seen as technology in a wide sense of the word. A practice, for example accounting, can be seen as a technology since it is a tool we have constructed to provide information. Accounting and calculations in the industrial firm will be seen as STAs as a way to understand them in relation to their networks in this study. Similar studies have analyzed other practices in the finance market (MacKenzie 2006). Mackenzie’s study show, among other things, how dependent agents are of their access to computers and mathematical equipment. To study how calculating tools are used can be a way to start the study of a market, to be able to understand its STAs as well as its power relations.

“Inequalities derive from the unequal power of calculating agencies that loop back to reinforce themselves.”

(Caliskan and Callon 2010, pg. 13).

This makes it possible for the calculating agencies to impose their calculations on others. This can also be used when studying access to technology or equipment in a market. Calculations are used in the energy service market to calculate the estimated profit and to study how this is done can be a way to better understand the Swedish energy service market.

3.2.3 Price-setting

Caliskan and Callon discuss how prices-setting mechanisms affect the market, and how calculations and valuations present the market with needed prices to make trade possible.
Caliskan and Callon state that price is an estimated quantification wherein a calculation of a value is turned into a figure. Human agents as well as mathematical tools and artifacts can affect this process and they are collected under the term *valorimeters*. Valorimeters are the tools used to set prices. The agencies that affect which valorimeters are used can impose the prices that their tools calculate. In this way they can make their valuations into an obligatory passage point in which all valuations, which are accounted as correct, need to pass through. Being in control of an obligatory passage point makes it possible to impose a definition of value that suits one’s interests. Furthermore, if an agency can complicate their calculations by linking them to a large number of other prices, their ability to affect the terms of exchange increase. (Caliskan and Callon 2010)

Prices are also affected by material aspects such as size and availability of certain materials. The methods and tools that calculate prices are also important in the perception of fairness of a price. A price is fair if the methods and its content that was used to calculate them seem to be fair. (Caliskan and Callon 2010)

### 3.2.4 Market encounters

To be able to perform valuations, goods and calculating agents have to meet. This is called market encounters and multiple encounters occur in different calculative processes simultaneously. The encounters are framed and formatted by series of devices which steer the possibility to trade. (Caliskan and Callon 2010) A specific network makes it possible for the actors within that network to meet and trade, actors outside the network do not have the same possibility to make encounters with actors inside the network. An encounter needs location, identification and monitoring of movements to be able to give humans and goods a chance to meet and negotiate over price. A good example off such network can be an electronic market which is made up by several socio-technical agancements. It can be useful to study the devices that control the encounters to understand the market and how it configures the actors. (Caliskan and Callon 2010)

### 3.2.5 Market design and maintenance

Markets have internal dynamics which are managed and maintained in many different ways. One way to study this is to look at the performativity of the market. This is, among others, done by Holm (2007) who studied the formation of a market of individual transferable quotas in the fishing industry in Norway. Performativity is the idea that a prediction comes true if we act according to it. Economists, but also politicians and other decision makers, can create changes in markets by presenting theories or predict behavior which will become performative.

The maintenance of markets is many times attributed to the use of trust between exchanging parties. Caliskan and Callon stress the idea that other feelings are important to the maintenance of the market as well. Hope, interest and passion can have an impact on the relationships between traders. They state that by assigning too many explanations of maintenance operations to trust we black box other emotions that can be affecting the dynamics.
3.3 Theoretical synthesis

Economic theory explains how market actors, sellers and buyers, interact by comparing costs and benefits. All market actors aim at maximizing utility, given the information that they currently have. Costs and benefits are often converted to monetary terms but the barrier theory attempts to go beyond and express the factors behind the costs.

The theory of economization on the other hand, discusses the assumption behind economic theory. The economy is acted rather than discovered and the market is not a preexisting reality since we are all part of the process that creates and maintains it. In order to understand how markets are constructed the researcher need to follow the processes and the agancements that constitute the market.
4 Method
This chapter will present the different methods used in this study and in the last section we will discuss methodological considerations. In this study we have used different methods to study different aspects of the energy service market. The aim and the study object have guided the choice of methods. Using different methods triangulates the research and thus provides stronger reliability for the results since the different methods can strengthen the arguments. (Neuman 2011) In this chapter we explain the choices of design and methods used to conduct our research for this report. We used a survey and an observation to understand which the main actors are who provide energy services to industrial firms and what kind of services they are providing. This made it possible to get an overview of the market and its actors. To better understand the experiences from the industrial firms we used interviews. To perform interviews gives the researcher an opportunity to get a deeper understanding of a phenomenon. The phenomenon is in our case the experience of being an industrial firm manager working with an ESP or an ESCO. By trying to reconstruct the process of hiring and working with energy service companies, we aimed to find understanding for our research objects. The challenges and opportunities with energy services was discussed and studied with help from all three methods since the all provided useful information to this issue.

4.1 Interviews
The interviews were semi-structured and an interview guide was used to find important topics. A semi-structured interview gives the researcher the liberty to change the order of the questions and the form that they are asked. (Kvale 1997) Since few interview studies have been done in this subject we took inspiration from different sources when we created the interview guide. One source of inspiration was Energy use: The human dimension (1984) but we also considered the network were the actions took place, inspired by the actor-network theory. The interview guide can be found in appendix II.

In total five interviews were performed with all together nine respondents. The interviews were done at the firms in conference rooms or the respondents’ offices and lasted between one and two hours. One of us conducted all the interviews in the late spring of 2011. The interviews were recorded on digital tape and then transcribed approximately word for word. This way of transcribing is suitable for studies that aim to capture a process and the respondent’s experiences. (Palm & Glad 2011) The transcriptions were then summarized and translated to English. The results are presented for each firm to provide the reader with an understanding for each industrial firm since their contexts are very different. The interviews were later categorized according to different concepts to show if there were any recurring opinions or actions to provide input to the analysis.

4.1.1 Respondents
The five industrial firms that were interviewed are all situated in Sweden. The firms were found using contacts within the department of Energy Systems at Linköping University but also through contacts with the SEA and an ESCO. We approached one ESP that we knew had worked with EPC and asked if we could contact some of their customers. Three of the interviewed firms have worked with the same ESCO, while one of the firms had hired a local, small energy service company. Another industrial firm had worked with several local ESPs.
We approached the industrial firms through contact information either to the person responsible for environmental issues according to their homepage or by contact information provided by the ESCO. In all the interviews, the person responsible for environmental issues was present. In some cases, as in the case with the smallest firm, the plant manager and the environmental manager was the same person. In one case the firm themselves had invited an ESCO consultant to be present.

One of the interviewed firms requested to be presented anonymously in the study, therefore all firms names will be confidential. All the respondents except one were male, and to preserve anonymity, all the respondents will be referred to as male. Since this study do not focus on gender relations this will probably not affect the outcome of the study.

4.2 Observation

Academic literature on energy efficiency and energy services as well as reports from governments and interests organizations provide information and hypotheses about how markets for energy services function and how the actors act. We were offered to take part in a network meeting for energy supply companies in Sweden and saw it as a valuable chance to understand their views on energy services, academics aside. Swedenergy is an interest organization for energy supply companies in Sweden and to listen to what they chose to discuss and how they talk about energy services helps to give an understanding of their view of the Swedish energy service market. The researcher participated in the meeting, but did not engage in the discussions, only listened and asked questions for clarification. Since the program continued all day, the meeting was not recorded, instead notes were kept and transcribed the following day.

We chose to do an observation of the meeting since this method is useful to understand behavior and events. (Neuman 2011) There are different ways of performing observations; the researcher can either be a participating observer who takes part in meetings and can be a part of the studied groups or another alternative is to not participate but just try to just record and observe the behaviours of the studied group. The latter type of observations is generally more focused on specific types of behaviour or a narrower field of interest. Structured protocol can be used to specify when different type of behaviours occurs and which of the actors are conducting them. Knowledge about the situation is recorded in a more structured and quantitative way which can be easier to analyse than unstructured material that comes out of participant observations. (Patel & Davidsson 2008) According to this definition, our observation was partly participating since the researcher asked questions but did not engage in any of the discussions. Since we did not know what the respondent would talk about or what behaviours we could expect we did not have any structured protocol.

Since the participants of the meeting were not asked to participate or gave their permission to be cited, all participants are anonymous in the report. All parts of the program were not interesting for this analysis and therefore chosen parts are presented in the results and others are just briefly mentioned.
4.3 Questionnaire
One of the main objectives of this particular questionnaire was to identify actors on the market for industrial energy services, therefore the sample of the survey was important. The list of companies contacted came from two main sources: a report from the SEA (SEA 2011) describing, categorizing and defining the main actors on the Swedish energy service market, and the second source of contacts was the participant list of the network meeting organized by Swedenergy on energy efficiency and energy services in May 2011. This list of contacts does probably not include all actors working with energy services in Sweden but we estimate that the main large actors are included.

The decision to conduct the survey over phone was mainly made due to the limited number of contacts. It was assumed that the response rate would be higher if we contacted the respondents by phone rather than by mail or email. Also, by conducting the survey over phone it was possible to verify that each respondent was working with something related to energy services and was involved in the company’s market development of segment. When conducting a survey with specific questions about energy services and the market development of energy services it is important to get answers from someone working with these questions and finding the right person to talk to was one of the more time consuming parts of this project.

According to Brace (1949), the first thing to consider when formulating a questionnaire is the objective of the study. The objective of this survey was to identify the main companies that provide energy services to industries and to find out how they project the future market development for energy services to industries and what challenges they see with industrial customers. All questions were closed and demanded yes-or no answers, ratings or numerical answers, this to simplify the analysis of the results.

Conducting the survey over phone also had the advantage that the respondents got to ask questions to clarify the meaning of the survey questions and they could also elaborate on their answers which sometimes meant more interesting answers than just the yes or no answer or the numerical rating. It also happened that the conversation continued after the survey had ended, that the respondent continued to discuss opportunities and challenges related to energy services for industrial customers. Then notes from these discussions were taken and sometimes this reasoning is included in the presentation of the survey result.

The complete questionnaire can be found in appendix I. The objective was to get a more comprehensive picture of the market for industrial energy services, since previous studies of the energy service market have focused on services for buildings.

In total, the list of contacts consisted of 51 companies that were all contacted. One great challenge was to get in touch with the right person at each company to answer the questionnaire and in the end only 33 were reached. Of these 33 companies only one declined to participate and eight answered that they do not provide energy services and are not intending to do so in the near future and were therefore excluded from the list. This means that in total 24 companies answered the survey. Most respondents answered the complete
questionnaire but it occurred that some respondents were unable to answer parts of the survey due to lack of information.

The questionnaire consisted of three parts. The first part included questions regarding the company’s current energy services, e.g. what services the company offer, how they charge clients for their services and which sectors demand their services. The respondents were asked to estimate the company’s total turnover for energy services 2010, a question that proved difficult to answer for many of the respondents. Many of the companies do not have separate numbers available for energy services because they are often included in other collaborations. In the first part of the survey the respondents also got to rate different market development tools that have been suggested in academic literature and policy documents, to improve the energy service market. The rating scale included five points where one meant negative market impact and five positive market impact. The uneven scale gave the respondents the choice of being neutral but some respondents chose to answer that they did not want to speculate.

Companies who offered energy services to industrial companies continued to the second part of the survey where questions involving future market development for industrial energy services and what types of energy service projects are most interesting to provide to industrial customers were asked. The questionnaire made a distinction between different types of industries. The classification was between industries that utilize less than 500 MWh per year and therefore are not included in the Energy Audit Program, industries that utilize more than 500 MWh per year and therefore are included in the Energy Audit Program and energy intensive industries that are included in the EU ETS. This differentiation is not presented in the results since few of the respondents estimated different potentials or market development for the different industrial sectors.

The third part of the survey was asked all respondents, even the ones who did not provide energy service to industrial companies. The respondents were asked to rate challenges to offer energy services to industrial customers. These challenges were formulated from difficulties mentioned in academic literature as well as hypotheses that we wanted to investigate. The scale consisted of four points, one meaning (no negative impact) and four meaning (large negative impact), obliging the respondents to either agree or disagree. All of the respondents chose to answer these questions.

The last part of the survey included only companies that provide energy services to industrial companies. The questions regarded, as in section three, a list of barriers, formulated from Sorrel 2004, for implementing energy efficiency. The respondents got to ask how they think that industrial customers would rate these questions from one (meaning no negative impact) to four (meaning large negative impact).

4.4 Methodological considerations
Several factors need to be taken into account when designing and conducting a scientific study. In this chapter we provide the reader with more information on the methodological considerations of the study. To choose methods is always an important part of designing a study. The reason why we chose to do interviews, observations and a survey can be discussed
but we believe these methods best provided the information we needed to understand our research objects. The interviews gave the respondents the possibility to give their views of the collaborations while the survey and the observation gave insights in how the supply side perceives the market. We could have done interviews with the supply side as well but this would not have given the overview we looked for since one of the main objectives was to get a broad picture of the supply side of the energy service market. At the same time, we could have done a survey to cover the demand side but this would not have given the deeper insights the interviews provided. By using the different methods we believe we, at least partly, triangulated our research even though we looked at different sides of the market.

4.4 The interviews
The aim with the interviews was not to give an accurate image of all the customers in the Swedish energy market but to give an insight in how the respondents experienced the collaborations with the ESPs and ESCOs. The respondents have had different experiences within the energy service market and they are not a homogenous population since they differ in size and production processes. This makes it difficult to analyze and to draw generalizations from the interviews. At the same time, the respondents are common Swedish industrial firms and the results from these interviews give glimpses of the firm’s perspective of the energy service market.

One of the interviewed firms invited a consultant from the ESCO that they worked with. This might have affected the outcome of the interview since their presence could make it difficult for firm B’s representatives to speak freely. This probably has affected how they talked about the collaboration, but the fact that they did bring up a smaller conflict indicates that they felt relatively comfortable in the situation.

In some of the interviews the person that we interviewed was not a present at the time of the collaboration. Since some of the collaborations started several years ago, employees have changed positions and moved on to other firms. A complementing study could investigate in companies that recently started collaboration with an ESP to study the process while it is as most intense.

4.4.2 Observation
To perform observations is a method to understand an ongoing situation rather than to collect information in retrospect. (Neumann, 2011) however, there is always a risk that the researcher disturbs the situation with her presence. We did not notice any specific reaction of our presence but to minimize the risk of affecting the network meeting we did not participate in its discussions but sometimes asked clarifying questions. Hopefully our presence did not have a large impact on the Swedenergy network meeting.

The attendants at the meeting were not asked to participate in the study but since the meeting was an open meeting, we do not believe this has any ethical implications on our study.

4.4.3 Questionnaire
The sample is critical for a survey questionnaire and its validity. Our list of contacts does probably not contain all actors on the Swedish market for energy services but we expect,
given previous studies, that it contains the large majority. All companies on the list were contacted at least three times by phone, but still we did not manage to reach them all. A larger sample would have given the survey a better validity but our estimation is that the sample is large enough to draw conclusions from.
5 Results
The results are presented in two different sections. The first section covers the supply sides perception of the energy service market in Sweden today and is based on the observation of the Swedenergy network meeting and a questionnaire. The demand side’s perception of the energy service market is based on five interviews with industrial companies that have had different experiences of working with energy service companies.

5.1 Which are the main actors providing energy services to industrial clients in Sweden today and what kind of services are they providing?
To understand the market for energy services it is important to know which companies are providing the service today and what services they are offering. By observing a network meeting and conducting a questionnaire survey we have investigated the supply side of the energy service market and how they perceive the future development of energy service in Sweden.

5.1.1 Network meeting
The 25th of May 2011, Swedenergy organized a network gathering for energy supply companies on energy efficiency and energy services. 40 participants, the large majority from energy supply companies, but also representatives from SEA, participated in the meeting.

The program started off with a brainstorming session about a proposed education on energy services organized by Swedenergy. A proposal was presented for an education with two days of theory and two days of practicing the new found knowledge in role-plays and more practical exercises. Additionally the organizer proposed a continuation of the course online with focus on energy services for buildings.

After discussions in small groups, the participants were asked to express their needs and expectations on the proposed course. This lead to discussions about the challenges and opportunities of providing energy services. Who are the clients and how are they best reached? On that note one of the first comments that were raised was the demand for the course to aim at both technicians and salesmen since sales personnel and engineers need to cooperate to sell energy services. Often the client ordering the service is not represented by an engineer but rather an administrator that does not have full understanding of the technical system. A salesman is often better qualified to sell the product but it is important that the sales personnel understand the technologies.

“We create the service together with the client.”

Said one of the energy supply representative and explained that since the energy service takes place at the client’s domain it has to be developed in communication with the client, there are few standardized solutions. Therefore it is important that all parties understand each other. The sales personnel act as a bridge between the engineer and the administrator.

One of the participants raised the courses lack of industrial focus. This was explained by the representatives that it is difficult to organize a general course on industrial processes since manufacturing processes are different, the scope is too wide and there are few general rules.
Each manufacturing process is unique and demands its own analysis and therefore it is difficult to include energy services for industrial clients in a course.

After having debated the challenges with industrial clients someone raised the importance of earning the clients trust.

“It is a challenge that we as an energy supply company want to sell energy and at the same time improve the efficiency of utilization”

This statement stirred up a debate. One of the participants argued that it is rare that the client question their motives and when it occurs, it is often the result of simplifications. Another participant compared trusting an energy supply company with trusting your dentist. Doubting the energy supply company’s objective to improve energy efficiency is as clever as believing that the dentist would do a poor job fixing your teeth in hopes for a comeback next year.

The second part of the program was an invited accountant who answered questions about the administrative challenges of providing efficiency services. Detailed questions on how different types of investments and payments shall be accounted for were asked and the difficulty with joint investments discussed.

The third part of the program was SEA presenting their recently published report (SEA 2011) on the energy service market in Sweden. It was concluded that the SEA judge the Swedish market for energy services as well-functioning, especially toward the public and building sector, but also that there is a need for more complex energy services and EPC. The SEA representative ended by asking what the members of Swedenergy expects SEA to do, to help the market development. These were some of the suggestions:

- Clarified information of government support systems was demanded.
- The question of trust was raised again and the participants asked the SEA to help legitimizing energy supply companies at the energy service market.
- Also a control system for the Energy Audit Program was requested. Several participants asked the SEA to clarify what an energy audit must contain and what qualifications are necessary to perform it so that the in-house caretaker, without technical competence, does not perform it.
- The SEA was asked to function as a partner to help develop ideas for example new key-figures to report energy intensity.

The program continued with items that were not related to the market development of energy services and therefore beyond the scope of this analysis: two of the energy supply companies presented current and planned energy efficiency projects, the Swedish District Heating Association presented information new regulations on third party access and Swedenergy presented information about EED.

5.1.2 Market structure

Table II shows a list of the participating companies. To get a better overview the companies have been classified in five different broad categories given their core businesses and what kind of services they offer. This classification is rough and has not been done in dialogue with
the companies but is based on information of their webpages and from other reports (SEA
2011, Lindgren and Nilsson 2010). 24 of the respondents answered that they provided energy
service to industry or planned to do so within twelve months. The eight companies that
answered that they do not and do not plan to provide energy services to industrial customers
did not complete the survey.

<table>
<thead>
<tr>
<th>Category</th>
<th>Company name</th>
<th>Provide/ or plan to provide within the following year energy services to industry in some form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy supply companies</td>
<td>Halmstads energi och miljö AB</td>
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</tr>
<tr>
<td></td>
<td>Varberg Energi</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Gislaved energi AB</td>
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<td>Öresundskraft</td>
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<td>Karlshamn Energi</td>
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</tr>
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<td>Mälarenergi</td>
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<td>Umeå energi</td>
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<td></td>
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<td>Fortum</td>
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<td></td>
<td>Borås Energi och Miljö</td>
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<tr>
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<td>Växjö energi</td>
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<td>Faluenergi och vatten</td>
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<td>Tranåsenergi</td>
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<td></td>
<td>Honeywell AB</td>
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<tr>
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One of the goals of the survey was to estimate the size of the market for energy services in
Sweden. The question included all energy services, not only services to industrial customers.
This proved harder than expected for several different reasons. Estimating the turnover for
energy services is complicated for many of the respondents because energy services are not accounted for separately. Energy services are often integrated as a part of another project, where increased energy efficiency is not the only, or even the main, objective. Another problem in the survey was that many of the respondents had not yet started to offer energy services and therefore their turnover at the time of the survey was zero or close to zero, but they will start up their activities in the following twelve months.

In total 17 companies gave a rough estimate of their turnover for energy services in 2010. Added up, the total estimated turnover for the respondents was 549 million SEK. This figure is not, in any way, a good estimate of the market size, but the distribution of the answers say something about the structure of the market. As figure II illustrates the market consists of a few dominating actors and several smaller companies. The three largest actors answer for more than 85% of the total turnover figure. For nine of the respondents the total turnover for energy services was less than one million SEK in 2010. All respondents, but one, forecast increased or strongly increased turnover for energy services within their companies in the next two years.

Figure II: Questionnaires estimated turnover for energy services: 548 550 000 SEK

Figure III shows to what different sectors the energy service projects were offered in 2010. As expected the public sector, including public housing and private properties (i.e. buildings) are the main receivers of energy services. The industry answers for more than 40% of the total turnover which is a surprising result, given the estimation of 10% in the SEA report (2011). However, it must be remembered that companies that do not provide energy services to industrial customers are excluded from the survey. 29% of the total turnover for energy services went to industrial companies with energy utilization larger than 500 MWh / year. This is the industrial sector that is included in the Energy Audit Program. Only four of the participating companies offered energy services to energy intensive industries, i.e. industries included in EU ETS.
Energy services for industries have been treated as sort of a parenthesis in most reports and articles on the subject. And this reports high figure is explained by the fact that only the respondents that actually offer energy services, in some form, to industrial partners, have answered the questions. Therefore the opinions of the respondents are not a perfect reflection of the total market, instead it puts focus on a part of the markets that has gained some political attention in the last few years. Compared to the previously mentioned studies, for example the 2008 study that estimated the Swedish energy service market to be 781 million SEK, it is not far-fetched to believe that energy services for industrial clients answer for more than the 10% that SEA estimates.

Energy services for industrial partners
In table III the type of service functions that the companies offer, or plan to within the following year, are listed as well as how they are charged. However this division between different service functions is hard to make since they are often combined. In direct energy services such as energy audits, energy declarations, energy counseling and analysis are often pre-studies of energy efficiency project. These indirect services can then be followed by more complex energy services implementing of energy efficiency measures. Sometimes the indirect services are even free of charge if they are part of a more complex service project. Many of the respondents expected to see an increasing demand for energy audits in the recent future, partly due to the Energy Audit Program. None of the respondents however anticipated an increase in energy declarations, many even projected a decline.
Table III: Provided energy services

Table III shows that performance based remuneration are offered by a third of the respondents in energy efficiency projects. Only one of the respondents answered that their company only provides energy services for a performance based remuneration. Nine of the companies in the survey have no such contract and do not plan to start offering energy services on performance based remuneration or guarantee savings. Out of the six companies that estimated a turnover greater than 15 million SEK, five offered EPC, for these companies EPC was estimated to answer for 34% of their energy service activities. Only three of the thirteen energy supply companies that participated in the survey had offered EPC during 2010.

**Challenges and opportunities with industrial partners**

The survey showed that both long term project with a payoff time over two years and short term projects were rated as interesting with industrial partners. The short term projects were rated as more attractive mainly because many of the respondents perceive that industrial clients prefer project with shorter pay-off time.

In order to understand what the respondent sees as challenges to offer energy services to industrial partners as opposed to other market sectors, they got to rate obstacles. The

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3 Indirect energy services can only be part of an EPC if they are combined with complex energy services.

4 Since 2006 all buildings that utilize energy to change the thermal indoor climate must have an energy declaration performed at least every 10 years. This includes information about the buildings energy performance and how it can be improved as well as reference values for similar buildings. It also contains information about the ventilation system and if a radon measurement have been done.

5 The number is parentheses in Table III show ESPs that provide energy services for both fixed and performance based remuneration. They are included in the total number in the column for fixed price.
suggested obstacles are formulated with inspiration from a literary review of different sources, articles and reports discussion energy services. (Sorrell 2000, Thollander et al. 2010)

One challenge for energy services that is mentioned in most literature about energy services is transaction costs. Transaction costs are not, necessarily, related to the size of the transaction and therefore larger energy service projects have been estimated to be more profitable than small projects. This has been one of the explanations to why energy services have mainly targeted the public sector and commercial buildings. Therefore the respondents got to consider the statement: individual industrial plant does not have large enough savings potentials. This argument was not supported by the respondents in the survey, the large majority, more than eighty percent, disagreed with the statement that low savings potentials is a barrier for energy services providers to work with industries. When asked to quantify their answer on a scale between one and four, where 1 meant “does not agree” and four meant “agree” the mean was 1, 65.

Another challenge for ESPs to work with industrial firms is that ESPs are often specialized in generic technologies and industrial plants demand more specific competence in order to implement energy efficiency measures. This stated barrier divided the respondents who distributed themselves rather evenly over the answering scale. The statement got a mean of 2,71.

Another barrier related to transaction costs is industrial firm’s lack of trust in external consultants. The general opinion among the respondents in the survey was that they did not agree with this statement that firms have weak trust in external consultants. Only one of the respondents answered a four to this statement while most of the respondents answered a two or three; however the mean was at the lower end of the scale, an even two. This can be interpreted as that there are some trust issues but that it is not a severe barrier for ESPs to cooperate with industrial partners.

Since energy services are a way to increase energy efficiency it is reasonable to believe that they to some extent face same barriers that face energy efficiency. Industrial firm’s lack of knowledge about energy efficiency is often mentioned as one of the greatest barriers, if they are not aware of the issue, they are not likely to take measures to fix it. At the same time this is also the barrier that ESPs are supposed to overcome. Industrial firms lack of knowledge about energy and energy efficiency was rated in means 2,52, the respondents neither agreed nor disagreed. One of the respondents did not see it as a barrier at all and explained “that is what we are for, that is our sales pitch”.

But some of the respondents argued that lacking knowledge generate low priority. The barrier that scored the highest list of challenges was firms lack of budget funding to invest in energy efficiency, that barrier scored 3, 23.

**Perception of demand side**

In the last part of the survey the respondents got to rate how they think that industrial firms perceive different barriers to energy efficiency. They got to rate different challenges from an industrial point of view from 1 to 4 and figure IV shows their responses. All of the obstacles
got a mean higher than two which means that the ESPs believe that the industry considers them to be inhibiting energy efficiency. Highest ranked was that other investments have higher priority.

Figure IV: Perception of demand side

5.2 How do industrial firms perceive energy service collaborations and the energy service market?

We studied the demand side by conducting interviews with firms that had used energy services. All the interviewed firms have a common feature; they are small or medium sized industrial firms that belong to a larger corporate group. They are a part of a multinational enterprise with subsidiary corporations in different countries. The five industries that are represented in the interviews are all situated in Sweden. The largest firm has 500 employees and an approximate turnover of 1 billion SEK. The smallest firm has 43 employees and an estimated turnover of 200 million SEK. Four of the industries have had experience of working with ESCOs but the smallest firm has only had experience of working with an ESP. Their production is in some cases considered to be energy intensive since their energy cost is over 2% of their turnover. The industrial firms are presented in table IV.
<table>
<thead>
<tr>
<th>Firm</th>
<th>Number of employees</th>
<th>Turnover in million SEK</th>
<th>ESP/ESCO</th>
<th>Products</th>
<th>Interviewed respondent</th>
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<td>970</td>
<td>ESP+ESCO</td>
<td>Steel components</td>
<td>Environmental manager</td>
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<td>ESCO</td>
<td>Porcelain products</td>
<td>Environmental manager + maintenance manager + ESCO consultant</td>
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<td>Plastic products</td>
<td>Environmental manager + maintenance manager + production manager</td>
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<td>192</td>
<td>ESP</td>
<td>Steel components</td>
<td>Plant manager</td>
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</tbody>
</table>

Table IV

**Steel product firm A**

Steel firm A is a medium sized firm with 500 employees situated in a small town. The firm produces steel products and has a rather long history of engaging in energy efficiency. An environmental manager is responsible for all environmental matters, including energy. In this study we will refer to him as Anders. The firm has previously had collaborations with ESCOs and is currently in the process of deciding whether to hire an ESCO to continue to improve energy efficiency. The firm has so far had six heat recovery units installed as a part of the collaboration with an ESCO and has invested in energy efficiency measures in the production to lower the use of liquefied petroleum gas (LPG). Steel firm A also has collaboration with an energy supply company that provides compressed air as a finished product. The energy supplier own, and serves, the machineries that produce the compressed air to steel firm A. Steel firm A took part of voluntary energy efficiency program (PFE) and had an energy audit performed in their plant as a part of the program. This resulted in an action plan that the firm has worked to implement. Among several smaller investments, the firm optimized of the process of heating and covering the steel after it has left the furnace. They later also invested in a runner breaker that crushes the leftover steel from the molds into smaller pieces that demands less energy to melt. Anders thinks that is hard to evaluate the energy savings. The
use of liquefied petroleum gas (LPG) has decreased but since it now is used differently it is hard to say how much.

The work with energy management is spread throughout the firm in different levels. The board reviews energy and environmental matters twice a year but more regular meetings take place in smaller work groups in different departments of the firm. These working groups deal with occupational safety and health and environmental issues as well as energy management at their respective department. In the beginning the environmental manager led a group that worked with energy efficiency which consisted of the property owner, the maintenance manager, the plant manager, an engineer, a technician and another manager. The group worked intensively with implementation of the action plan but when the property owner was exchanged and the maintenance manager and the engineer went to other companies the group lost momentum. Anders does not have a technical background and neither had his supervisor; being the only two members in the energy group, they have realized that they needed to bring in a consultant to keep the process alive. Their plan is now to engage an ESCO but they have not yet decided whom they want to hire for the job. If everything works out as planned, they will have a project running in September. They have previous experience of working with both ESP and ESCOs. In steel firm A the decision of hiring an ESCO will be taken by the CEO and the board. Several other actors will be able to influence the decision, for example the maintenance manager, since they will be working closely together.

Steel firm A today work with ESCOs in several parts of their production on their premises. One of these collaborations concerns installation and maintenance of heat recovery units and this project started in the 1980’s. Steel firm A and the ESCO shared the gained profit of the new heat pump that the service company installed. Steel firm A today pays for service and depreciation of the heat recovery units. Anders was not in the firm when the collaboration started so he does not know how it came about. He thinks that it probably was a result of personal contacts, maybe it started after a discussion on the golf course.

Anders says that the reason he thinks the firm should employ an ESCO is that it has reached a dead end in the work with energy efficiency:

Anders: “Because I know our people! (short laughter) Nothing major has happened the last ten years. No one has the will, or maybe no time or opportunity to push energy issues. To be able to get somewhere you would have to have someone working fulltime with energy. I do not see any other alternative.”

Anders has tried to show how much money could be saved by hiring an energy manager but since the firm is not allowed to employ officials his suggestions have not been met. When asked if he feels that he has do defend his suggestions of investments in energy efficiency to the board he responds:

Anders: “Yes, some of it you have to defend. Like this suggestion that we now will use a consultant agency. It is a bit like, it you scream loud enough then they will understand. And you also have to be able to show it, with statistics and money. You have to have a good basis when you approach the board. It is not just to aim from the hip.”
Anders has made several calculations on how to save energy in firm A but he seems to meet resistance even though his calculations show how his suggestions clearly can save money, this was the case when he wanted to hire an energy manager. He has done a calculation to investigate the potential savings in hiring an ESCO and he thinks it can save up to seven millions.

Anders has developed a working document to help the firm with the effort to choose an ESCO to collaborate with. After the ability to show that their efforts are economically beneficial, the most important aspect is their way of working. The ESCO needs to be able to work closely together with the engineers and maintenance managers at steel firm A. Since Anders is not an engineer he therefore will set up meetings with representatives from the ESCO and firm A’s employees that will be part in the process. Other aspects that Anders has in his documents concerns the work process and specific issues around different technologies, e.g. compressed air.

Anders have done other calculations to show that it would be profitable to let two operators close the leakage from the compressed air instead of doing their usual work assignments in the production. According to Anders, if two operators worked two weeks with closing leakages they would make the firm the same profit as if they worked over 15 years in the production. He thinks he would get this suggestion through when he presents it to the board since it is so profitable. He still feels that it is hard to get grants to work with energy management:

Anders: “I don’t know, it doesn’t show on some line in the accounting that is really important. I don’t know what line it is. But it is like. It’s not productive. It is not a part of the production process. It doesn’t seem to count.”

And when asked who actually has control over the investments he responds:

Anders: “It is the financial officers\(^6\). [...] It is the same everywhere. I don’t know anything about economy, I don’t know if there are any economical control systems where you can get it in (energy issues), that would be interesting. And to get it in the systems so that it shows that it can make profit that it is a valuable work. So that it does not get hidden in some account that says nothing.”

Anders believes that the board of firm A does not want to invest money in future collaborations with an ESCO. The aspiration is that ESCO take the investment, but at the same time Anders says that it cannot be a leasing deal since it becomes too complicated when it comes to taxes.

Firm A has experienced problems with long EPC involving undefined responsibilities. When the ESCO changed staff they ran into problems because the contract had oral agreements that

\(^{6}\) In Swedish, the term “ekonom” is a broad term that refers to both economist and financial officers. In this study we have chosen the translation financial officer since we believe the respondents more often refer to the persons responsible for budget, funding and other economic issues at a company, rather than the more theoretical economist.
the new staff was not aware of. To prevent this from happening in the future Anders had taken courses in law and how to formulate contract clauses but he still thinks that they will need a specialist to help them to write the contract.

Anders thinks that the government should put pressure on companies to have a more energy efficient production by new laws.

Anders: “Then you will have to go forward, and to actually do something. Then you won’t be able to say: we have done it like this for a long time. […] If you are a small firm you would probably not want the same regulation. But if you are in a multinational company that competes over investments with the rest of the world, then it could be useful to have good support from the authorities. “

The Porcelain Firm

This porcelain firm is a medium sized firm with 500 employees situated in a suburb to a large city. This interview was done with the environmental manager for the plant who also has responsibility for a part of the production process, the maintenance manager and a consultant from the ESCO they collaborate with. The environmental manager will be called Bertil, the maintenance manager is called Magnus and the consultant will be referred to as Eskil. Since the consultant from outside the firm was present, this interview turned out slightly different from the others.

The firm produces porcelain products and has collaborated with an ESCO since 2006. Before the collaboration started, the firm’s old boiler caught fire. When it had to be replaced, the firm also decided to invest in the first heat recovery pump. The heat recovery pump turned out to be unsuitable for the production since the wastewater was too hot and stated to boil too fast. Instead of replacing it the firm let it stand still and this was the way the ESCO found it when it conducted an energy audit. The ESCO have, among other improvements, optimized the use of waste heat, improved the ventilation system and installed a digital control system. The changes led to a reduction of energy use of 80% according to the ESCO. The ESCO changed a lot of the firm’s heat piping as well as the use of waste heat from ovens used in the production process. Before these changes, the heat was let out in the oven hall which became unnecessarily hot. Today the heat is instead redirected and used to heat other parts of the plant and to dry products. The whole central heating system was rebuilt but there were not changes in the building layout. A new control system, which was designed by the ESCO, was installed to control and optimize heating and production. No changes were done to the production process other than the use of waste heat from the ovens.

The collaboration started when the ESCO approached the porcelain firm and offered a free preliminary energy audit of the plant. After the preliminary analysis was conducted, the ESCO highlighted potential energy savings and offered a deeper analysis. The porcelain firm accepted and bought the deep analysis in which the consultant company made exact measures of interesting components in the process and gave suggestions for future implementations. The ESCO also offered to collaborate with the porcelain firm and make the necessary
investments for these implementations in an EPC. According to Eskil, the firm could choose to work with another ESCO after the deep analysis.

As a part of the decision process, the porcelain firm also went on a study visit to a firm that had been very pleased with their collaboration with the ESCO. The final decision to go ahead with the collaboration was taken by the board of the multinational group:

Bertil: "It was the board of the firm, I think it was brought to the board of the enterprise in Germany. So they probably took the final decision about this. However things are, even if the ESCO is large and everything there is always a risk for… that things would collapse or that it won’t work and when it is about so much money I guess they wanted.. well.. Then it ends up at the top of the organization.”

The investments that was made by the porcelain firm was between 10-11 million SEK and according to both Bertil and Eskil only a few companies can handle such a large investment. The savings that the porcelain firm has gained from the collaboration with the ESCO is estimated to be 7-8 million SEK per year according to Eskil. He also stress that to hire a small firm is more risky than to collaborate with a larger ESCO:

Eskil: “And then the customer wants to feel safe, Kalle on the corner can maybe provide certain services very cheap because he has no overhead costs but he might, when you call him he says that he lives in Thailand now and has closed down all activities. But our company will probably exist during the whole contract period, and that is a comfort in itself.”

When we ask them why there is an interest in working with energy efficiency they talk about how economy and environmental matters sometimes go hand in hand.

Eskil: And even a plumbing engineer in the 80-this saved energy, and that the environment gained from that was there no one that thought about it back then.

Bertil: No, it was only the money they thought about.

Eskil: Luckily, these two go hand in hand.

Bertil: Yes, that is true!

Eskil: Yeah, so you make money and improve the environment. That is amazing, and it is the fastest way.

Bertil: Yes, and it is the only possibility. If you didn’t make money and just had to spend, it would be so much harder to get things through, if there weren’t laws that forced you to do it. But voluntary, if there isn’t any economic incentive, I don’t believe in that. I don’t think it would be possible to get company boards to…

Eskil: It is greed that drives us (Bertil and Magnus laughs). It is the strongest force except for envy and begrudge. It is what makes us work hard. (B + M laugh again) Luckily it is this way…
Both Eskil and Bertil seem to agree on the economic argument as the driving force behind investments and they perceive it as very natural. The next question we asked was how The Porcelain Firm’s environmental policy works within this situation. Bertil responds:

Bertil: “Well, yes.. Let me put it this way. At least there is a will to be environmental friendly, from the board and in environmental issues and so.. There is definitively a will. And, sure, the first project we did, with the acid-history and the heat exchanger, it was purely for environmental reasons that it happened. It.. To lower the use of acid, there was a pressure from the authorities but the fact that we lowered it so much, that we could put a heat exchanger in, that was purely for environmental reasons. “

In some ways Bertil thinks that it is money that control which investments the company decides to make, but at the same time they seem to be ready to stretch their investments a bit further if there are environmental reasons for it.

Magnus and Bertil trusted the ESCO in their calculations and Eskil believes that was because there was no risk involved in the collaboration. At the same time Bertil earlier told us that the board of the company group had to make the decision to collaborate with the ESCO. The porcelain firm and the representative from the ESCO seem to have different view on what risks are attached to the deal.

The project was very big, even for the large ESCO. Eskil has put a lot of hours in the project and says that some of the personnel at the porcelain firm actually think that he belongs to their firm. Both Magnus and Bertil think that it feels more secure to work with the same persons from the ESCO, they also appreciate the well-working collaboration. One problem that occurred was when the communication with one subcontractor did not work as well as it should have. They ended up in problems with the environmental agency since a permissions was not handed in as regulated. But in the end they think that they managed to solve the problem and since it was such a big project a mistake like this was not surprising.

In the future the porcelain firm will try to work more independently with energy issues. In the next years they will move the plant to a new location and in this process energy issues are important. The firm has also been a reference case to another company that now has a new collaboration with the ESCO.

_The steel product firm B_

At steel firm B we met the environmental manager, here called Carl. Steel firm B has about 200 employees and is situated in a medium sized town in the eastern parts of Sweden. Carl has a background in the paper industry and is currently employed by a subsidiary to steel firm B that owns all of the firm’s properties. The firm produces steel components to large industries; most products are exported to Asia. The firm is a part of a multinational group which has its headquarter in USA. Steel firm B started collaborate with an ESCO in 2003 and this resulted in 63% savings in energy use by changes in the control systems, ventilation and optimization of the heat recovery from ovens in the production process.
In the late 1990’s a collaboration to improve steel firm B’s energy efficiency started with a small ESP. They tried to reduce electricity utilization by performing night walks to find idle running and also re-used wasted heat from ovens. After this project ended it took a while until the next energy efficiency project started for the firm. Another ESP was involved in steel firm B’s production process through a service deal concerning heat and ventilation. This firm was later bought up by a major group that also had energy performance services. They approached Carl with an offer on a control system that would further reduce the energy use. Carl liked the idea and saw an opportunity to invest in energy efficiency:

Carl: "If you want to ask for funding for investments, it is much easier to get the money if you want to invest in the production process, if you can invest in the process and make money. But if you want to invest in the heating system it is not as easy."

When the board of steel firm B was persuaded the collaboration started. It was not easy for Carl to convince all concerned actors that the collaboration with the ESCO was a good idea. He felt that it was important that he believed in the collaboration and that he could present convincing numbers. When asked if it was obvious that they should take the deal he answers:

Carl: “No, well to me it was. Because I, I understood that I wouldn’t get any further with the things I was doing then. For me it was a way to dislodge money and to be able to… make improvements in the plant. To me it was obvious, but it wasn’t for everyone.”

When the ESCO carried through the changes to make steel firm B more energy efficient Carl felt that he got better control of heating and ventilation but also over the energy use in the production processes. The ESCO invested about 7 million SEK and the estimated saving per year was 100 000- 200 000 SEK per year. Carl thinks that the operating costs have been reduced, but he also says it is hard to estimate how much:

Carl: “Then there is this thing with these deals, you follow up and evaluate. And then if the production goes up, you are not at the same starting point any more. It is a difficulty. If we increased the uptime [production] then people are here and use the plant a lot more than what was… To measure against this, it is.. really tricky.”

Carl thinks that the firm would have made a greater profit if they had decided to make the improvements themselves but he believes that the board of steel firm B was not interested in doing these kinds of investments:

Carl: “But it is clear that if we had had the money [to do the changes] ourselves our profit would have been bigger. But we hadn’t. Or, we had money but they were appointed to other kind of investments. Maybe they wanted to improve the process or the production or something. Not just put it on energy.”

When asked what he thinks about the risks with the collaboration he answers:

Carl: "Well… I don’t know, I can be a bit naïve as a person. I listen to something, and then it is fine. But of course there were people who did not believe in this and thought that it would not give the results it was supposed to. I think it was.. financial officers.. other people..”
Carl thinks that the risks are partially about how to make calculations and measurements:

Carl: “But then you end up in this, how do you do evaluations, how do you measure the factor how much we work in the production process? I think, it would probably been harder if I wasn’t in this position, to be honest. What I tried to do was to see how much we produced and to put it in relation to kilo produced product. [...] Those things were a bit tricky but it worked anyway. But there were people who said that you can’t measure like that, you can’t do it like that. And then you might end up in a dispute over them having to pay… But in the greater picture it worked out well.”

Carl had an important part of the process, both as a driving factor as well as his competence to make calculations. Carl had tried to measure the use of heat and electricity and put it in relation to the production to understand how they were connected. He had a few disputes with the ESCO over how things should be measured and they did not agree on how some numbers were calculated. They started from the existing production rate but when the production rate changed they had different views on how these changes were calculated in the model the ESCO used to estimate the savings. Carl refused to sign some of the reports the ESCO produced since they disagreed on the calculations. He tried to understand the ESCO’s model but he never really fully understood it. He thinks that the model should be better highlighted before companies start the collaboration with an ESCO to avoid these types of problems. He still thinks the collaboration has worked out well and the personnel at steel firm B got to know the people they work with at the ESCO. Steel firm B is pleased with the new control system and has its own appointed technician responsible for the system. The deal with the ESCO has now run out and steel firm B now owns the machines that they leased during the contract period.

Later on, steel firm B applied for a subsidized energy audit through the SEA’s Energy Audit Program. The audit resulted in an action plan and one of the first actions was to replace the old windows. This was done last year even though the payoff was estimated to be 19 years. Carl says that they were in need of changing anyway. The next action will be to isolate attics to prevent heat leakages. The attics differ in their design and different techniques have to be used in the different attics. The expected payoff times range from 4 to 30 years depending on the used technique but all the attics are planned to be isolated. When asked why these actions are carried through despite the long payoff Carl says that it is important to have an understanding boss.

Furthermore, Carl thinks that saving energy has several reasons:

Carl: “These maybe my own personal views but that might not be a problem.. I don’t think we should use up that much of the earth’s resources. And if you do it you should do it as little as you can, and leave as little waste as possible. Then I think there is economy in it as well. That you use, use your resources as efficient as possible. And then that shows in the financial result to a certain.. And then you have to weigh it against the investment costs. And then you tweak it a bit.”
Carl thinks that financial arguments are the most commonly used in the firm but he thinks that it is important to be aware of the finite natural resources. He also talks about the different responsibilities that comes with the role of being a manager and that it is important to be aware of your part in the firm. Carl feels that his work with energy efficiency is his way to contribute to the firm and its development. He thinks that it is important that there is someone in the firm that feels responsible for the collaboration with the ESCO to make it work. Carl worked three extra years in the firm despite that he could have retired earlier. One of the main reasons for that is that the firm has not found a suitable person to replace him. He has now decided to retire even though no one will take his place. His responsibilities will be placed on the plant manager.

To promote change towards energy efficient industrial firms in Sweden Carl thinks that it would be nice if the government not only let the price rise. He is not sure how to create efficient incentives but thinks that it sometimes can be useful to force the industrial firms to change:

Carl: “In the paper industry they used to bleach the paper with chlorine and that wasn’t very good. They measured per kilo ton paper pulp and then they lowered the allowed amount to 2 kilo per ton paper pulp. And our plant manager said that it would be our death, we would never be able to do it. I worked there for many years and now they use 0,1 to 0,2 kg per ton paper and it works perfectly!”

The Plastic Firm

The plastic firm is a medium sized firm in a small town in southern Sweden. The firm produces plastic products and is a part of a multinational group. The plant has four different production divisions in the same factory. Three employees from the firm were present at the interview; an environmental and quality manager, who we call David, the maintenance manager, Markus, and Peter, who is production manager for one of the four departments.

The plastic firm started to collaborate with an ESCO in 2005 after a few years of delay since the firm was for sale and bought by an international group in 2003. The ESCO approached the purchase division with an offer and it was then handed over to the division for maintenance and environmental issues. At the time Peter was environmental manager, he later moved on to become production manager and David took over his role. According to the ESCO’s homepage, where the collaboration is featured, the firm’s energy use was reduced with 78% by changing the control system, recovering the heat from the production in the central heating system, installing a new heat pump and time controlling activities in the plant. The savings were calculated to 62% of the use of liquefied petroleum gas (LPG) and the ESCO guaranteed 80% of this saving. Peter makes a comment on the guaranteed savings:

Peter: “The risk for this plant was relatively low (for the ESCO) or otherwise they played it very safe, but we don’t know that!”

During the contract period, about 7-8 years, the ESCO made investments estimated to 10 million SEK in the plastic firm. The plastic firm pays a fee for service and leasing of the
machinery during this period. When the deal runs out they can buy the machinery for a symbolic sum and only pay for the service. There were many discussions before the plastic firm decided to join the collaboration with the ESCO. The discussions often concerned the risks of such a close collaboration.

The interviewed representatives for the plastic firm do not think that they would have been interested in investing money in the energy saving measurements themselves, even though it might have been more economical beneficial. Peter says it comes down to the payback period being too long:

Peter: “We would have had problems to make a payback on this. If we had made a calculation on this we would have had to base it on the worst possible outcome, which is 80% [of what the ESCO predicted] and not that we are doing as well as we are now. So even if it would have been profitable we wouldn’t have been able to show it in a calculation.”

The plastic firm uses the control system that the ESCO installed on a daily basis and it is now a part of the normal routines. The production leaders have to order production time from the maintenance division to be able to use energy to work in the production process. The firm has better control of the electricity use and there is also a higher awareness of overall energy use. Nowadays the employees turn out the lights during weekends and try to buy more energy efficient machineries. Even so, the interviewees still think that staff awareness have to be higher to further reduce the electricity use.

Another outcome of the collaboration was that if the plastic firm changed anything in the production, they are obligated to tell the ESCO about it, since it can affect the use of electricity and LPG. The ESCO adjusted the calculation of saved heating compared to the production and also to a measurement called “normal year”. This measurement compares the average temperature from 1970 to 1995 to the specific average year temperature to compensate for temperature fluctuations. The first years the firm used less LPG than expected which to some extend had to do with the temperature that was higher than the normal year. Peter adds:

Peter: “You have to have in mind that what we call the metrological normal year, these two last years that we see as terrible cold, with snow and everything, they have been normal years. They have not been worse than normal years, if you compare with the average period. They hit the normal year pretty good.”

After the implementations, the use of LPG was lower than expected which resulted in that the plastic firm had to share the profit gained from the savings according to the deal. They saved 75% instead of expected 62% and that came as a chock when the ESCO send them the bill after the first year.

Another aspect that should be discussed according to Peter is the scope of the calculations that are used to make the model for the energy system. In the calculations on their heating system two heat pumps were left out, they were estimated to contribute with 1400 megawatt hours as
their signs said. In reality they did not produce near that amount of energy and it became a source of discussion who had responsibility for the miscount.

When asked if the deal was complicated Peter answer:

Peter: “Yes, it was. And it was probably one of the reasons it took some time to get the deal through. There is a model to calculate the expected saving. And why I say the expected saving is because it is dependent on the operating conditions we had compared to the pre-study and what temperature we had compared to.. how it should have been a normal year, and then there are made compensations.. And since I have held this presentation a few times I can say that if you are not familiar with the model it is hard to understand how it leads to savings. The ESCO has an advantage here since they made the model. So I think someone with technical knowledge should “own” the model. […] What I have done in practice is not to scrutinize calculations but to go in the back door and with rules of thumb find the same numbers.”

The plastic firm had a few bumps on the road during the project that was not expected. One problem was that the productions was optimized which left no room for overproduction. The optimization was calculated from the production rate during the pre-study and when the production changed they ended up with capacity problem in some parts of the production. They also discovered that a lot of worn out parts needed to be replaced in the existing machinery which added to the plastic firm´s costs.

The project together with the ESCO has made it possible for the environmental manager at the plastic firm to maintain a focus on energy saving over a longer period of time. David appreciates to be able to work with the project:

David: “This [project] has been going on for a longer period. And it feels safe to hold on to this thread. That it is a long term environmental improvement project that we have worked with for several years. And that actually feels quite good, I have to say.”

The plastic firm belongs to an international group of corporations and they have an environmental policy that applies to all included firms. Peter explains that he thinks that in some aspects the environmental policy differs from the reality in this plant and therefore it is hard to have the same focus as the policy. David agrees but adds that it is also useful to sometimes be “forced into” some of the processes that spring from the concern´s policies.

When asked how to make Swedish industrial firms more energy efficient Peter responds that energy services are a part of the solution but that the responsibility still has to be attributed to the production manager, but political and financial incentives can help. He thinks that it would be beneficial to allow a longer payback on investments and changing the mentality to make people understand that it is a long term process. David also agrees and thinks that financial incentives will help people to make the right choices.

The plastic firm still collaborates with the ESCO on new ways to improve the plant. There is a lot happening in the plant and the firm waits for all the changes that are expected to take place this year.
Steel components firm C

Steel firm C is a small industrial firm that belongs to a large firm group with 800 employees. They are situated in a medium sized city and produce steel products. The plant manager (we will call him Eric) is responsible for energy issues but he works together with a team, including a foreman, a technician and the maintenance manager. The same team works with several different issues and when needed they involve workers from the steel mill as well. They have an energy efficiency action plan that they work with actively and revise every year.

Steel firm C belongs to a group of local companies that cooperate around energy and other environmental matters. The group, called Ekoperspektiv, started in 1997 when they decided to work together to get ISO environmental certificates (ISO 14001). Since it consists of small corporations they thought it was a good opportunity to work together and do the certification. The project was initiated by Nutek (a governmental initiative to support local companies) and it included a free energy audit. This first energy audit resulted in an action plan and the implementation of several energy saving measures. The ESP that did the audit gave suggestions of suitable implantations that would increase energy efficiency, many of them was connected to heat flows and ventilations. An important implementation was to change a compressor that was too large compared to their needs into two new, smaller compressors. Another implementation was to seal leakage of compressed air which was an effort that was categorized as easy to recoup.

It is typical for a many investments in energy efficiency, when corporations need to replace old equipment they take the opportunity to also invest in energy efficient implementations. This becomes very clear in the next change that steel firm C made. The most expensive investment was to connect the plant to the central heating system. We asked how the calculated on that investment:

Eric: “Not that much actually since we ended up with a choice when our old boiler broke down and we thought: Why should we buy a new boiler? It is better to connect to central heating.”

The firm started a discussion with the local energy supplier who then hired a master student who did his thesis on the opportunity to connect firm E to the district heating system.

Eric: “..it [the thesis] looked into, how to use district heating in the process so there were quite a lot of calculations… wrong or not, there were probably a lot of errors in these calculations but it turned out that we made the investments and changed from oil to central heating.”

It was an investment on 2-3 million SEK for steel firm C. The plant manager has tried to evaluate the investment afterwards but he thinks that it is hard to evaluate one separate measure. According to his calculations the overall use of electricity has been reduced with 5% in the same production rate, but then he has not compensated for fluctuations in temperature over the year.
The report the ESP made predicted that steel firm C should reach a decrease of 13% if they were to implement all these actions. There were actions that have a payoff in 20 years the investment that was not carried through, but the actions with shorter pay-off was implemented.

When asked what a short payoff is Eric answers:

Eric: “Well, it depends on who you ask, if you talk to a financial officer I think you would talk about one year, but I think you should stick to at least 3-4 years.”

The decision to invest in district heating was taken by the board of the firm. There are board meetings once or twice a year and in between meetings, the plant manager can make decisions about investments, according to the investment plan. If there is any other issues the board communicate informally and can make decisions outside the meetings. The board was only informed about the collaboration with an ESP, the decision was made by the plant manager. Steel firm C is the smallest firm in our study and that can explain why the plant manager has more freedom to make choices for the firm. However, it does not explain why the firm invested themselves in energy efficiency measures. According to Eric it was natural for the firm to work actively with energy efficiency since it is such a large expense.

At a later stage, in 2006, steel firm C hired the same consultant firm that did the audit in Ekoperspektiv, to do another energy audit of their plant. The firm felt that the cooperation with the consultant firm had worked well and wanted to continue the collaboration.
6 Analysis
In this chapter we analyse our empirical findings by applying the previously presented economic theory and socio-technical theory.

6.1 Economic analysis
From an economic perspective, the objective to increase energy efficiency can be attained in three different ways; by legal regulation, raising energy prices (e.g. by introducing taxes) or decreasing costs for energy efficiency measures. Energy efficiency measures will be demanded if the monetary gains from energy savings exceed the cost of the investment. Therefore in the neo-classical perspective all barriers to energy efficiency can be boiled down to costs.

6.1.1 The costs of energy efficiency and energy services
Energy services are stressed in political directives as an important tool to improve energy efficiency in sectors whose core activity is not related to energy. This suggests that the EU and SEA believe that energy services can decrease the costs for implementing energy efficiency. Energy services are assumed to reduce many of the costs, or barriers, that are often mentioned as reasons behind the energy efficiency gap. Consulting an ESP or an ESCO is a way for organizations to outsource energy management; but do energy services always decrease the costs for implementing energy efficiency?

To what extent the consultation of energy services reduces or increases costs depends on what type energy service it is and on what kind of venue and organization it is applied. In this report we have divided energy services in two categories, indirect and complex energy services.

Indirect energy services are generally provided at a fixed fee and function as pre-studies for energy efficiency projects; they provide information about potentials and possible energy efficiency measures. One of the interviewed respondents testified that efficiency measures had been implemented after conducting an energy audit, partly financed by the Energy Audit Program. This supports the EED argument that knowledge and transparency can increase energy efficiency. But imperfect information is not the only barrier to energy efficiency and therefore knowing the potentials does not necessarily mean that the efficiency measures will be implemented.

Complex energy services implement energy efficiency measures and can be offered in EPC. EPCs reduce the barrier of risk since ESCOs share the project risk and can also overcome the barrier of access to capital (opportunity cost) since they sometimes help finance investments. However complex energy services in EPC can, as the phrase indicates, be complicated. One of the interviewed in the report compared the collaboration with an ESCO as a marriage. One difference between an energy service collaboration and a marriage is that the collaboration is not based on love. Instead on love and mutual trust the terms of the collaborations are regulated and negotiated in contracts. Industrial firms, which hire ESCOs to outsource energy management, need to understand complex models to understand the terms of the contract. This takes time and efforts that could have been spent differently. In one of the interviews the
environmental manager even had to take a course in law to better understand the contracts. All these cost due to lack of trust and moral hazard. Both parts in an energy service project have an interest in monitoring that the collaboration partner does not act in its own advantage. The results from the interviews give evidence to that lack of trust generate a lot of extra work and costs.

Transaction costs are not merely related to the size of investment. Therefore transaction costs become less significant in projects with large energy saving potentials. This is usually the explanation for why the energy service markets, especially complex energy services, in Europe have mainly been targeting the public sector and other large building complexes. However, the EU estimate that there are enormous energy saving potentials in small and medium sized industries and studies of Swedish industries have shown that the greatest potential is in the support process, i.e. generic technologies. The participating energy supply companies do not consider the energy saving potential in individual industrial plants as an obstacle to offer energy services.

While the ESD pointed out ESCOs as important tools to tap energy saving potentials the new directive for energy efficiency EED points out ESPs while at the same time underlining the energy saving potentials in small and medium sized industries. This could be an indication that the EU assumes that energy services at fixed remuneration are better suited for small and medium sized industries. The participant in the questionnaire of the supply side of the energy service market consider industrial firms as an attractive market segment, mainly for short term project but also for more complex energy services and EPC project. However, in the interviews with the demand side, it is clear that the respondents value long term relationships with energy service companies. Also the difficulty to finance energy efficiency projects keeps recurring and ESCOs have for the interviewees been a way of overcoming the lack of financial means. This indicates a demand for complex energy services and cooperation’s.

6.2 Socio-technical analysis
There are several interesting points concerning the industrial firms’ perspective on the energy service market that can be discussed, both on their own and from a theoretical perspective. In this chapter we will analyze the interviews, and to some extend also the observation and the survey, in order to better understand how the industrial firms perceive the collaborations with energy service companies. This analysis uses a socio-technical perspective and with the help from Caliskan and Callon (2010; 2009) we make visible some of the processes that are important for the collaborations and the energy service market.

6.2.1 Different modalities of value
The actors in the energy service market have different views on what actions are the best suited for their firm and their situation. There are different modes of value (Caliskan and Callon 2010) practiced by the actors identified in the Swedish energy market. This is evident in the interviews in the way the different actors value what actions should be taken and how the values of the ESCO’s service should be calculated. Different modalities of value can be seen as separate views on which actions are considered as the best for the firm. Modalities of value are not a way to calculate prices since it is more inclusive and takes other aspects in
consideration. The environmental managers believe that the other actors’ ways of doing valuations are different from their own and their perspective will be guiding in this analysis. In our material we find three socio-technical agancements STAs, (Caliskan and Callon 2010) that have different views on how to calculate and decide what the most suitable action is for the industrial firm. Environmental managers, financial officer and the ESCO can be seen as STAs and we begin this analysis by looking in to these agancements and their modalities of valuation.

The environmental managers have an important role in making energy service deals happen. They have to push the issue and believe in the collaboration. The environmental manager-STA consists of the manager who is responsible for environmental matters and the different devices connected to him. The interviewed managers use calculations as an important tool to understand and communicate energy issues. Anders reports on how he tried to justify why steel firm A should hire an energy manager by calculating how long it would take for the manager to become profitable. Peter and Carl made calculations to understand the ESCO´s model and to see if their own calculations of the quantities of saved energy matched. Calculating can be seen as a technology in a wide sense of the word. Their calculations are dependent on their position in the firm and their intentions as well as their perceived responsibilities. The calculations can therefore be seen as a part of socio-technical agancements since they influence the energy service market; sometimes by justifying investments in energy efficiency, and sometimes by questioning the ESCOs model. The way that they present suggestions, based on what the most profitable actions for their firm are, is a way to present their modality of valuation. We will find later in this analysis that the environmental manager-STA value things differently than the other STAs.

Our interviews show how most of the respondents express that their suggestions for energy efficiency investments are not implemented even though they are perceived as economically beneficial by the environmental managers. At times they feel that they have to prove to the board of the firm why investing in energy efficiency is the most efficient use of firm resources and show calculations on how they can save money by reducing the cost for energy. Sometimes managers believe that the firm actually has the money but the board does not want to invest them in energy efficiency since they are more interested in investing in the production. This can be illustrated by Carl at steel product firm B.

Carl: “But it is clear that if we had the money [to do the changes] ourselves our profit would have been bigger. But we hadn’t. Or, we had money but they were appointed to other kinds of investments. Maybe they wanted to improve the process or the production or something. Not just put it on energy.”

Carl is not alone in his view that companies do not want to invest in energy efficiency. Many times the board of the firm has to be persuaded and the respondents are not sure why seemingly profitable actions are not taken when it comes to energy efficiency. Anders, the environmental manager at steel product firm A thinks that it has to do with the accounting system and this came up in some of the other interview as well.
The respondents also refer to financial officers as being suspicious of investments in energy efficiency; Anders believes it is the financial officer who controls the investments, Carl says that the financial officers mistrusted the potential for economic gain in using an ESCO and Eric says financial officers has a too short payoff time to justify energy efficiency investments. Financial officers, their calculations and accounting principles are important actors in deciding in energy efficiency investments. They can be seen as socio-technical agancements (Caliskan and Callon 2010) as they, in this context from the respondent’s perspective, act as one. They influence the decision process with different ways to value the worth of investments, and their modality of value is perceived as dominating. Accounting principles and payoff calculations can be seen as technologies that is used as obligatory passage points that all decision has to go through. The financial officer-STA has another modality of value that is in many ways conflicting with the environmental manager-STA’s.

The interviewed respondents connect the model used to calculate profit to the ESCO and try to understand it in order to understand if the calculated profit is correct. The ESCO and their models can also be seen as a socio-technological agancements where their technology to produce a model is connected to their intentions to make money by saving energy for their firms. The ESCO’s calculations are an arrangement that affect the energy service market and calculations play an important role when ESCOs package the good “energy service”. Energy service companies that do not provide EPC are also important actors, their calculations and suggestions results in implementations in the customers’ plants. In the interviews, the ESP calculations are not questioned but some of their suggestions are not implemented. Their calculations are, in some sense, not accepted as economically justified from the firms. The ESP differ from the ESCO since they, in our material, only provide suggestions to implementations and the firm can decide if they want to implement the actions themselves. The ESCOs’ relationships to the firms are more complex since their collaborations are longer and create a closer dependency. In the rest of the analysis, we will only study the ESCO-STA since we have more material in our interviews concerning this STA rather than the ESP-STA.

6.2.2 Different modalities of value leads to different investments
One interesting encounter of different modalities of value is made visible when the environmental managers try to get funding for investments in energy efficiency. Our respondents describe how they experience difficulties to get funding for their ideas since they compete with several other firms in the corporate group. In competition with hundreds of other firms it can be hard to justify investments in already well-functioning plants. Instead of trying to get funding to invest in energy efficiency they can use ESCOs as a tool to make progress without investments. Carl and Anders reports that they felt that they reached a dead end and to use an ESCO was a way to help the firm be more energy efficient. Peter at the plastic firm talks about how they inside the firm have to use calculations differently than what the ESCO can, and therefore it is easier to suggest collaboration with an ESCO than it is to get funding for investments in energy efficiency:

Peter: “We would have had problems to make a payback on this. If we had made a calculation on this we would have had to base it on the worst possible outcome, which is 80% [of that the
ESCO predicted] and not that we are doing as well as we are now. So even if it would have been profitable we wouldn’t have been able to show it in a calculation.”

In a context where the financial officer-STA decides on what investments are most profitable, the ESCO can provide a new calculation that is different from industrial firm’s calculations on payoff and profitability. The managers feel that the calculations theESCOs provide gives them material to illustrate how investments can be profitable in a way that they could not have done themselves. Their modality of value differs from the financial officer-STA since they are prepared to invest in long time payoff investments in energy efficiency.

The differences in opinion over modalities of value between the different STAs are not the only conflict connected to energy efficiency investments. The managers also express how complex the situation is for them in their role as an environmental manager in a firm. The environmental managers think that they are responsible for environmental issues and strive to make the firm as environmentally friendly as they can. They all report about the profits of investing in energy efficiency but they also talk about the responsibility they have as environmental managers and as industrial firms in a society. Carl at steel firm B thinks that it is important to consider the earth’s limited natural resources but still be aware of your position in the firm. Anders also brings up the firm’s role in the society and the managers in the plastic firm thinks that responsibility for energy saving should lie at the firm. A complex situation exists were the managers have to balance the responsibility for the firm’s environmental issues and in addition contribute to the economic profit. This situation is most obvious in the interview with the porcelain firm and the ESCO. Both Eskil and Bertil seem to agree on economic arguments as the driving force behind investments and they perceive it as very natural. The next question we asked was how the porcelain firm’s environmental policy works within this situation. Bertil responds:

Bertil: “Well, yes… Let me put it this way. At least there are a will to be environmental friendly, from the board and in environmental issues and so... There is definitively a will. And, sure, the first project we did, with the acid-history and the heat exchanger, it was purely environmental reasons that it happened. It... To lower the use of acid, it was a pressure from the authorities but that we lowered it so much, that we could put a heat exchanger in, that was purely for environmental reasons. “

There is in other words a will to make investments that are not economically beneficial if there are environmental reasons for it. At the same time, this way of talking about investments has to fit in within a framework where the financial-officers’ arguments always are supposed to win. The mode of value the financial officer- STA provides can only be overlooked if there are good reasons for it. Even so, we find in our material that there are “good enough” reasons for the companies to make investments that are not economically driven if these investments are done for environmental reasons.

There is a duality in this discussion, a restriction on the arguments from a modality of value that supposes that economic profit is the reason that the company exists, and with a will to contribute to society. Caliskan and Callon (2010) put forward the argument that there are more feelings other than trust that are involved in market maintenance. In our case, there are
several feelings other than trust that affect the outcomes of the collaboration and the decisions concerning energy efficiency investments. The will to reduce the company’s use of the earth’s resources and the perceived responsibility for environmental concern are factors that would be interesting to study further as it seems to be a complex situation for the managers.

The board plays an important role in the decision to start collaboration with an energy service company. The environmental managers feel that they have to convince the board of the company that the collaboration is worth trying. One of our interviewed firms said that they could themselves decide to hire an energy service company (steel firm C) but this was only a service deal that did not include any investments. The investments the plant manager had to take with the board of the company group. The plastic firm and the porcelain firm involved the company board, while steel firm A and steel firm B took the decisions on firm board level. The board plays an important role as an obligatory passage point where decisions have to get through to be implemented. They have to judge between the different STAs, the financial officer, the environmental manager and the ESCO, and decide who’s modality of value is right for their firm in the specific context.

The three STAs and the obligatory passage points show how very complex the market for energy services is. This can be a part of the explanation to why some investments in energy efficiency are carried through and why some are postponed. In some contexts the financial officer-STA wins the argument and in other situations the environmental manager-STA walks away with victory. When the environmental manager-STA is not heard he can turn to the ESCO-STA and receive new help to develop the firm’s energy efficiency. To find a deeper understanding of when the different STA’s modalities of values are allowed to guide decisions, the other STA’s perspectives needs to be studied.

6.2.3 Models and calculations
As discussed in the chapter above, the financial officer, ESCOs and the environmental managers all make calculations to justify, or prevent, investments and collaborations. These calculations are essential for how the energy service market functions and to how buyers and sellers trade in the market. Energy services can be seen as a good in an energy service market and how it becomes a good is central for how the market configures customers and sellers. (Caliskan and Callon 2010) One reason for why energy services are conceived as risky business can be that EPC is not a well-defined good. A service has to be packaged as a complete good to be able to be easily traded. EPC has not yet become a pacified good in Caliskan and Callon’s words. There are few established market practices and each case is different to the other. This is made visible in the observation of the meeting with Swedenergy where one representative from an ESP stated that they created the service together with the firm. A project is developed in communication with the firm since every manufacturing process is unique. This makes the EPC difficult to package and compare and thus to trade. To be able to make EPC to a more pacified good, the ESCO tries to distangle it from its network by trying to present a complete deal with guarantees and without risks. They use a calculated model to show how they objectively can reduce costs and present a service that does not require any own funding. They also try to detach themselves from the model and present it from a more objective view. This can be seen in their way to use standardized measurements
to support their model. The most prominent example is their use of “normal year” as a way to compensate for temperature changes. This comes up in discussion with the plastic firm and steel firm B, Peter explains:

Peter: “There is something called a normal year which means that they have looked at the average temperature from 1970 to 1995 or something like that, and this is conventionally used. If it is a lot warmer the savings are not as large, and if you see it from the ESCOs perspective, they want to have the compensation anyway. They don’t want to be dependent on whether it is metrologically warm or cold. So it means that they have quite good control over how much we use.”

The first years the firm used less LPG than expected which to some extent had to do with the temperature that was higher than the normal year. Peter adds:

Peter: “You have to have in mind that what we call the metrological normal year, these two last years that we see as terribly cold, with snow and everything, they have been normal years. They have not been worse than normal years, if you compare with the average period. They hit the normal year pretty good.”

A “normal year” is today not considered to show the normal average year temperature since the climate today is warmer. Still the ESCO can use it to make their calculations more “objective” since they can refer to a practice from a different actor which makes the valuation more unbiased. This makes the energy service easier to trade since the industrial firm does not have to rely in trust in the ESCO, but can instead relay to a standardized market practice. The practice also provides a comfort for the industrial firm that there will not be any moral hazard where the ESCO can invent their own ways to value how temperature affects the calculations.

At the same time, there are no guaranties that what economics refer to as moral hazard will not occur in other parts of the calculations. In its quest to make energy services to a pacified good the ESCO run into troubles when the industrial firm does not accept the calculations in the model. Then industrial firms open the black box that the good energy service comes with and this makes the good unstable and hard to trade. The industrial firms relate the models to the ESCOs and do not trust their objectivity. As with other price setting mechanisms (valorimeters), when the calculations are very complex and linked to other prices, they provide a greater power to affect the terms of the trade (Caliskan and Callon 2010). This results in a power relationship where the ESCO have a greater ability to affect the prices since they “own” the model. Carl and Peter tried to challenge the model by making their own calculations by “rules of thumb” but they found it hard to understand the model. Even if no moral hazard actually occurred, the environmental managers do not have enough knowledge of how the calculations are done to be sure that the calculated profit is justified.

Calculations are a point for discussion for most of the interviewed firms but in different ways. The managers find it difficult to talk about energy in a way that makes it understandable to the board and to the staff. They try to show energy efficiency potentials by calculating profits or comparing the industrial energy use with the utilization of an average villa, rather than megawatt hours. In steel firm A, the environmental manager produces calculations to show
financial benefits with investing in energy efficiency with mixed results. Calculations are contested in other situations as well beside the case with an ESCO, steel firm C can serve as an interesting example. Eric’s firm hired a masters student to calculate the economics of connecting the firm to the district heating system.

Eric: “…it [the thesis] looked into how to use central heating in the process so there were quite a lot of calculations… wrong or not, there were probably a lot of errors in these calculations but it turned out that we did the investments and changed from oil to central heating.”

In this context, the calculations are not accepted but the firm decides to go forth with the large investment anyway. The calculations are used as a base for decisions but at the same time they are many times contested and not accepted. Who’s calculations that are seen as correct and how much they rely on these calculations depends on the context. The calculations are constructed and justified according to the intentions of the actors involved in their making and their use. They are also affected by other factors, such as knowledge, access to measurements and choice of standardized parameters. What is perceived as the most profitable decision in the energy service market is dependent on several factors and cannot be explained from only one side of the STAs.

6.2.4 Risk, trust and knowledge
In all studied cases in the interviews, the decision of hiring an ESCO was a bit controversial even though there were no large investments made by the industrial firms. The investments ranged from 7-11 million SEK which the ESCO used to optimize the production process and building systems. After the installations are completed, the industrial firms pay a leasing fee and a service fee for the machineries and the control systems. After the contract period is ended they can buy the machineries for a symbolic fee and continue to pay for the service. Even if there are only smaller investments included for the industrial firm, the deal is seen as risky. Both the calculated economical gain is questioned as well as the nature of the collaboration. A close collaboration makes both parties dependent on the other, when the contract is sealed it is important to be able to trust each other. If the ESCO would go out of business it would affect the industrial firm negatively but our interviewed firms (and the ESCO) do not see this as the most important risk. This could be connected to the size and the stability of the ESCO in our case.

The connection between trust and risk is most apparent when it comes to steel firm B and the plastic firm since they to some extent disagree with the ESCO over the calculated profit. They have different views of how measurements should be calculated and how changes in production should affect the calculations. In this process the firms do not trust the ESCOs’ calculations and this can be seen as a risk as it endangers the collaboration and it could lead to unexpected costs for the industrial firm. This risk was not highlighted enough according to these managers. In the interview with the porcelain firm, a consultant from the ESCO was present and his view of the risk differed from the views of the managers of the industrial firms. He did not think that there were any risks since the ESCO guaranteed that they would compensate up to at least 80% of the calculated profit. The different STAs that encounter in
this discussion have different views on what risks are and how the collaboration could be a risk for the firm. They value the risk factors in different ways since they have different modalities of value. The managers with their calculations see risk as having to accept the prices the ESCO put forward for their services since they cannot understand and question the model the ESCO uses. The ESCO-STA sees no reason to distrust their calculations and present the model as a market practice rather than a part of a chosen method. This could be done by referring to earlier projects where the model was accepted. In this way they reinforce the calculations and thus make them a market practice.

All the managers in the industrial firms appreciate the long term relationship that comes with the collaborations. This reduces the risks and enhances trust between the partners. This could be connected to that their different modalities of value are made more visible through a long collaboration. David, the environmental manager in the plastic firm, likes to work with energy efficiency in a project over a longer period of time:

David: “This [project] has been going on for a longer period. And it feels safe to hold on to this thread. That it is a long term environmental improvement project that we have worked with for several years. And that actually feels quite good, I have to say.”

The other managers highlight the importance of long term working relationships with the same partners, the consultants have many cases worked so close with the industrial firm that they are mistaken for employees. Steel firm C decided to start a new collaboration with the same partner as they worked with earlier and steel firm B was introduced to EPC by a company that they already collaborate with. The firms are more likely to continue or start up new collaborations with companies they already have worked with. The industrial firms that we have interviewed see the importance of long contracts and a long perspective. The long term relationships that were highly valued in our interviews can be contrasted with the responses from the ESP-survey. The ESP in the survey thought that the industrial firms preferred projects with short pay-off time. This could have several reasons, one could be that there is a misperception of the ESPs, another reason could be that it is a sign of that the financial officer-STA with their focus on shorter pay-off times is the most visible (and maybe dominating) actor outside the industrial firm.

6.2.5 Summarizing the socio-technical analysis
To summarize this analysis we will very shortly draw attention to some interesting discussion points we found using Caliskan and Callon (2010) to analyze our material. The industrial firms perceived their collaborations with ESCOs and ESPs as successful even though they also saw challenges in the collaborations.

In the interviews we find three STAs that have impact on the energy service market: the environmental managers-STA, the financial officer-STA and the ESCO-STA. They have different modalities of value which can be seen in their different was to justify investments and collaborations. The financial officer-STA and their pay-off times are perceived as an obligatory passage point that can only be overridden if there are good reasons for it. Environmental issues can sometimes be considered as “good enough” reasons. The decision
to collaborate with an ESCO or an ESP is most often taken by the board of the company group who has to decision between the different STAs.

The calculations play a central part in the collaborations since they are an important base for decisions for investments. The calculations are often discussed and questioned since the different STAs have different ways of measuring and choosing parameters. The calculations also create a power imbalance between the ESCO and its clients in performance based collaborations since the clients do not have the knowledge to be able to understand the ESCO’s calculations. The model for calculated profit is perceived as too complex for the environmental managers to understand which makes it hard for them to understand if the requested remuneration is correct.

This analysis also shows that a performance based energy service is not a pacified good and is as a result hard to trade. The model for calculated profit is presented as a black box by the ESCO but when the industrial firms try to open it they challenge a practice that could have been seen as market practice. Instead, there are few standard solutions that are established market practices and this make the good hard to package. Therefore it is difficult for the customers to know what they buy when the commit to a collaboration with an ESCO.
7 What challenges and opportunities do the current energy service market actors forecast?

In this chapter we return to the most interesting findings from the economic and the socio-technical analysis. We will briefly discuss some of the challenges and opportunities of energy service market that the actors in our study made visible. In the last section we contextualize energy services by discussing the political objectives connected to the market.

7.1 Market development

A challenge for future market development is that energy services are not an easily traded good since it is entangled to its network. The ESCO tries to distangle it and make it a well packed good but the market has not stabilized what an energy service is and what exactly are included. There are few standardized solutions; the service provider and the firm create the service together. This lack of market transparency creates search costs for industries interested in implementing energy efficiency measures through energy services. This is mentioned in the EED. Both socio-technical- and economic analysis of the Swedish energy service market point out the absence of established market practices as a challenging circumstance for further market development.

The results of this study indicate that the market for energy services in Sweden is in an expansive phase and that there are opportunities for it to expand. Even though it is hard to detangle energy services from other products and services, the turnover on the market seem to have increased in the past few years. The participants in the survey estimated increased activity for energy services and many ESPs were in a start-up period. The market for energy services is in an emerging face. Swedenergy is planning courses for its members on how to sell energy services. The market contains both of small, local actors and large actors. Energy supply companies answers for an important part of the supply side. A comparison between the estimated market turnovers from different years suggests that the Swedish energy service market is moving in the direction desired by the EC. Both indirect and direct energy services are provided by several different ESPs. Previous reports on the energy service market in Sweden have mainly focused on energy services for buildings. The industrial market segment has been estimated as a small part of the market. The results from our survey indicate that the industrial market segment is a significant part of the market. The respondents estimated that their turnover for industrial energy services was 225 million SEK. This equals almost 29 % of the estimated market size from the 2008 study by Lindgren and Nilsson.

7.2 Cooperation

Knowledge is seen as the main advantage of the energy service industry, the main asset of the energy service companies are their knowledge about energy which decreases costs of implementation. However, knowledge also carries power; the ESCOs advantage in knowledge can create imbalances of in the collaboration with industrial firms. Environmental managers receive power and attention to energy efficiency questions through the calculations that the ESCO bring to the collaboration. Energy services are often complex services that involve many calculations, both economic and technical, and these calculations are a factor of
uncertainty. Calculations are often black boxed and the uncertainty of calculations is something that we believe has not been highlighted enough in barrier-theory. As seen in the interviews, calculations are often questioned by the industrial firms and can become a challenge for the partners in energy service collaborations. How to calculate gained profits from the energy service is viewed differently by the different STAs. The different STAs use their own valiometers to do calculations and their intentions are not separable from their calculations.

The ESCO provides knowledge that the industrial firms needs in order to make energy efficiency improvements. At the same time, since ESCOs payment is performance based, their calculations does not only estimate the industries energy savings but also their own remuneration. This provides the risk of moral hazard, the ESCO is tempted to act opportunistic. The calculations impose payments for the calculated profit through a complicated model which only the ESCO has complete understanding of. This can create insecurity and doubt for firms who cannot fully grasp the calculations. The knowledge about energy and efficiency measures that the industries want to attain, the reason for hiring the ESCO in the first place, becomes a weakness in the cooperation if industrial firms perceive that it is used against them. Lack of trust generates the transaction costs that are often highlighted as a problem in economic analyses of the energy service market. The issue of trust was raised at the Swedenergy meeting but the participants disagreed on the importance of this as an obstacle and some even called it irrelevant. Lack of trust in external consultants was not perceived as an obstacle to provide energy services of the energy service companies that participated in the questionnaire. This indicates different views on the issue of trust as an obstacle between the supply side and the demand side of energy services.

The result from the ESP-questionnaire states that low energy saving potentials for industrial plants is not an obstacle for ESP to work with industries. This is also strengthened by our interviewed industrial firms. Most of the firms saved more energy than expected and the managers think that there still are potentials for further energy efficiency work in their plants. All firms still work to improve their energy efficiency in some way. Some of the firms, like the porcelain firm, will try to do more energy saving actions on their own in their new plant. Other firms, like the plastic firm, are interested in finding a partner to help them further develop their energy efficiency in the production process. The collaboration with an ESP made them aware of their potentials in energy savings. This is an opportunity for the energy service market since it might make industrial firms more interested in future collaborations with ESCOs and ESPs.

When the industrial firms themselves invest in energy efficiency it often happen together with other investments. As an example, steel firm C made a large investment by connecting to district heating instead of buying a new boiler when the old boiler broke down. This can also be exemplified by steel firm B that invested in new windows, an investment that had a payoff on 19 years, which was justified by the fact that they needed to be changed soon anyway. In these investments, the financial-STA has to stand back for material aspects that justify the long pay-off for the investments. This creates an opportunity for industrial firms to invest in energy efficiency and might also enhance the chances for collaborations with ESP if the firms
themselves want to invest in energy efficiency but do not have the knowledge to do it in house.

7.3 Final thoughts
We have described different benefits and disadvantages, problems and costs on the market for energy services and to some extent discussed how the benefits can best be attained and the costs be overcome. The political ambition to develop a market for energy services has however not been questioned.

Energy services have gained a lot of political attention both in the EU and Sweden. The EC directives highlights energy services as a tool to overcome barriers to energy efficiency and recommends policy measures to facilitate market development. This leads to the question; if there are large energy saving potentials that could be tapped with cost effective technologies and if energy services are efficient tools to implement these measures, then why do the market need all this political attention and support? The Energy Audit Program is supposed to increase awareness and raise knowledge about energy efficiency in industries and is designed so that industries consult external help. The SEA decreases the costs for energy services by both providing financial support (energy audits) and decreasing costs by increasing market transparency and firm knowledge with other measures. Energy efficiency measures are financially supported with public funds; costs are transmitted from industries and energy service companies to the public sector. Many of the political initiatives aim to help the market to package the good “energy service”; as we see in our interviews the energy service market still lack established market practices. This could be explained by the fact that the energy service market is a relatively young market in Sweden, the market is emerging. Would the energy service market develop established market practices and be able to package it’s goods without these public policy measures?

The political interest in energy efficiency and energy services can be traced back to what was mentioned in the introduction, decoupling. The political ambition is ambiguous since the objective is not only to conserve energy, to save 20 % by 2020, but also simultaneously maintain economic growth. Raised energy price would aggravate the international competitiveness of European industries. However, to investigate the environmental, macro-economic and social consequences of this strategy is beyond the scope of this study. It remains to be seen whether energy services are an effective tool to implement energy efficiency measures in Swedish industries and if decoupling energy utilizing from economic growth is possible.
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Appendix I

Questionnaire

1 Introduction

1. Company name:
2. Core business:
3. Ownership:
4. Turnover 2010 (M SEK):

What kind of energy services do your firm offer?

<table>
<thead>
<tr>
<th>Service</th>
<th>No</th>
<th>Yes, at a fixed remuneration</th>
<th>Yes, performance based remuneration</th>
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</thead>
<tbody>
<tr>
<td>Energy audits</td>
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<tr>
<td>Energy declarations(^7)</td>
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<td>Energy counselling and analysis</td>
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<td>Energy efficiency</td>
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<td>Service contracts</td>
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<td>Energy service contracts for maintenance and operation</td>
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<td>Energy audits</td>
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</table>

2 Market development of energy services

1. Total turnover for energy services 2010 (M SEK)?
2. How large (what %) of your energy service have performance based remuneration (e.g. EPC)?
3. How do you estimate the development of energy services in your company until 2020
   decreased turnover/ unchanged turnover/ increased turnover

\(^7\) Since 2006 all buildings that utilize energy to change the thermal indoor climate must have an energy declaration performed at least every 10 years. This includes information about the buildings energy performance and how it can be improved as well as reference values for similar buildings. It also contains information about the ventilation system and if a radon measurement have been done.
What percentage of the total turnover for energy services did the following sectors answer for 2010?

i. Public sector

ii. Private properties

iii. Manufacturing industries < 500 MWh/year

iv. Manufacturing industries > 500 MWh/year

v. Manufacturing industries included in EU ETS

vi. Other sector

4. How do you believe a certification of energy service companies would affect the credibility of the market for energy services in Sweden?
   Answer 1-5 (1 decreased credibility – 5 increased credibility)

5. Comment:

6. How would standardized contracts (developed by for Example SEA) affect the market development of energy services in Sweden?
   Answer 1-5 (1 inhibit development – 5 stimulate development)

7. Comment:

   How would increased energy prices affect the market development of energy services in Sweden?
   Answer 1-5 (1 inhibit development – 5 stimulate development)

8. Comment:
How do you estimate your company’s development of the following services for industrial firms that utilize *less than 500 MWh / year*?

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<thead>
<tr>
<th>Service</th>
<th>Decreased turnover</th>
<th>Unchanged turnover</th>
<th>Increased turnover</th>
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<td>Energy audits</td>
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<td>Energy declarations&lt;sup&gt;8&lt;/sup&gt;</td>
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<td>Energy counselling and analysis</td>
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<td>Energy service contracts for maintenance and operation</td>
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<td>Energy audits</td>
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<td>Performance based energy services?</td>
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<tr>
<td>Other type of energy services? What type?</td>
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<sup>8</sup> Since 2006 all buildings that utilize energy to change the thermal indoor climate must have an energy declaration performed at least every 10 years. This includes information about the buildings energy performance and how it can be improved as well as reference values for similar buildings. It also contains information about the ventilation system and if a radon measurement have been done.
How do you estimate your company’s development of the following services for industrial firms that utilize *more than 500 MWh / year*?

<table>
<thead>
<tr>
<th>Service</th>
<th>Decreased turnover</th>
<th>Unchanged turnover</th>
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<td>Energy declarations&lt;sup&gt;9&lt;/sup&gt;</td>
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</table>

<sup>9</sup> Since 2006 all buildings that utilize energy to change the thermal indoor climate must have an energy declaration performed at least every 10 years. This includes information about the buildings energy performance and how it can be improved as well as reference values for similar buildings. It also contains information about the ventilation system and if a radon measurement have been done.
How do you estimate your company’s development of the following services for industrial firms included in EU ETS?

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<tr>
<th>Service</th>
<th>Decreased turnover</th>
<th>Unchanged turnover</th>
<th>Increased turnover</th>
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<td>Energy declarations&lt;sup&gt;10&lt;/sup&gt;</td>
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<sup>10</sup> Since 2006 all buildings that utilize energy to change the thermal indoor climate must have an energy declaration performed at least every 10 years. This includes information about the buildings energy performance and how it can be improved as well as reference values for similar buildings. It also contains information about the ventilation system and if a radon measurement have been done.
4 Barriers for energy services in industrial firms

1. How do you estimate the potential for the following energy services for industrial firms? (1 not interesting – very interesting)
   I. Short term (less than 1 year) energy efficiency projects
   II. Long term (more than 1 year) energy efficiency
   III. Energy services with performance based remuneration

2. How do you estimate the following barriers for developing energy services for industrial firms? (1 no barrier - 4 large barrier)
   I. Small energy efficiency potentials in individual plants
   II. Specific knowledge demanded to implement energy efficiency measures for each individual plant
   III. Lack of time/interest for energy efficiency in industrial firms
   IV. Lack of knowledge about energy utilization and efficiency potentials in industrial firms
   V. Industrial firms lack confidence in external consultants
   VI. Lack of budget funding to invest in energy efficiency in industrial firms

5 Barriers to energy efficiency in industrial firms

1. How do you believe industrial firms estimate the following barriers to energy efficiency (1 no barrier - 4 large barrier)?
   I. Limited access to capital
   II. Limited knowledge about the companies energy utilization
   III. Costs for production stop and other indirect costs related to energy efficiency projects
   IV. Perceived high technical risk for investments in energy efficient technology
   V. Perceived high economic risk for investments in energy efficient technology
   VI. Energy costs are not derived to specific users and units at the company
   VII. Lack of time and/or information and/or staff to make energy management decisions
   VIII. Costs for identifying energy efficiency potentials at the company
   IX. Limited access to information about energy efficient technology
X. Low priority for energy management
XI. Other investments have higher priority
XII. Uncertainty regarding the company’s future
Appendix II

Interview guide

Background questions

- Name, position in the company?
  - Tell me about the company! Organization, history, production process and energy use

The company’s use of energy services

- How long?
- What kind of services has been used?
- Tell me about the first stages of the process
- How come this collaboration started?
- Where did you find information?
- How did you experience the work with the external consultants?
- Did you have any contact with SEA?
- Did you evaluate the first results?
- What is your expected pay-off for your investments?
- Who makes the decisions?
- How did the collaboration work?
- How often do you meet with the ESP? Who are present at the meetings?
- How do you work with energy efficiency today?
- What changed after the collaboration?
  - In the production process?
  - Habits?
  - Awareness?
- What do you see as the largest advantages and disadvantages with energy services?
- Do you receive the support you need from other parts of the organization?
  - How involved are the board / company group board?
  - How involved are other employees?
- How do the firms view of energy efficiency relate to your environmental policy?
- What does it mean to work with environmental issues and energy?
- What is most important, profit or environmental issues?
- Do you think your company is a role-model in environmental issues?
- Why is energy efficiency important?
- What is the company’s responsibilities when it comes to
  - Energy efficiency?
  - Environmental issues?
- Who should be responsible for making Swedish industrial firms more energy efficient?
• Wherein lays your greatest responsibility as a company – towards the shareholders, society, customers…?