Energy Performance Contracting in Czech Republic

A Systematic Approach

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Preface

The present study is the final master thesis conducted at Aalborg University during the forth semester of the Joint European Master of Environmental Sciences. The topic of the study is energy performance contracting development as an energy efficiency service as well as an evaluation of opportunities for dissemination of the service. The study was conducted in Czech Republic, in collaboration with the members of the Association of Energy Service Companies (APES) in Prague.

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Abstract

Energy generation from fossil fuels is the primer cause for increased concentration of greenhouse gasses in the atmosphere. Global climate change is the result of intensive energy consumption. Renewable energy costs remain too high for these technologies to become mainstream. Governments have acknowledged this issue and strive to promote energy efficiency policies. Services that create energy savings represent a key tool for energy consumption decrease. Energy performance contracting can be understood a successful energy service and it is being promoted on a European level. This research aims to understand energy performance contracting activity and development and seek for opportunities to enhance its capabilities. The history of this model in Czech Republic provided a suitable case for the purpose of this research. The current situation and opportunities for dissemination of energy performance contracting were studied based on system theory and relevant information acquired during the study trip in Prague. The final results of the empirical research concluded with five opportunities for dissemination of the energy performance contracting in Czech Republic.

Keywords: energy performance contracting, system theory, system thinking, Czech Republic

Chapter 1. Introduction

Intensive use of fossil fuels for energy generation and land use changes are the primary drivers for the global increases in carbon dioxide (CO_2) concentration. Changes in the atmospheric concentrations of greenhouse gasses (GHG) such as CO_2, alter the balance of the climate system and lead to global warming. (IPCC 2007) CO_2 emissions derived from energy use accounted for 9.9 Gtong in 2004, a 65% increase compared with 1971. (Worrell *et al*. 2009) Contribution of renewable energy of primary energy supply was estimated at 12.9% in 2008. (IPCC 2012) The remaining of global energy supply relies on fossil fuels and nuclear resources. Therefore, a sense of urgency has installed in most of the global regions and energy efficiency policies were enacted with the scope of reducing energy consumption.

Energy services are a key tool for achieving energy savings. European Union (EU) initiatives such as the Energy Roadmap or Energy Service Directive (2006/32/EC), which included energy services in the past, have created an important starting point for the development of innovative technologies and business models in the member states. They have created awareness and know-how. However, energy services are not used on a large scale and therefore do not work at their full potential. According to the Coalition for Energy Savings (2013), the EU Energy Efficiency Directive (2012/27/EU) has the potential to transform the energy market in such a manner that it will focus on energy services instead of simple delivery of energy.

As former incentives were adopted, different types of organizations focusing on energy services emerged in the member states' markets. Such organizations are energy consulting companies and energy service companies (ESCOs). They have encountered a very slow development and struggle with unfavourable legislative framework and market conditions. Article 18 of the EED (2012/27/EU) addresses the issue of energy service markets by clearly requiring the member states to promote energy services and facilitate access for small and medium size enterprises (SMEs) to this market, support the services' proper functioning and ensure that actors in the field of energy distribution refrain from any activity that might impede the development of energy services. Among others, the member states are requested to inform the public on the energy services available. However, the only specific model mentioned in article 18 is *energy performance contracting* (EPC).

Fang, Miller and Yeh (2012) argue that ineffectiveness of energy service markets limits the reduction of energy consumption. This conclusion is derived from complex calculations using a dynamic econometric model (I=PAT where I is the environmental impact, P refers to population size, A is the economical affluence in per capita GDP and T represents the existing technology). The study is based on data collection from 60 countries where energy service companies (ESCOs) develop their activity. Several formulas are derived in order to adapt the model to the energy service situation. The final results mathematically prove that short-term effect of ESCOs in a country lead to approximately 3.87% lower energy use and long-term effect can reach 39.66% lower energy use. However, these calculations do not take into account the intensity of ESCO activity in a specific country, only the time (years) since the first ESCO was established.

Energy performance contracting (EPC) is an energy service designed to increase energy performance through implementation of a product-service package, which is delivered by ESCOs. (Bleyl *et al.* 2009) This is achieved through a long-term contractual agreement where the consumer benefits from a new or upgraded energy equipment and service. (European Association of Energy Service Companies 2012).

The potential of energy performance contracting lies in the interest of ESCOs to achieve the most possible savings, as this is the source of their revenue. The ESCO fully engages with the projects by guaranteed savings and commits to support the client with technical and financial assistance. (Bleyl *et al.* 2009) Former projects have proved to achieve savings over 20% of the initial energy consumption. (Sochor 2012) The techniques and methods used by ESCOs for achieving the savings are further described in Chapter 3.

This research is focusing on the development of EPC in Czech Republic. EPC was first introduced in Czech Republic in 1993 when an American company found a favourable business environment and decided to invest in the implementation. (Slavotinek 2013) Since then, it has developed slowly and proven the potential for energy savings in both public and private sector. However, it has encountered several barriers during its development and its activity remains isolated. Current barriers in Czech Republic are depicted in Chapter 4.

EPC expansion in Czech Republic was realised on a bottom-up basis, without a general support and developed through the intrinsic interest of ESCOs and their clients. While this activity brings relatively moderate financial benefits for ESCOs, other actors on the market such as consultancy companies describe it as poorly paid. However, they support EPC based on the belief that *"this is a good activity, which may bring important benefits for the country"* concerning energy efficiency and climate change. (Helenova 2013).

Problem formulation and research questions

Based on European legislation, Czech National Energy Efficiency Action Plan has set the target of 9% reduction in national energy consumption by 2016. The overall energy consumption in Czech Republic is approximately 25% higher than the EU average and it is 80% covered by fossil fuel. (ABB 2011) This research assumes that energy performance contracting (EPC) has the potential to contribute to Czech Republic's energy efficiency strategy and bring substantial contribution to meeting the EU requirements and reach the national target. However, EPC activity in Czech Republic is not widely disseminated. EED (2012/27/EU) requires several measures, which should be taken in order to increase the use of energy services. This research explores the perspective of the supply side of EPC on the local market discussing the situation of EPC in Czech Republic with experts representing ESCOs and energy consultancy companies who are working to disseminate this model on a larger scale. Two research questions were designed for the purpose of sorting the information input. They are the following:

1. What is the current situation for the system of energy performance contracting in Czech Republic?
2. What are the opportunities for broader dissemination of energy performance contracting in Czech Republic?

The current situation of EPC in Czech Republic refers to its overall contribution to energy savings until now, the potential for savings on a project level and methods applied for achieving these savings. The broader dissemination of EPC refers to accomplishments of more savings and can be conducted on a quantitative level by implementing more projects or a qualitative level, by increasing energy savings in the running projects.

A multidisciplinary model

EPC is a complex model involving not only energy consumption issues. It incorporates financial and accountings expertize, political influence, legislation, technological handling, social perception, etc. (Mingers and White 2010) The multidisciplinary nature of EPC concept has attracted attention of numerous scientific fields apart for environmental studies, such as economic and planning in the attempt of promoting energy efficiency. However, the multiple approaches have been used in isolation and recommendations depend on the perspective adopted. (Chai and Yeo 2012) This phenomenon depicts a fractured general perspective of the EPC condition. In the attempt to provide a homogeneous picture of the EPC situation and understand the interconnection between the major elements influencing EPC activity, this research proposes a systematic approach. As described later in Chapter 5, systems' thinking provides a holistic approach underlining the relationship between structures and behaviours over time. Moreover, it enhances our understanding of how systems work and how to change them in order to create better patterns. (Meadows 2008)

The objective of this paper is to illustrate the opportunities for scaling up the EPC activity in Czech Republic by analysing all the relevant elements and the relationships, which define their behaviour. The progression of this research required a literature review on the concept of EPC and it's activity on an international level in order to develop the conceptual framework and on system theory to put the basis for theoretical approach and analysis. Substantial information was acquired during the study trip in Prague, which took place from 16^{th} to 26^{th} of June. Data collection incorporates quantitative and qualitative information to provide a holistic image over EPC in Czech Republic.

The following chapter describes the methodology applied in this research.

Chapter 2. Methodology

Overall methodological approach

This research uses a deductive perspective assuming the premises of system theory as being a valid approach for identification of the current situation and dissemination opportunities for energy performance contracting (EPC) projects in Czech Republic. The strength of deductive approaches lays in the expectation that if the theoretical premises are true, then the results will be valid and applicable. (Shank 2008). The premises involve the functioning of aspects delivered by system theory: stocks of elements, flows properties on one hand and on the other hand, points of leverage in the system structure. This approach has proven to function in the process of answering the first research question and deliver knowledge regarding the current situation. The results of the second research question however, reveal that only part of the premises have brought clear answers for the second research question, thus not all the points proposed by the theory delivered opportunities for dissemination of EPC projects.

This research was designed in two main parts. The first part forms the study background and consists in the introduction of the energy efficiency aspects on a European and local level and the potential of EPC to bring its contribution in achieving the national target of Czech Republic. Problem formulation and the two research questions emerge from this context and the introduction further elaborated on the theoretical choice. The activity of EPC is considered to touch economic, organizational and social aspects. To capture all these aspects, system's theory was chosen due to its general applicability in cross-sectorial problem solving. (Mingers and White 2010) Chapter 3 and 4 further elaborate on the EPC concept and barriers for its development in Czech Republic. The second part of this research comprises the data analysis conducted in two steps. The first step includes quantitative data gathered from previous studies and parts of the qualitative data received through interviews, to answer the first research question. The next step critically examines the current situation to seek for possibilities for improvement with the purpose of illustrating opportunities for broader dissemination, relying on qualitative data based on the interviews conducted. This is accomplished by making use of the 12 points model proposed by Meadows (2008), as a systematic approach.

This research has commenced with a literature review debating over EPC concept and application in different geographical locations, the methodology used in Czech Republic based on the International Performance Measurement and Verification Protocol (IPMVP), different sectors of sustainability where EPC was previously applied, based on the research conducted by Dobes (2012), in cleaner production sector, barriers for future development and the non-technical approach for system theory and analysis proposed by Meadows (2008). The literature review only imposed difficulties in answering the research questions. Therefore, data collection through interviews brought important insights about key aspects in Czech Republic.

Overall, this research has achieved its purpose to capture the current situation of EPC in Czech Republic and deliver opportunities for dissemination mostly based on qualitative data. According to Haisler (2011), results derived from qualitative data are often not appropriate for generalization because they are specific to contextual social settings and circumstances. Therefore, this research is not expected to bring the same results in different countries or locations. However, it provides several key aspects that determined the EPC evolution in Czech Republic. These can be evaluated and adapted in different contexts by further research.

Data collection

Data collection for this research was realised on a qualitative basis through six interviews with representatives who are interested to disseminate the EPC activity in Czech Republic. The respondents represent two energy consultancy companies: ENVIROS and SEVEn, two energy service companies (ESCOs): ENESA and Siemens, and one representative from EMPRESS, the National Cleaner Production Centre of the UN the have been willing to participate personally. One ESCO representative of d-energy was able to answer in written to the interview questions. The interviews were conducted during the study trip in Prague between 17th and 21st of June, 2013 and took place in the interviewees' offices. The interview questions were designed to be open-ended and leave freedom of the interviewee to elaborate on the topic while avoiding the bias created by closed questions. (Grindsted, 2005) According to Suchman and Jordan (1992), the validity of qualitative interviews is insured by the common understanding of the interlocutors upon the meaning of the questions. To insure this validity, the author of this research had offered clarifications and elaborated on the questions during the meeting. The interviews were semi-structured as the questions were previously designed and sent to the respondents one day before the personal meeting. However, the order of the questions was not entirely respected as the interview followed mostly the flow of the conversation. The information received in the interviews was also supported by quantitative data from previously published statistics of private companies in Czech Republic. The most important sources were ABB and ENVIROS. Some of the answers received in the last interviews were understood as a repetition of former discussion. This was perceived as the data collection has reached a saturation point and the key information had been achieved.

Philosophy of Science

This research makes use of a realist approach as a way to emphasize the independence of the world in relation to our knowledge, acknowledging the distinction between the object of study, in this case EPC in Czech Republic and our understanding of it, thus models and theories used. (Sayer 2000) Williams and Hummelbrunner (2009) explain this distinction by arguing that representations of systems (the object of study), regardless of their nature, imply a necessary simplification. Studying and modelling of the real world implies application of boundaries with the scope of extracting the relevant information. However, the world is composed out of connections between different systems and rarely marks a real boundary. (Meadows 2008) In critical realist view, this distinction is pointed out to emphasize that the real world shall not be understood as unified with our understanding of it. Further, this underlines the ontological world of the EPC system and our epistemological lenses, the system theory and modelling. Critical realism acknowledges that social phenomena have inherent meaning and therefore always implies an interpretative dimension, used in this case to capture the knowledge received through personal interviews. (Sayer 2000)

The next chapter elaborates on the EPC concept.

Chapter 3. Energy Performance Contracting (EPC)

This chapter aims at providing a detailed overview of the EPC concept. The definition of EPC and the most important conceptual features are elaborated according to its application in Czech Republic.

Energy performance contracting (EPC) is defined as *"a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings".* (EED, 2012/27/EU, p. 11)

During the oil crisis in the 1970s, the importance of energy efficiency measures was acknowledged and this became a priority for policy makers in many industrialised countries. (Chai and Yeo, 2012) In this context, the concept of energy performance contracting (EPC) emerged in the US. Supported by the utility integrated resource planning and demand side management, the EPC market grew during the late 1980s and beginning of 1990s. The US EPC market is considered the most mature market today. Further, it continued to expand towards Europe and Japan. It rose gradually in these markets and further expanded to others locations in Asia and Africa. Nevertheless, the financial crisis in 2008 has negatively influenced the growth of ESCO markets, which developed more slowly in the recent years. (Wen Shwo Fang *et al.* 2012)

Energy performance contracting (EPC) is a concept applied in practice mainly by energy service companies (ESCOs). ESCOs are private enterprises, which generally act as project developers in the field of energy efficiency. They are responsible for planning, financing, installation and monitoring of energy efficiency projects in public or private buildings and industry. (Bleyl *et al.* 2009) Financing of the projects can be supported by the capital of ESCO, by the users' own funds or by a third-party (i.e. a sponsor or a financial institution which covers the investment). Reimbursement of the investment is paid from savings. (Wen Shwo Fang *et al.* 2012) ESCO earns its revenue from the energy savings and provides a contractual guarantee for these savings. Therefore, it takes responsibility for the technical and organizational risks. (Bleyl *et al.* 2009).

In many ESCOs, EPC is not the main activity. ESCOs can vary from small companies with three employees, focused mainly on EPC to large corporations with thousands of employees. The later assigns specific departments (with i.e. nine employees) who are responsible for EPC projects. Energy consultancy companies work with this concept and support it in their different activities. Moreover, international organizations such as UN have adopted the concept of guaranteed savings to different areas then energy efficiency (i.e. cleaner production). According to Dobes (2012), the results of the pilot projects conducted in cleaner production sector were successful and effective for the promotion of energy management and cleaner production in industrial sites.

Energy savings are dependent on performance and operating time. Performance refers to the amount of energy used to pursue a specific task (i.e. watts) and operating time is generally understood as working hours per year of specific equipment. Energy consumption (EC) is determined by the multiplication of performance (P) with operating time (U) according to formula (1). (IPMVP 2002) The concept of EPC is illustrated in Figure 1.

$$EC = P \times U \qquad (1)$$

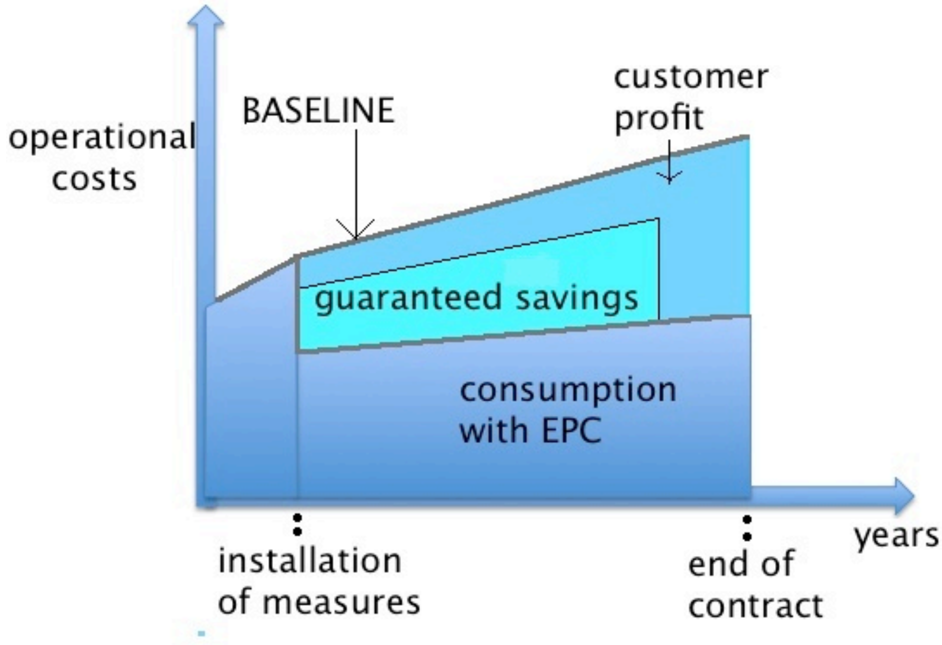

Figure 1.EPC Concept (Source: Sochor 2012)

In Czech Republic as in many other countries, the way savings are verified and measured is realised using the International Performance Measurement and Verification Protocol (IPMVP). (Helenova 2013) IPMVP is a large international coalition of facility owners and operators, financiers, contractors and ESCOs and it is sponsored by the US Department of Energy. (IPMVP 2002)

Savings (ES) are determined by comparing the baseline with energy consumption after the retrofit while taking the adjustments into account, as expressed in formula (2). (IPMVP 2002)

$$ES = \text{Baseline} - \text{Post-retrofit energy use} +/- \text{Adjustments} \qquad (2)$$

Calculation of the baseline is a key element in developing of EPC projects and it requires a complex and comprehensive audit. The baseline is defined by the energy consumption before the beginning of the contract. The ESCO is responsible for the baseline calculation. Inspections and short-term measurements are conducted. The complexity of the variables taken into account depends on the stability of the baseline. The most common variables are energy consumption rate, equipment inventory, control strategies, etc. over a period of one year, in general. The baseline can be evaluated only before the installation of measures. After that, it no longer exists. Therefore, it is essential for the good development of the project, that the baseline illustrates real consumption and the calculations are transparent. (IPMVP 2002)

Post-retrofit energy use measurements are dependent on the type of installations. Installations can focus on specific equipment or on a whole building. Computer simulation and modelling can be included in complex projects. In most of the cases in Czech Republic, projects include entire buildings and therefore the projects are more complex and costly then in the case of specific equipment. Measurement and verification protocol used in Czech Republic will be further elaborated later in this chapter.

Adjustments are administrated during the process in order to achieve an equitable comparison of the post-retrofit measurements with the baseline. These adjustments are divided in two categories. Routine adjustments for changes in parameters can be expected periodically, dependent on weather, ownership modification, etc. Non-routine adjustments occur in cases when parameters cannot be anticipated and when a significant change in energy demand is expected. Any changes on the contracted site, which significantly affect the energy demand have to be communicated to ESCO and are treated as adjustments.

The importance of savings calculation cannot be emphasized enough. The accuracy of these calculations determines the revenue of the ESCO for the next 8 to 12 years on average, depending on the length of each contract. If these calculations are not clear and transparent from the beginning, they generate negative discussions and in extreme cases could lead to pre-term contract termination.

IPMPV (2002) was implemented within the local ESCO Association through educational seminars and workshops organised by EVNIROS, one of the energy consulting companies, which is also a member of the Association. This protocol became standard in what concerns the methodology for measurement and verification of savings. The IPMVP methodology describes four options for measurement and verification (M&V) planning, which are designed according to the objects of the contract. Options A and B apply to partial (A) and full (B) field measurements of one or more systems where energy conservation measures (ECM) have been implemented in isolation from the rest of the facility. For example, lightning efficiency measures in a school are installed where more efficient fixtures replace old devices. The energy requirements are reduced while the lightning levels remain the same. The partial measurements are conducted for lightning periods (hours per year) and fraction of lightning load. In the case of option B, the boiler in an office building is replaced by a more efficient one. The boiler is the only device in the building using gas. Therefore, the parameter fully measured is the gas consumption, regardless of the electricity consumed by the boiler auxiliaries. In this case, there is a boundary specified for the gas fuel system only. Options C and D apply to whole facility measurements of savings. For option C, measurements of the utilities are conducted for one-year period to define the baseline and continued in the post-retrofit period. For instance, a school was contracted. The project aimed at reducing energy costs in relations to lightning, HVAC, pool heating, operator training and awareness campaigns. The baseline was calculated according to the following parameters: energy use and demand, metering period length and degree-days. In cases where baseline data is not available, option D is applied. In this situation, computed simulations are conducted in parts or whole facility for defining the baseline. A representative case can be the library building in a university campus without individual building meters.

The post-retrofit energy use shall be measured and verified according to the IPMVP protocol. Techniques implemented are one or a combination of the following:

- Utility invoices and/or meter readings
- Separate measurements for single retrofits or fractions of the facility
- Separate measurements of single parameters
- Computer simulations (Option D)
- Agreed assumptions of the parameters which are generally accepted

While assuming the responsibility for the development of the project, EPC presents a series of risks for the ESCO. According to Wang and Chen (2008) one of the major risks are the guaranteed savings. They involve the forecast for how the project will evolve in the future. When making an engagement for the following ten years for instance, many unpredicted events could occur ranging from omitting important parameters in measurements to misuse of the technology by the customer. These errors are directly reflected in the revenue of ESCO.

The risk of energy costs lays in the dependency on energy prices. When the energy price increases, ESCOs revenue increases together with it but in the case when prices drop due to energy subsidies or economic strategies, which lower the cost value of resources, ESCOs are negatively affected and in some cases they are incapable of covering their costs. Furthermore, when energy efficiency is not supported by appropriate legislative framework and support from the government, the potential customers are not specifically interested in adopting EPC. Therefore, ESCO activity relies mostly on the good will of the customers who evaluate this as good practice. (Dobes 2012)

Chapter 4. Barriers for energy performance contracting in Czech Republic

Barriers of different kinds determine what some literature describes as "the energy efficiency gap" (Jaffe and Stavins 1994, Rohdin and Thollander 2006). This term was coined by Jaffe and Stavins (1994) with the intention of explaining the inconsistency between the potential of cost-effective energy efficiency mechanism at the willingness of the market to adopt them. Sorell *et al.* (2000: 27) defines energy efficiency barriers as *"postulated mechanisms that inhibit investment in technologies, which are both energy efficient and economically efficient".* From a wider perspective, barriers not only inhibit investments in technologies but also development of 'soft' mechanisms, which promote energy efficiency. Energy service companies (ESCOs) have encountered resistance from potential customer and financial institutions due to the complexity and unfamiliarity of their practices on the demand side. (Painuly *et al.* 2003) This chapter comprises barriers towards energy efficiency depicted in literature and relates them to barriers identified in Czech Republic for EPC through interviews.

Chai and Yeo (2012) classify the barriers depicted in literature in three main categories: economical, policy and analytical and social. Brown (2001) and Gillingham (2009) argue that information problems, unpriced energy costs and the spillover nature of research and design determine market failures and slow the adoption of energy efficiency measures. Further Rohdin and Thollander (2006) explain that policy makers and analysts emphasize the multidisciplinary nature of energy efficiency measures and identify barriers in technical, economic and organizational sectors. Social sciences on the other hand, illustrate barriers related to behaviour and attitude towards energy efficiency. Owens and Driffill (2008) argue that changes in population's attitude towards energy consumption determine changes in energy efficiency. The remaining of this chapter elaborates on all three perspectives and illustrates the resemblance with the Czech market.

From an economic perspective, major barriers were identified in information flows, unpriced energy costs and spillovers in research and development (R&D).

Information sources available for energy efficiency issues are plenty. They reside in research on an international scale, media is more and more preoccupied with this matter and different types of actors on markets deliver a multitude of solutions to their potential customers. The barrier is not lack of access to information. On the contrary, the information is available from many sources, which do not line up with each other. An important barrier however is revealed in cases when one of the parties has more information that the other. An asymmetry of knowledge is created which can lead to inadequate decisions. ESCOs can explain the potential for energy savings of an energy performance contracting (EPC) project if the potential customer does not find this aspect relevant to his activity. Chai and Yeo (2012) argue that knowledge asymmetry barrier is increased by the incapacity to observe energy efficiency as it is not a tangible product but an abstract one.

The information related barrier in Czech Republic was identified as follows: the concept of EPC appears to many potential customers as *"too complicated"* (Helenova, ENVIROS). This concept is not new to the market but the procedures that it involves are not mainstream. Therefore, consultancy companies who are responsible for organization of the tendering procedures for instance, face difficulties in negotiating with the customers, who are not accustomed with these procedures. The same situation emerges during negotiations between ESCOs and customers. Some ESCOs consider their methodology and calculations of savings, the major part of their know-how. Even if the methodology is discussed during tendering procedures, they will use specific data in official reports after all the measures were installed and the customer is relying on ESCO expertize when signing the contract. An external body such as consultancy companies are involved in many of the procedures for this reason. Nevertheless, this requires additional costs. On many occasions, ESCOs and other actors advocate for energy efficiency and its benefits but because of the complexity and limited understanding, customers often do not consider this as an important aspect.

Incorrect energy prices energy prices constitute another major barrier for energy efficiency development. Muratore (2011) highlights that energy markets fail in designing a high enough spot price. This hinders companies in covering their investment costs in optimal time. In cases like this, energy prices are held low on one hand by price caps established by regulative bodies and on the other hand by operator behaviour and protocols. In the interview, Slavotinek (ENESA) mentions that in the attempt to mitigate this issue and minimize the risk related to energy prices, ESCOs use fixed prices in their contracts. The fixed price is the minimum price at the time of signing the contract. If the market price decreases, the fixed price is taken into account, while if the market price increases, the actual (high) price is taken. Slavotinek explains that both situations are also in the advantage of the customer. If the energy price drops, the client will be in the advantage of a low-priced energy bill from which the savings are further subtracted. On the other hand, if the price rises, the customer will still have the lower consumption on the bill.

Research and design (R&D) spillover is a term coined by Chai and Yeo (2012) and appears in situations when companies make investments in R&D, which bring benefits that cannot be captured by the investor. Brown (2001) further argues that while society benefits from these investments, companies rarely reach full economic benefits. Therefore, private companies will restrain form investing in research and design as the beneficiaries of such investments are also their competitors. This barrier is stronger in fragmented markets where there are many small companies engaged in competition. In Czech Republic, the competitors tend to unify the market in order to avoid this situation and increase its development. In 2011, ESCOs and consultancy companies have established the Czech Association of Energy Service Companies (APES). The members include energy saving companies and energy consultancy companies who work together to establish standard protocols and documentation for EPC projects with the aim of creating more transparency, stability and trust for the market.

Painuly *et al.* (2003) identifies institutional and organizational barriers for energy efficiency and argues that market development of energy efficiency is highly dependent on governmental support. On one hand, government owned facilities present a large potential for energy efficiency projects. Energy efficiency directive (EED 2012/27/EU) requests member states to adopt energy efficiency measures in their facilities and provide examples of good practice to the market. However, the international methodology on national debts (EUROSTAT) includes energy efficiency projects in the calculations for debts. In Czech Republic this is reflected in a conflict of interests between two institutions: the Ministry of Industry and Trade, responsible for implementation of the EED and Ministry of Finance, responsible for application of EUROSTAT methodologies to reduce public debt. This leads to more barriers on an organizational level. Public organizations such as municipalities are not motivated to adopt EPC because not all of them are remunerated for their efforts in relation to energy efficiency. Slavotinek (2013) explains that EPC is tolerated but not supported in Czech Republic.

Kaplowitz *et al.* (2012) argue that adoption and implementation of technologies and models in areas of policy making, energy research and technology is a function of human behaviour. Human behaviour such as energy use is driven by a number of influences such as culture, values, emotions and ethics. Therefore, the central role of human behaviour to diminish or amplify efficiency initiatives must be highlighted. Knowledge inadequacy at an individual level was considered to be the main reason for the lack of energy conservation behaviour. Abrahamse *et al.* (2007) argue that tailored information, goal setting and feedback are factors that can facilitate changes in consumers' behaviour towards energy consumption. Individuals who acquire sustainable values and attitudes are more likely to engage in positive actions toward energy efficiency. Behavioural scientists propose direct dissemination of information in the attempt to create changes in individuals' attitudes and values. On the other hand, individuals with positive attitude not always take action. This is believed to reside in a range of factors from financial costs to personal discomfort for adopting changes. It has been observed that practices associated with lower cost in terms of money, time or effort are more likely to be applied in practice. EPC as a concept has the attribute for financial savings. However, the financial benefits of customers will only be significant after the contract termination. Moreover, engaging in EPC projects also implies an investment of time and effort on the customer side. As mentioned before, the EPC concept appears to be too complicated and hard to understand. To summarize the local context, there is little interest from the public to engage in activities that would lower the energy consumption and the government is not taking initiative in encouraging these activities. Therefore, EPC implementation is a very challenging task for ESCOs in Czech Republic.

This research understands the upper-mentioned barriers as sources of inspiration for change. However, understanding the problem does not lead to immediate solutions. Systems Thinking was used for further exploration of the EPC activity in Czech Republic and analyse the current situation and the opportunities for dissemination. The theoretical aspects of System Thinking are elaborated in the following chapter.

Chapter 5. Thinking in Systems

System thinking or system theory is a self-reliant discipline characterised by its generality. For this reason, it is applicable in almost all domains and has been commonly used in problem solving. Mingers and White (2010) underline that systems thinking is well established in academic departments both in quantity and variety of its applications. Major disciplines that make use of system thinking have been identified as information systems and cybernetics, management and organization, production and operation, ecology, agriculture, medicine and health, etc.

System Thinking proposes a shift from linear causality, which involves *"regularities among sequence of events"* (Sayer 2000: 13) to a circular causality based on the internal system structure with the purpose of identifying the route cause of a problem. (Chai and Yeo, 2012) This research identifies a compelling resemblance between Systems Thinking and critical realist views of the world. Sayer (2000) further elaborates in his book on realism in social science, on the relation between structures and causal powers. Elements are part or whole structures. Causal powers emerge from interrelated elements within a structure but the results of their activity are dependent on other conditions. For instance, a causal power is activated when an unemployed person finds a job within an organization (i.e. the structure). The person starts working. However, the outcome of his work is conditioned by the nature of his responsibilities, the context, the accessible tools, etc. If this person would be employed under different conditions, it is likely that results of his work would be different. On the other hand, if a different person would be employed under the same circumstances, the result may also be different because of the distinctive abilities and personality of the other person. Therefore, explanation of causal powers does not rely on gathering data on regularities and repeating circumstances but on the identification of causal mechanisms, understanding how they work and under what circumstances are they activated. *"There is more to the world then patterns of events. It has ontological depth: events arise from workings of mechanisms which derive from structures of objects and they take place in geo-historical contexts".* (Sayer, 2000, p.15) In order to highlight the connection between Sayer's realism and system thinking, the structure is identified as *the system*.

Meadows (2008, p.2) defines the system as *"a set of things – people, molecules or whatever – interconnected in such a way that they produce their own pattern over time. The system may be buffered, constricted, triggered or driven by outside forces. But the system's response to these forces is characteristic of itself and that response is seldom simple in the real world."* It is important to underline that the same *"set of things"* which are usually described as elements, would produce different patterns in different circumstances and if triggered by other forces in distinct contexts.

Williams and Hummelbrunner (2009) depict the three main features of systematic thinking: interrelationships, perspectives and boundaries.

Understanding of interrelationships between different elements and actions of a system portrays a worldview where everything is connected. Nevertheless, different people perceive these interrelations in radically distinct ways, which led to the acknowledgement of different perspectives or lenses to look at the world. Complexity of this worldview is characterized by holism. However, it is impossible to explore the reality in all its complexity. For simplification and clarity, boundaries have to be settled.

For a better explanation of how systems work, the example of a slinky and a box is given. A slinky is held on an upturned palm and the fingers of the other hand grasp the slinky from the top. If the bottom palm is removed, the slinky will bounce up and down while being held with the fingers from the other end. The same experiment is conducted with a regular box, for instance the box where the slinky came in. When the bottom hand is removed, the box does not bounce up and down, but hang still on the hand that holds it from the top. In both of the experiments, the action (i.e. context) is the same. However, the nature of the object is different and thus, the behaviour differs. The essence of system thinking lays in the relationships between the system's structure and its behaviour. When this is established, one can move forward in understanding how systems work, why do they produce poor results and how can they be changed to create better behaviour patterns. (Meadows, 2008)

This principle is easy to understand with an example such as the slinky and the box. In this case, consistent regularities may occur. The slinky will always bounce up and down and the box will hang still when the bottom hand is released. As the causal power is stable (i.e. the nature of the object) and the external conditions of the situation (i.e. the hand moving away), this case may be considered a closed system. In larger, open systems, causal powers can produce different outcomes depending on how the conditions for closure have been broken. (Sayer, 2000) A system generally creates its own pattern of behaviour. External powers may in the same time unleash that behaviour or supress it. However, in most of the cases the same causal power applied on different systems, produces different results. For instance, when a company looses market share it is usually not due to its competitors but at least partly created by own business policies. (Meadows, 2008)

The situation of a company that looses market share is a relevant example to illustrate the different perspectives involved. For clearance, three perspectives are chosen by this research. The loosing company will be pushed by a natural reaction to look at the faults that caused its problems in places like the market and its own strategy. The competitors, who gain from the losses of the first company can seek for opportunities to reinvest their financial benefits. Consumers might be interested in the price and quality of the products and services offered by the companies involved but rarely preoccupy with understanding the processes that determined the quality or price. Therefore, different actors understand a situation through the personal interest and needs. As Williams and Hummelbrunner (2009) expressed it, people will make sense of the different interrelations of a system in different ways, depending on how one looks at the picture. In social science, the perspectives of different actors are interpreted in the realm of hermeneutics that adds meaning to different social settings. (Sayer 2000)

Depicting relevant knowledge about an analysed system is conditioned by the chosen boundaries. Every systematic model is a simplification of reality and no model was yet designed to comprise a system with all its elements and interrelations. (Meadows 2008) The simple creation of choice of a model implies setting a boundary. Thus, a decision has to be made on what is the irrelevant knowledge, which is left out and what is the relevant knowledge, which makes the subject of analysis. (Williams and Hummelbrunner 2009)

System Structure and Behaviour

From the introduction to system thinking it is concluded that systems represent more than a sum of their parts. They are formed by interconnected elements, driven by causal mechanism to fulfil a function. All elements, relations and functions or purposes are essential because they define the system. However, the purpose is the most significant determinant of the systems behaviour. Meadows (2008) provides a general understanding of how systems work. This section elaborates on her view of the main characteristics and illustrates it through examples.

Elements of systems are easy to identify. Professors, students, buildings, computers, etc form a university. It also has elements that are not physical or tangible such as identity or image, teaching approach, etc. Elements of systems are very numerous and one element is composed by other smaller and smaller elements. It is almost impossible to classify all of them. It is important to move a step back and look into the interconnections within the university. The equipment in the laboratories is related to the financial input and administration of the university. The subjects students learn are dependent on their choice for one faculty or the other and the quality of knowledge is dependent of the ability of the professor to transmit it and the capacity or willingness of the student to absorb it. The purpose though, is harder to identify than elements and interconnections because it is not visible but deduced from the behaviour of the system. Going back to the system of a university, it is intuitive to say that its purpose is dissemination of knowledge and education. Nevertheless, different elements in the system have different purposes. The student aims to learn, the professor aims to deliver knowledge and continue with research, the financial administrator aims at using the resources in the optimal way and so on.

The importance of features in the system is determined by the impact caused when they are changed or replaced by other features. The least important are elements. New students are enrolled in universities every year and others graduate. The university will continue to exist in the same form. However, if the interconnections between elements change, the system will be rather different. In an imaginary situation where students teach and professors take notes and receive grades, our general understanding of 'the university' now, would be drastically affected. Further, changing the purpose or function of systems would mean changing their nature. If the university will no longer have the main purpose of disseminating knowledge but earning money, this shall profoundly affect the whole system even in the case where elements and their interactions remain the same. For this reason, functions of systems are the highest on the importance scale.

To explain systems behaviour over time, the notion of stock and flows is introduced. Margalef (1968) indicates that accumulation of information over time increases the complexity of a system. For natural sciences, this information is stored in nature, in earth's crust, genetic systems or chemicals in plants. Sayer (2000) further argues that social sciences are intrinsically meaningful as well. However meaning cannot be calculated nor measured, it is an intangible element, which is perceived and understood in order to receive the information. In analysis of systems such as markets, the interpretative aspect is often overseen yet it manifests in actors understanding of each other's actions. Interpretative understanding is a dimension of both natural and social sciences but researchers in natural sciences interpret their circle in the scientific community while social researchers also need to understand the circle of actors they study.

Meadows (2008) explains stocks and flows giving a simple, physical example of a bathtub. She describes stocks as foundations of the system formed by an accumulation of elements, which can be seen, felt or measured. Stocks change under the actions of a flow over a length of time. The example of a bathtub filled with water is given. When the drain is plugged in and the faucet is turned off, the stock of water does not change. However, if the drain is pulled out, the stock of water decreases gradually. If the faucet is turned on, there will be a permanent change of the stock, which depends on the quantity of inflow and outflow of water from the tub. Transferring this concept to social science, one can refer back to the university example. If the scope of the system is to disseminate knowledge, we shall consider the knowledge a student possesses. He or she reads books and attends courses to accumulate more knowledge and generate new ideas. As the student progresses through university, he or she will forget a significant part of what was learned. The knowledge measured by an examination is the stock resulted from the inflow and outflow of knowledge. This example does not differ substantially from the bathtub until now. Nevertheless, the student itself illustrates the major difference. The grade or the measurement of the stock is dependent on a large variation of factors. A social scientist will evaluate the psychological well being of the student, his or her capacity to concentrate under time pressure, if the requirements to achieve a specific grade are clearly explained and so on. The social scientist aims to understand two dimensions, the subject of the examination as well as the student and his or her condition, compared to the natural scientist, who shall focus on water deposit in a dam, for example.

Stocks have the property of a buffer. They allow inflows and outflows to work at an uneven pace for a while. If the drain in the bathtub looses water faster than the faucet adds, there will still be water in the tub for some time. Furthermore, the level of the stock can be regulated by mechanisms for controlling the flows. System theory defines these mechanisms as *feedback loops.* They are responsible for maintaining the stock at a certain level, yet they also have the capacity to determine an increase or decrease. Acting upon the stock itself shall change its level while the stock reacts back to correct itself. The student who gained knowledge in a course or from a book shall have a different activity after the knowledge inflow and forget a share of it. However, in order to prepare for the upcoming exam, he will react by going through his notes and be reminded of the knowledge.

Two types of feedback loops occur: balancing feedback loops and reinforcing feedback loops. As the name indicates, a balancing feedback loop will seek to stability. It tends to neutralize any change in the stock and bring it back to the initial state. Reinforcing feedback loops engage in circles of vicious or healthy nature. The more they work, the more power they will gain to work some more. They create an amplifying and self-multiplying pattern. The student is studying for an exam. The more he studies, the more interesting his subject is and he will be motivated by a reinforcing loop to study more. After several hours, he becomes tired and needs to rest in order to balance his capacity for up-taking knowledge. If the student will not stop to rest, in an extreme situation he would reach a point of self-destruction, described in psychological terms as *burnout.*

Highly Functional Systems

The basic concepts of systems have been introduced. But systems may fail or flourish. For systems to work well, they need to posses specific properties: resilience, self-organization and hierarchy.

Resilience lays in a system's restorative power. A variety of feedback loops working through different mechanisms and time range in different directions to rehabilitate the system. The main characteristic of resilience is the elasticity with which it springs back after it was affected by an external factor. A resilient system is dynamic and oscillating within its limits. The wider the limits, the more resilient the system is. Resilience is a property one can acknowledge when the limits have been crossed. At this point, the system structure is damaged. On the other hand, stability of a system does not prove its resilience. If the property of the system to recover is not exercised, it might become rigid.

Self-organization forms the basis for evolution of a system. Complex systems have the capacity to learn, transform and evolve by creating a more complex structure than the previous. On a simplistic level, self-organization is a collection of feedback loop with the ability to restore other feedback loops and so on. The necessary conditions for a system to self organize is its liberty for experimentation. Moreover, complex systems can arise from a few simple rules in the same way as life on earth evolved from unicellular organisms.

From the level of simple elements that interact based on simple rules, new upper levels emerge in a bottom-up hierarchical arrangement. The purpose of hierarchies is that for higher levels to assure the well functioning of the lower levels. If the subsystems on lower levels are self-organized in such a way that they can assist the needs of higher systems and the higher systems manage to coordinate the functioning of lower systems, a strong, stable and resilient structure emerges. This structure can be threatened however by excess in control of the central system or antithetic event when a subsystem tends to dominate a higher system for fulfilling its own goals and at the expense of the entire structure. The balance between central control and autonomy of subsystems define a highly functional system. Good management of the three most important properties of systems improve its capacity for well functioning and healthy development over time.

This chapter has provided with an overview of how systems work. However, this is a fairly general description. Checkland (1981), Wilby (2006) and others highlight the limitations of this approach.

Limitations of system theory

Thinking in systems requires a complex and complicated vision upon the world that surrounds us. Meadows (2008) discusses systems in a non-technical manner to emphasize the potential of comprehending systems without use of mathematics or computers. However, in order to explain this complexity, system thinkers such as Meadows have turned to different models and diagrams. It is important to emphasize on the fact that these models are only simplifications of the real world. Checkland (1999) refers to this as a reductionist approach. He further argues that the level of theoretical analysis should not hold below the level of factual world we are analysing. Wilby (2006) reflects on Boulding's image on organisms and organizations, which perceive messages through a system of values while discharging the existence of facts. Humans perceive images and interpret them as they find themselves in the position of an observer. Checkland's perspective that *"there is no definition of scales to define systems complexity"* (Wilby, 2006, p.699) is grounded in the inability of systems to perceive raw data and understand it as fact. Therefore, it is impossible to agree upon an absolute model for complex systems. Only simplifications are possible and the way we use these simplifications influence the final image we create.

Meadows (2008) explains that working with systems implies an intrinsic duality. On one hand existing knowledge, as we know it is an accumulation of models. Therefore, our understanding of the world is a model or an image. Even though we are able to improve our understanding, we will never be able to 'picture' the whole world. For this reason, we can be mislead in our analysis of systems.

The most common sources of our errors lay in our ignorance towards long-term behaviour of systems. Behaviour patterns over time provide evidence of a system's structure providing reasons for why an event has happened. Moreover, humans have the tendency to think in linear patterns and this is another reason for why we design models. In many systems however, the relationship between cause and effect is not linear but influenced by numerous feedback loops.

More limitations of system thinking lay in the necessity to establish boundaries. All elements are part of the systems hierarchy. In a systematic structure, each investigated element reveals a complex sub-system. While making use of system theory to analyse systems in their complexity, we shall establish boundaries in order to understand it. In the real world, there are rarely clear determined boundaries. The ones we artificially create for simplification may create problems in planning a project when our thinking is to narrow and fail to acknowledge the initial purpose they were designed for.

Barring in mind the properties and limitations of systems and system thinking, the following chapter elaborates the system of EPC in Czech Republic. The first step is identification of the main concepts and the second step is evaluation of the possibilities for change. Williams and Hummelbrunner (2009) compile a various collection of models used for systematic analysis. However, most of these models make use of computed modelling and software that requires substantial quantitative data. This research has chosen a social approach mostly based on qualitative data. The model designed by Meadows (2008) proposes an analysis of 12 points of action, coined as leverage points. In increasing order of importance, these are: 12.Numbers, 11.Buffers, 10.Stock-and-flow physical structures, 9.Delays, 8.Balancing feedback loops, 7.Reinforcing feedback loops, 6.Information flows, 5.Rules, 4.Self-Organization, 3.Goals, 2.Paragigms and the most important, 1.Transcending paradigms. In this context, change is referred to as broader dissemination of EPC in Czech Republic. This approach is an attempt to illustrate the capacity of a nontechnical model to deliver knowledge and understanding of systems.

The following chapter elaborates on the analysis of the EPC system in Czech Republic.

Chapter 6. The system of EPC

Analytical Framework

This research makes use of systems theory to understand the activity of EPC in Czech Republic and identify the possibilities for future development. In order to do so, the structure, behaviour, and properties of the EPC system were studied. Moreover, this research seeks to identify opportunities for change at the system structure with the purpose of dissemination. The analysis of the EPC system is divided in two main parts in order to answer the two research questions. The first part is focused on interpreting and discussing the current situation of EPC in Czech Republic. This relies on properties and concepts of Systems Theory and data from previously conducted statistical studies and information received through qualitative interviews. The second part of the analysis focuses on answering the second research question. Meadows (2008) proposes 12 points for intervention in the system structure. These are derived from the basic concepts of system thinking and analysed in the Czech context of EPC.

For answering the research questions, this study proposes a first analytical model that illustrates the application of system theory in the practical context. In order to do so, system characteristics are identified and discussed according to Figure 2.

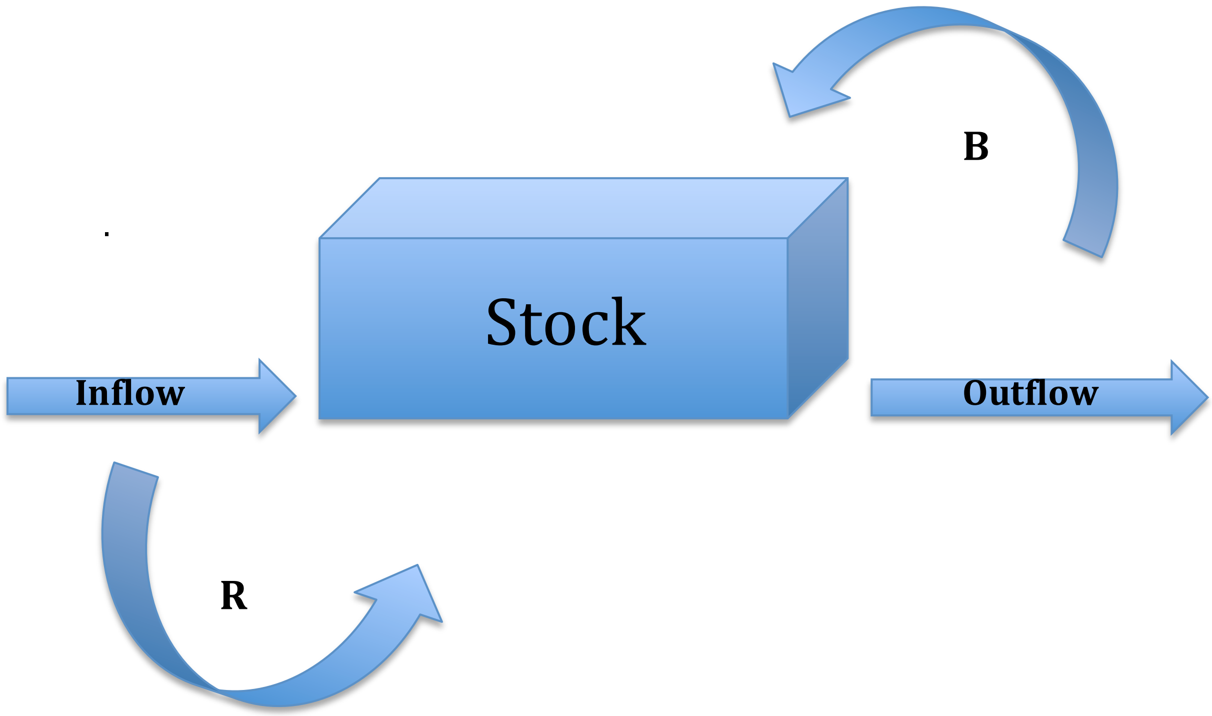

Figure 2. Analytical Model

The framework is designed to find the interconnections between the components and properties of the system and determine the how they work together. The letters B and R are abbreviations for balancing feedback loops (B) and reinforcing feedback loops (R).

In the second stage, the 12 leverage points construct the second analytical model. This model connects the theoretical perspective of these leverage points, identifies them in the Czech context and examines which of these points provide opportunities for dissemination in the actual local context. This model is a simplification of reality aiming to create an image as congruent as possible with the actual EPC activity. Therefore, this research is focused on the key components of the system.

Current Situation

A complex chain of stocks, flows and feedback loops represents the system of EPC in Czech Republic, as shown in figure 2. To examine the current situation and answer the first research question, the analysis starts from a general perspective of energy consumption in Czech Republic, followed by capturing aspects of the EPC system. The key elements forming the main stocks are: energy generated from non-renewable resources and targets for savings. Energy consumers determine the outflow of the stock. Buildings further managed by humans represent the elements that determine the outflow. Power plans are the elements that create the energy inflow. For the purpose of simplification, this study is only focused on the consumption aspect and how EPC is able to adjust it.

Meadows (2008) illustrates the perspective of consumers by underlying that humans tend to focus more on the inflows than on the outflows and often fail to realize that by consuming less energy, they can achieve the same results in fulfilling their needs then by looking for more resources. The purpose of EPC is to generate energy savings and thus to decrease the outflow of consumption. Therefore the concept itself creates a balancing feedback loop (B). The barriers identified represent the reinforcing feedback (R) loop for unsustainable energy consumption.

Figure 3. illustrates the national situation of energy consumption. Power generation in Czech Republic is mostly relying on the mix of coal and lignite. Development of power generation over time suggests a decrease of coal and lignite, from 76% in 1990 to 57% in 2009 and an increase in nuclear power generation from 20% in 2000 to 33% in 2009. Power generation from renewable resources represents a share of 4-5% in 2009. (ABB, 2011) Intensity of energy use, calculated in relation to GDP shows that energy consumption in all sectors increases together with economic growth and decreases in case of economic slowdown. (EU, 2013) Thus economy is and has been a strong feedback loop for determining the national consumption. The energy savings target by 2016 is 9%

compared with average consumption for 2002-2006 at a national level, equivalent of 1.7 megatons of oil equivalent (Mtoe). (ABB, 2011)

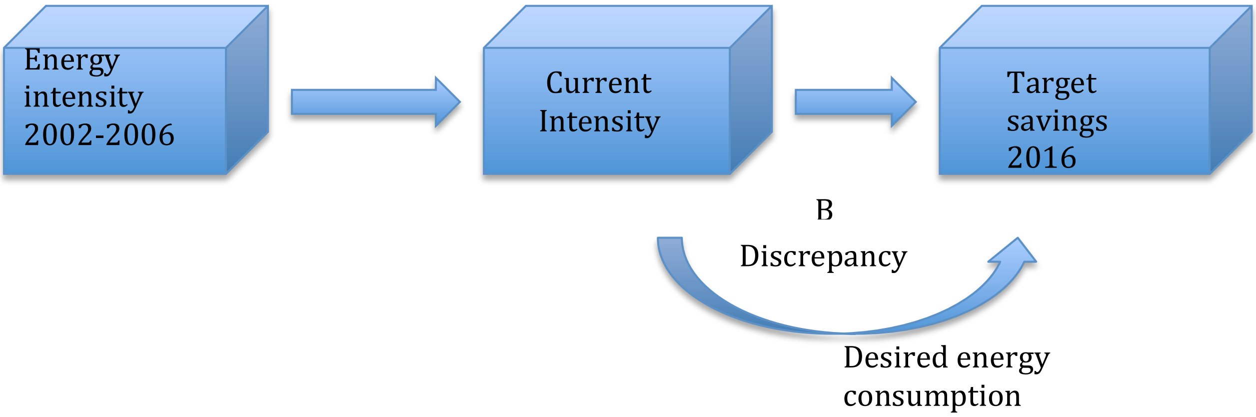

Figure 3. Energy consumption

The discrepancy identified between the current intensity and the target has a value of 1.7 Mtoe or 9%, the present consumption being approximately 28 Mtoe. (ABB, 2011) To eliminate this discrepancy, a balancing feedback loop (B) is added, that of energy savings. The study conducted by ENVIROS (2012) shows that Czech energy intensity has grown between 1997-2004. However, after 2004 to 2007, the total energy intensity decreased by 5%, demonstrating an improvement in energy efficiency, which was in line with the EU average energy efficiency. From 2007 to 2010, energy intensity remains roughly constant due to economic recession. It is not expected that EPC alone will neutralize the discrepancy between current intensity and target. However, it is a tool that can bring its contribution to diminish it. EPC projects mainly focus on heat consumption in the public sector and they work on a very isolated scale. (Slavotinek, ENESA) The EPC projects implemented in Czech Republic since 1993 are about 150-200. The total energy savings achieved by these projects is roughly estimated at 0.02 Mtoe with an investment of about 100 million euros. (Sochor, SEVEn) However, significant savings are achieved in former and current projects. The example Kosmonosy clinic located at about 70 km northeast from

Prague is taken to illustrate this contribution. The system is represented in Figure 4.

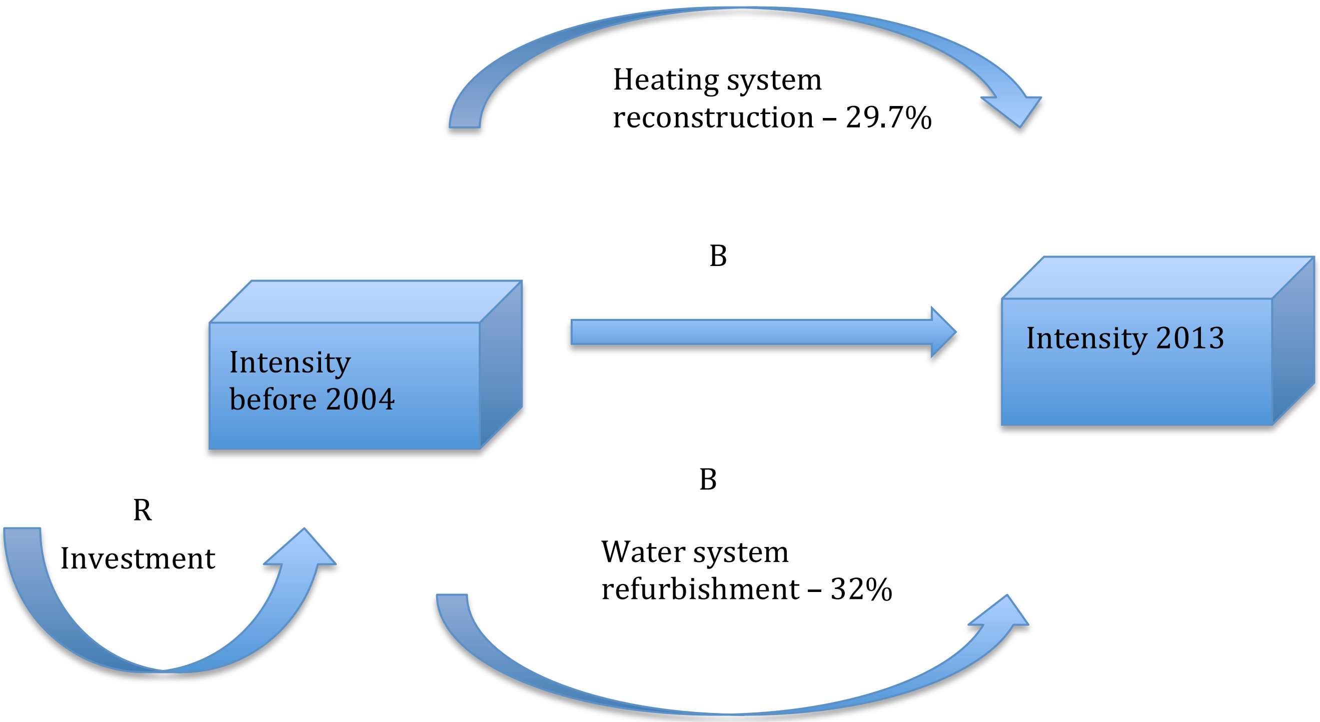

Figure 4. Kosmonosy clinic

The first instalments for reconstruction of heating were made between 2003 and 2004 with a total investment of 0.6 million euros. The savings achieved from this measure count 29.7% per year. The second two measures installed in 2006-2007 were building of own water source and reconstruction of the laundry system. The investment reached 1.4 million euros. The water savings achieved were calculated at 32% and 0.2 million euros per year. The stocks in this case are the amounts of heat and water, which outflow through consumption. In order to decrease the outflow, the measurements are installed as balancing feedback loops (B). The measurements needed a trigger, the investment. The latter is considered the reinforcing feedback loop (R). The higher the investment is, the more savings will produce and the more money is available for further investments. (Sochor, SEVEn)

Self-organization

The system of energy performance contracting (EPC) emerged in Czech Republic in 1993 when SEVEn, a local energy consultancy company, implemented the first project. This was achieved with support for finance and expertize from American institutions that were interested to enter in the Czech environment. In the same time, similar projects were implemented in other countries such as Poland, Bulgaria, Russia and Ukraine. Since then, it evolved at a slow pace without specific legal or political support. Projects were developed based on the individual interests and motivations of customers and other energy service companies (ESCOs) that adopted it in the following years while the basic, initial principle of guaranteed savings was maintained throughout the entire development. (Sochor, SEVEn) Figure 1. illustrates this principle. Today, ESCOs and consultancy companies dedicate different shares of their activity to EPC projects ranging from 0.5% in Siemens to over 80% in ENESA. The motivation of companies to adopt EPC is rather common among all representatives who were interviewed. Implementation and dissemination of the concept came naturally because it is understood as "good business" which brings benefits for the country, the environment and the people. Helenova (ENVIROS) explained that the share of the business focused on EPC is very small (2-3%) because the financial benefits are little compared to the work involved. However, EPC provides a "very good commercial article" because of its capacity to combine all the knowledge within the company. It involves municipal environment concepts, promotion of sound energy management and energy audits. The system of EPC started as an "interesting model" (Sochor, SEVEn) and developed to generate not only energy savings but knowledge, awareness and interest in different sectors and of public and private bodies. This capacity to diversify and complexify is understood as self-organization by system thinkers. It determines the evolution of systems over time. Self-organization yields from the creativity of human mind producing heterogeneity and unpredictability. (Meadows, 2008)

Self-organization does not imply constant development over time. It involves freedom for experimentation and a degree of disorder and imbalance. On one hand, the freedom for experimentation is somewhat supported by small amounts of money provided for determining buildings that are suitable for EPC implementation. The programme is called EFFECT and was initiated to support energy efficiency projects in Czech Republic. The programme generated about 40 applications from potential customers for the subsidy. On the other hand, ESCOs have initially conducted EPC projects in both industrial sector and public sector. The projects between these two sectors were divided rather equal. (Slavotinek, ENESA) However, the focus shifted to public buildings and only a minority remained focused on industry because of the diminished risk and labour intensity required. The desire for security and balance proven by this pattern of development does not hinder the system but it reduces its capacity for self-organization. The degree of reduction is impossible to determine but is a point to be taken into account when mapping the possibilities for up-scale of EPC.

Few simple principles of EPC systems' organization have generated the complex system active today in the Czech market. These principles lay in the structure of guaranteed savings, transparent and fair methodology for calculations of the baseline and savings and long-term contracts.

Resilience

The sectors of ECP activity are public buildings and partly industry. These two sectors form the field where ESCOs and consultancy companies have expertize and power to perform their activity. It is considered the safety area where actors operate their normal activities. The resilience of the EPC system is determined by its ability to persist within this variable field. For this, EPC needs a degree of flexibility, which is determined by its capacity to minimize the influence of unpredictable factors. As the system is focused on heat consumption, one important factor that cannot be controlled is the outside temperature. However, a temperature correction is introduced for an accurate calculation of the savings in relation to measures installed by ESCO. In the same time, temperature development is investigated. In some projects, a web-based tool constantly monitors the meters installed. This allows ESCOs to supervise the consumption constantly, evaluate the situation in case of overconsumption and take action. Situations of overconsumption can occur in various situations: the equipment is used more hours than initially calculated, windows are left open by the building personnel, the building is closed for a period of time, etc. These situations have influence on energy consumption and they have to be reported by the customer if a particular situation persists. ESCOs generally overlook minor modifications or exceptions but they do inform the customer, try to fix the problem and give advices. (Slavotinek, ENESA) If the problem persists, this will be reflected in the methodology for calculations. This procedure indicates flexibility and avoids conflicts because the relationship between customers and ESCOs are critical for EPC business.

The Association of Energy Service Companies was founded in 2011 and promotes the EPC concept. The Association creates a milestone in the development of EPC. It delivers more recognition and elasticity for EPC activity by attracting small funds such as in the case of EFFECT project and striving for political support as an institutionalized body.

Hierarchy

The system of EPC incorporates many other subsystems in a hierarchical structure. This hierarchy emerged from the first EPC project in 1993 and started to build new structures around it generating connections. In 1995, the first Act of Public Contracts came into action. This had no initial connection with EPC but it provides the procedures for the award of public contracts and therefore, a first legal framework for the EPC activity. Different changes in the commercial law and public procurement law were made for compliance with the EU directives but have also eased the development of EPC. These are all different systems with no apparent connection to EPC or energy efficiency. On the other hand, the system of EPC integrates smaller systems related to procedures for measurements elaborated in chapter 1., the technological and training system for their customers, information and communication of ESCOs with customers and consultancy companies. Once installed, the technology and measures work to produce savings. Usually this system doesn't need further interventions except for the situations when errors occur or when new measures are installed. The training system is conducted by ESCOs, sometimes with the help of consultancy companies through workshops and aims at creating awareness among the users of the building for how to use the measures installed and other good housekeeping practices. The rules of formal communication between ESCOs and customers are rather clear and stipulated in the contract in regards to the annual reports. However, the more casual communication forms the relationship between ESCO and the customer and this plays a significant role for the good development of the business. If all these subsystems are able to regulate maintain themselves, pursue their function and assist the needs of the larger system and the larger system is able to coordinate their functioning, the resulting structure is resilient and stable. The system of EPC becomes stable and resilient when the upper levels do not impede its work, when the consultancy company organizes the tendering properly, when the building users handle the technology and the measurement correctly, when they communicate well with the ESCO and are determined and proactive in achieving the savings and when the savings are properly and transparently calculated.

As pointed out by Meadows (2008), in cases when the dominant system takes too much control over its subsystems, the resulting behaviour might create damage for the entire hierarchy. The political environment in Czech Republic does not support EPC but it tolerates it. However, the most recent edition of the international methodology for calculation of national debt (EUROSTAT, 2013) states that municipalities have to calculate EPC projects into their debts. This provides a reason for the Ministry of Finance to be strongly reluctant towards implementation of EPC projects in state owned buildings. Slavotinek (ENESA) explains that this is a minor issue when you compare the public debts with EPC projects contribution. ESCOs are looking for mechanisms to avoid this conflicting situation. Slavotinek (ENESA) further underlines the belief that even if this is a strong argument against EPC implementation, the problem lies deeper: "it's a question of trust" because EPC is not a traditional approach and it is a much more complex model, developed over a long period of time. For a person who is not working with EPC, it is a lot of information, which needs time to be processed and politicians rarely have that time.

Results

The current situation of energy performance contracting (EPC) is well illustrated by its contribution to Czech energy efficiency plan: 0.02 megatons of oil equivalent (Mtoe) achieved savings over a period of 19 years, compared to the target of 1.7 Mtoe or 9% until 2016. The average savings achieved by EPC implementation is around 20% per project. Therefore, the small contribution to the national plan is the result of isolated activity on the Czech market.

The procedures for evolution of an EPC project are illustrated in figure 5.

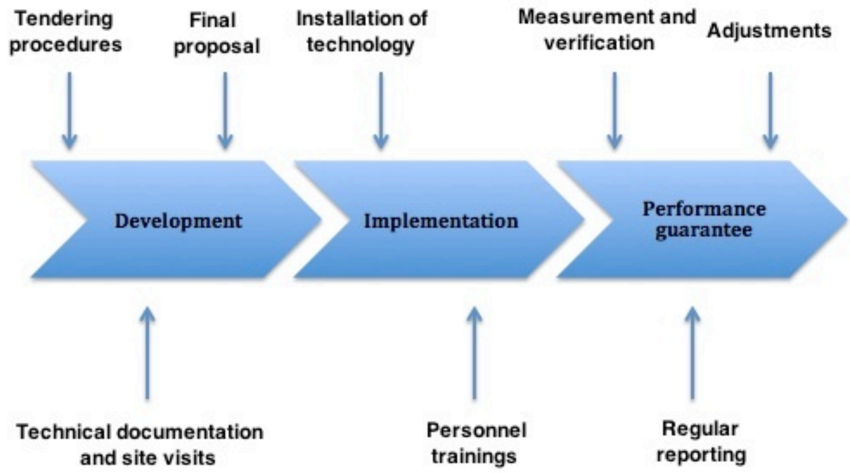

Figure 5. EPC evolution

Energy performance projects are developed in three main phases. Development phase consists in the tendering procedure, also called *'negotiation procedure prior announcement'* by the European legislation. This is a special procedure used in cases where the subject of tendering is not very clear. Within this process, tenders release their individual proposal and the price offers are not comparable. This procedure includes the announcement of preliminary information, regular announcement, application for participation in the tender, invitation of participation from the tender organizer, site visits, bidding procedures and the final proposal and contractual agreement. The development phase is a long process of negotiations and discussions, which can take from a few months up to two years. The implementation phase is shorter and consists in installation of technology and training sessions for the customer. The last phase is the performance guarantee, which is in fact the duration of the contract. This phase consists in measurement and verification of savings, reporting on a yearly basis and applying adjustments when necessary. After the contract is terminated, the customer is the only beneficiary of the savings. Duration of one contract could vary between six and twenty years, depending of the contracted site. In buildings, the period of a contract is longer then in case of industry. (Helenova and Slavotinek 2013)

The current system of EPC emerged from experiences gained over a long period of time. To underline the interconnections between elements and systems and subsystems, figure 6. was developed. The complexity of a system cannot be represented graphically. For this reason, symbols were used to illustrate the key layers of the hierarchy and the most important subsystems.

Systematic hierarchies are highly dependent on the goals of each system and subsystem. The system's functionality is optimal when the subsystems work to fulfil the upper goal and when the controlling system coordinates and supports the lower subsystems to perform their individual functions. Energy efficiency is the controlling system as EPC's goal, which is the immediate lower subsystem, is to decrease energy consumption. Energy intensity was calculated relative to GDP by ABB (2011) and the study shows an increasing or decreasing trend over time in relation to the economical factor. Therefore, the behaviour pattern shows that more energy is consumed in times of economic growth.

EPC's field of expertize is public buildings: municipalities, schools, hospitals, etc. and private facilities: industry. Figure 6. illustrates this area to be divided almost equally. In reality, most of EPC projects are conducted for public buildings while a very little number is focused on industry. ESCOs describe the industrial projects as risky and difficult. The measures implemented by EPC projects in buildings create a balancing feedback loop, which regulates the consumption. However, this loop needs to be reinforced by elements that constitute the next level of subsystems.

The key elements, which contribute to reinforcement, are represented on the lowest level in Figure 6. People, their motivations, knowledge and expertize play a crucial role in EPC activity and development. It was Ivo Slavotinek (ENESA - ESCO) and Jaroslav Marousek (SEVEn - consultancy company) who first introduced the concept in Czech Republic. The success of their projects attracted more actors and their motivation and knowledge created the complex system existent today and driven by expertize. Slavotinek (ENESA) underlines that good development of the projects is highly dependent on the customer as well. If there is motivation and enthusiasm on the customer side, the project is improved and delivers more savings: *"there is a lot of human influence and the communication is very important for this project, it's not just technique, it's a lot of communication."* The importance of communication is also reflected among competitors. Members of the Association share knowledge and information with each other while working for the same goal: to keep their activity on the market. This serves again the higher goal of the entire system: restraining consumption by delivering more savings.

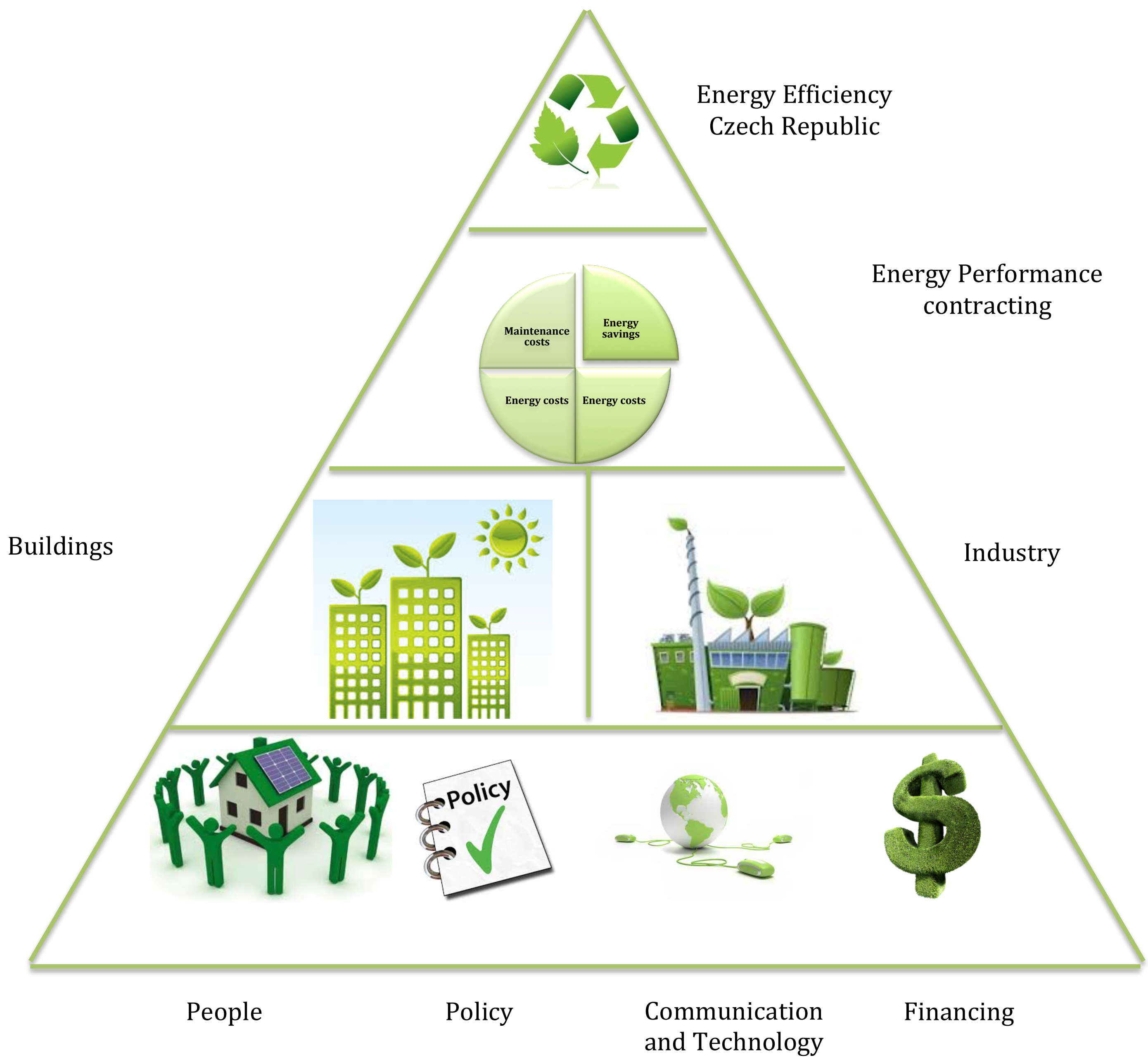

Figure 6. Systems and subsystems of EPC in Czech Republic

Helenova (ENVIROS) emphasizes that customers are very interested in technology applied. The quality of technology is defined by the long-term warranty of technological assets (boilers, meters, etc.) that are implemented. ESCOs do not guarantee above the warranty provided by the producer but the projects are dependent on the product lifetime. Slavotinek (ENESA) argues that technology is not an issue. There is a large variety of products on the market and their warranty satisfies the needs of EPC projects. Savings however, are a *"delicate area"* which is not only driven by technology but how motivated customers are and what are the factors influencing their motivation. As Helenova (ENVIROS) pointed out, many of the customers are not remunerated to work with these types of incentives such as EPC. Therefore, financing is an element, which raises some problems on the customer side.

Policy and legislation around energy efficiency is a highly debated subject in Czech Republic. All the interviewees have stated that there is no support from the government for EPC as a tool to achieve the national target for energy efficiency. The Ministry of Industry and Trade shows interest and asked the Association for support to adapt the new energy efficiency directive (EED) and a few representatives are taking initiative to standardize the business environment of EPC. However, this conflicts with the Ministry of Finance, which is strongly reluctant and therefore progress is achieved on a very low speed.

Leverage points

In order to answer the second research question and capture the possibilities for up scaling, this study makes use of the model proposed by Meadows (2008). This model is based on 12 leverage points or places to intervene in a system for creating change. The purpose of change is dissemination of EPC activity in Czech Republic in a way that energy performance contracting (EPC) will accomplish more energy savings. This model is not intended to offer a recipe for determining leverage points but an analytical lens for exploring the system of EPC in space and time. This research has reflected upon the 12 points in relation to EPC in Czech Republic and discussed the perspectives with different actors working to promote the model on the Czech market. The opportunities for dissemination arise from connecting the theoretical points with the knowledge derived from interviews. The leverage points are treated in order of importance, starting with number 12, the least important of all and increasing gradually to the most important.

12. Numbers and parameters

The activity of ESCOs and consultancy companies was primarily evaluated through the number of projects conducted, share of the business focused on EPC and size of the company. These numbers provide a general image of the organization because they a quantifiable and comparable. Changing the number of employees in a company or the share working with EPC will probably bring benefits to the administrative system of that company but the impact on energy savings in Czech Republic will be insignificant. However, there are numbers that might have a higher impact on national savings. Parameters for illustrating the savings generated by ESCOs, to determine the national energy consumption and establish efficiency targets have been used to demonstrate the potential of EPC. Decreasing the number of megatons of oil equivalent (Mtoe) consumed by the Czech population is the most important parameter that creates energy savings. But to change this parameter, one has to go much higher up on the following list.

11. Buffers

Seven ESCOs and six consultancy companies form the Association of Energy Saving Companies (APES) established in 2011. This is an accumulation of elements, the companies involved in the association, which perform similar activities with the intention of creating a stronger structure and identity on the market. Establishing the Association increased the resilience of EPC system by forming a buffer against changing market situations. Changing the capacity of APES, thus the number of companies involved can create more stability but this implies a larger number of clients for those companies to work with. Again, numbers need to hit higher leverage points to be effective. Moreover, it is important to point out that increasing the capacity of a buffer too much determines a high degree of inflexibility in the system.

10. Physical stocks and flows

Technology used by ESCOs in building retrofit varies from insulation to room control and web-based measuring systems. The conditions to use this technology in EPC projects is the high quality of items installed, which is proven by long-term guarantee that covers the length of the EPC contract. Technological instalments are crucial for the project but can hardly be changed after they have been installed. Assuring the high quality of the product from the beginning is the important aspect ESCOs are concerned with. The technology is not an issue for ESCOs and most of the interviewees have stated that improvements in this sector are not necessary. However, Slavotinek (ENESA) pointed out that more important than technology is the customer's behaviour. This is again, a higher leverage point.

9. Delays

Operational factors, which influence the energy consumption, often occur over the length of a contract. Fluctuations in outside temperatures or operating time of the building can interfere with accurate calculations of savings and influence the final result, thus also the revenue of ESCOs. These errors may delay the calculations. To avoid this issue, the development of outside temperature is investigated and correction factors are added to the calculations. The cases when significant changes appear in the operating hours have to be reported to the ESCO by the client and stipulated in the methodology for savings calculations. Nevertheless, small delays are inevitable but they reach a balance during the long period of the contract.

8. Balancing feedback loops

Balancing feedback loops have the strength of keeping a specific stock near its goal and any complex system counts many of them. The EPC system itself is a balancing loop for energy consumption in Czech Republic because is works to approach it to the target of 9% savings. Also, every EPC project establishes its own goal by guaranteeing a specific percentage of savings. The balancing feedback loops in this case are smaller systems such as the technology installed and the trainings to adjust the building personnel's behaviour and habits towards energy consumption. Meadows (2008) points out that prices are regulated to moderate supply and demand and the more clear prices are kept, the easier the markets will operate. The price leverage point often attracts people and organizations but they also tend to influence it in the wrong direction by adding or removing taxes and subsidizes. The true benefits of this feedback loop reside in using the real price of energy.

7. Reinforcing feedback loops

Meadows (2008) explains that reinforcing loops are characterized by gaining power from their own work to produce some more. Investments in EPC projects determine savings and thus reduce the energy bill. The outcome of this chain reaction is generating more capital for investments in new measures or simply delivering the revenue to the ESCO, which will continue its activity to create more savings. The interview respondents did not identify financing of EPC projects as a barrier. Several banks in Czech Republic trust to finance the EPC projects mainly because they involve municipalities. This is because the commercial law requires municipalities to introduce their debt into the accounting structure and treat it as compulsory payment. The security of financing provides a helpful reinforcing feedback loop. However, the financial barrier can occur on the customer side in the preparation phase of the project. The customer has difficulties evaluating the building and deciding which building is suitable for EPC. The EFFECT programme was used to subsidise this preliminary evaluation of buildings but the entire budget for the programme was about 1 million euros and about 40 applications were received in two years.

6. Information flows

ESCOs receive information about energy consumption of the building through the monthly energy bill and the meters they have installed. Some of the meters are connected to a web-based information system and facilitate permanent access for the ESCO, which supervises the process. Slavotinek (ENESA) explains that before this system was installed, more complex calculation was necessary and communication with the customer was not as often as it is now. Moreover, constant access delivers more information on possible additional improvements within the building. Since web-based monitoring and room control was implemented, activities in the performance guarantee phase (after the measures have been installed) have increased as additional improvement possibilities are identified and communicated to customers. Kohoutek (Siemens) points out that normally, the information on consumption is evaluated on a monthly basis and at the end of the year, ESCOs conduct a final evaluation and report back to the client. At the end of the project, the customer receives an overall report on the progress of the project. In the present situation, the customer is updated on a monthly basis or less often about his consumption. Access to the web-based monitoring system or structured feedback from ESCOs gives customers permanent information on their consumption and determines the customer to be more aware of his impact and work together with the ESCO to achieve more savings.

5. Rules

The public tender procedures and specifications of the contract represent the rules of EPC. Helenova (ENVIROS) explains that tenders for EPC require a special procedure called negotiated procedure prior announcement, which is applied in tenders where the bidding subject is not very clear and thus the price is not comparable. This procedure is applied because every ESCO brings different proposals regarding the achievement of savings and the costs involved are dependent on their strategy. According to Slavotinek (ENESA), the key element of the contract is the methodology for evaluating the savings. To respect the transparency and fairness regarding the evaluation of the savings, monitoring verification is accomplished based on the International Performance Measurement Protocol (IPMVP). Moreover, respecting the agreed price, schedule and quality of measurements by ESCOs and operating the equipment and respecting the indications received in trainings by customers are important rules for the good cooperation. According to Meadows (2008), rules define the scope and boundaries of a system and determine its degree of freedom. Rules play an important role in discovering malfunctions of systems and more importantly, who has power over them. EPC activity is influenced by rather clear rules, which have to be respected by ESCOs and customers as well. In some cases, assistance from consultancy companies is needed. Therefore, one can agree that a balance in power over the rules was fulfilled.

4. Self-organization

EPC's capacity to self-organize is much supported by the activities of the Association. More than attracting programmes for financing such as EFFECT, members of the Association are working together and develop a standard contract and standard methodology for EPC implementation. Moreover, they are supporting the Ministry of Industry and Trade, responsible for implementation of Energy Efficiency Directive (EED 2012/27/EU), to develop the articles of the Czech Directive. The capacity to self-organize lays in openness to change and innovation, developing new responses to changing market situations while respecting the basic principles: guaranteed savings, transparent and fair methodology for calculations of the baseline and savings and long-term contracts. Several activities realised by ESCOs and consultancy companies in Czech Republic over the years prove EPCs self-organizing capacity. The public sector is restricted by several public procurement procedures. Standardized contracts and methods are helpful for bureaucratic environments. Use of fixed prices instead of market prices improves resilience in case of energy price fluctuations. Other initiatives such as organizing informative campaigns and road shows help the information dissemination.

3. Goals

The main purpose of EPC is to produce energy savings. In order to do so it needs to contract as many projects to cover its costs and keep the activity running.

ESCOs need to also focus on the quality of their projects and achieve more savings by focusing on the monitoring and verification phase. Slavotinek (ENESA) explains that in this area there is still *"untouched potential".* This can be achieved by learning more about the contracted building and increase the accuracy of communication with the customer through trainings and feedback with the aid of different types of information management software.

2. Paradigms

This research has illustrated two different paradigms. The concept of EPC involves many actors who work to produce energy savings and thus, their paradigm is partly represented by the EPC system. On the other hand, EPC in Czech Republic is not a new term to most of the potential customers. However, there is a general sense of scepticism and lack of trust towards it. From one perspective, they tend to find it too complicated and on the other hand, it seems rather abstract. Kohoutek (Siemens) explains that energy savings are not an asset, whereas virtual because they do not exist in the moment of negotiation with potential customers. They shall be achieved after the start of the project. Public organizations are reluctant to these types of initiatives because on one hand, they are not usually remunerated for their activity in this field and on the other hand, the concept appears complicated. Negative comments were related to the long-term contractual agreement. The approached potential customers were not interested in gaining additional income at the end of the contractual agreement, after 8 or 10 years. Meadows (2008) argues that creating changes at the level of shared ideas in the minds of society is very challenging as societies resist these changes harder that they resist anything else. Shapere (1964) mentions that paradigms seem to be patterns in the sense of archetypes from which traditions may emerge. This research understands paradigms as intrinsic mind-sets of communities. Kuhn (1996) argues that in scientific communities paradigm changes can occur when failures and inconsistencies are pointed out strongly and loudly in places of public visibility and working with actors interested in the same goal rather then struggling with rigid opinions.

1. Transcending paradigms

Transcending paradigms is the most powerful leverage point identified by Meadows (2008). It reveals the power of acknowledging that there is no 'true' paradigm and that the world has a large variety of worldviews. Therefore, the mechanisms that activate the system of EPC are dynamic and changeable as long as the concept respects its goal, to achieve energy savings.

Results

The previous analysis depicts that dissemination of energy performance contracting (EPC) activity can be achieved in a qualitative way by increasing the savings within single projects and also in a quantitative manner by increasing the number of projects. Moreover, this research highlights that several initiatives for dissemination of EPC activity have already been taken.

Establishment of the Association in 2011 has created a buffer through cooperation among competitors who now work together to disseminate their activity. Moreover, working with bureaucratic institutions has determined the members of the Association to use standard contracts for all projects. The specifications of every project are stipulated in the annexes. To insure transparency and fairness, the international performance measurement and verification protocol (IPMVP) was implemented as standard methodology for EPC projects conducted by members of the Association. Standardization of documentation and methodology creates a reinforcing feedback loop in an attempt to overcome the barriers related to the complexity of the model, which many potential customers have described as *"too complicated"*. (Helenova 2013) Consultancy companies play an important role in dissemination of EPC system as they are the neutral body and have the capacity to provide with objective comments for the customer: *"they trust us"* (Helenova, ENVIROS) Thus, the activity of consultancy companies creates a balancing feedback loop to overcome the barrier related to lack of trust. The implementation of the new energy efficiency directive (EED 2012/27/EU) by 2014 in all member states also provides opportunities for EPC to be disseminated. According to Sochor (SEVEn), EED implementation is a substantial point in EPC development. This will benefit in negotiations with state bodies by adding a balancing feedback loop in the conflict between the two ministries' interests. Moreover, the EED (2012) requires member states to adopt energy efficiency incentives in their own facilities and provide a good example for other institutions. According to Kohoutek (Siemens), *"if the state of CR would use EPC in a wider range, it would probably lead to more EPC projects".* He identifies important potential in the department of interior and defence where public buildings, which belong to the army or prisons, have not been touched yet by EPC. This is because the legislation does not allow these departments to accept third party financing. Members of the Association are lobbying to change this law. Also buildings such as schools and hospitals are not yet covered.

The financial system of EPC provides two dissemination opportunities for EPC. On one hand, the increasing prices of energy resources have previously determined improvements in energy efficiency (ENVIROS, 2010). The overall energy price in Czech Republic has been gradually increasing since 1990. The district heating price was evaluated at 19.1 EUR in 2011 by Euroheat & Power (2011). Nevertheless, energy prices in Czech Republic remain below the EU average. (Euroheat & Power, 2006) Adding a balancing feedback loop on calculation and adaptation of real energy prices in Czech Republic is a slow process and little can be changed in this aspect. On the other hand, EPC financial system can improve in the area of project development. The Association has the power to attract more funds and investments for preliminary evaluation of buildings suitable for EPC. This is supported by the necessity of implementation of the EED in member countries by 2014. Helenova (ENVIROS) ponders over the possibility of *"sending some clear signals to the potential clients which would increase their motivation"* to engage in EPC projects. She further argues that one reason for this lack of motivation on the customer side is lack of *"remuneration"*. Therefore, possibilities to add a reinforcing feedback loop through financing of the preliminary evaluation on public buildings should be further explored in order to increase the number of EPC projects.

The capacity for self-organization of the EPC system was illustrated by its ability to innovate and adjust to changes. Standard methodologies under development today stabilize the system and increase its credibility on the market. However, it is important to emphasize that too much standardization and control from protocols inhibit the potential for future adaptation and self-organization. This research has considered different field of activity for ESCOs as possibilities for dissemination of EPC projects and leave open doors for experimentation, which creates a possibility to balance the trend for standardization. Development of EPC over time shows knowledge and expertize to conduct EPC projects in areas of public buildings and industry as the activity was divided equally at the beginning. Over the years, it has strongly migrated towards the public sector. Slavotinek (ENESA) argues that in public buildings, ESCOs have more power to define the standards for how the building is used: overall temperature, lightning, etc. then in other sectors. ESCOs are taking small steps in including the industry sector more in EPC projects but this remains a minority. Dobes (EMPRESS) explains that this sector involves more risk and labour intensity for ESCOs. Economic instability created by the recession is still affecting the industrial sector and ESCOs are sceptical to engage in long-term contractual agreements for this reason. Moreover, according to Slavotinek (ENESA), private buildings are not of interest for ESCOs as they have too little control and cannot impose their standards for to private homes. Therefore, savings cannot be guaranteed. Guaranteed savings are a fundamental principle of the EPC system and therefore, ESCOs prefer to focus on other areas. Kohoutek (Siemens) explains that unexplored potential lays in the public sector as well for the buildings of the Ministry of Interior and Defence. Exploring this potential shall support dissemination of EPC. However, from a system's perspective, the industrial sector should be further explored as well. Expertize of ESCOs does not impose a barrier due to previous experience and increasing the area of activity will improve the resilience of the entire system.

Adjustments over the measurement and verification period provide opportunities for creating more savings in a qualitative manner, within already implemented projects. Information and communication flows between ESCOs and their clients form a key element in this process. Formal reporting provides a clear and concise type of communication. However, Slavotinek (ENESA) underlines the importance of informal communication and *"good chemistry"* between the partners involved in an EPC project. Dobes (EMPRESS) believes that *"EPC is a method or an approach, which brings people together"* while with the potential to determine change in the society, creating *"more cooperation, trust and security"*. EPC projects' healthy development relies on investing effort from both sides to explore more and more possibilities for savings, which in systems' wording refers to enhancing the power of information flows. Therefore, to fully explore EPC projects on a qualitative level and work with adjustments, more access to information is recommended on the customer side. Possibilities to accomplish this lay in the web-based monitoring tool which can de designed to deliver information also to the client and not only to the ESCO, on a more frequent basis that the reporting procedure (e.g. weekly electronic information delivery). This opportunity has the potential to overcome the barrier related to asymmetric levels of information between ESCOs and their customers.

Mistrust, lack of interest and motivation on the population side constitute the major barriers for dissemination of EPC. (Slavotinek, Sochor, Dobes, Helenova, 2013) Changing the social paradigm related to energy efficiency is a very challenging task. However, following Kuhn's advice about pointing out the damages created by the overuse of energy by advertise the European Union's requirements and providing solutions by delivering clear and accurate information in the media and to the potential customers can create changes. Intensive informative campaigns directed to focus groups such as youth communities, non-governmental organizations (NGOs), potential clients who have been working with ESCOs or consultancy companies before, both from public sector and industry, governmental bodies, etc. have the potential to attract more EPC projects. Different types of organizations, public and private might show increased interest in receiving funding for different refurbishment programmes and improve their image.

Chapter 7. Conclusions

This research commenced with the assumption that the service of energy performance contracting (EPC) provides a powerful tool for achieving the energy efficiency targets established by the European Union (EU). EPC development over a long period of time in Czech Republic provided an interesting case study. Despite its potential and expertize, the EPC concept is still applied in isolation. This problem formulation guided the author of this research to the seek opportunities for broader dissemination of EPC in the Czech market. The research questions were designed to map the current situation of EPC development and further explore the aspects that can be changed in order to increase the popularity of EPC. A general perspective of the whole EPC activity was needed to answer the research questions and systems theory was found suited for this purpose. The answers to the main research questions have been elaborated in the results of the analysis. The following paragraphs provide a summary of the main findings.

The main outcome of the analysis of the current situation reveals that the EPC systems has brought little contribution to the overall energy efficiency in Czech Republic due to its isolated activity. Further, it exposes the phases of EPC projects: development, implementation and performance guarantee followed by the key aspects of each phase. Moreover, the EPC activity has shifted form a balanced focus between public sector and industry to a governing interest in public buildings. A lack of motivation on the customer side to adopt EPC projects was identified, which is most likely determined by shortage in remuneration. On a policy level, conflicting interests between the Ministry of Industry and Ministry of Finance were identified in what concerns the governmental support towards EPC dissemination.

To answer the second research question and identification of the dissemination opportunities of the EPC system, the second part of the analysis was designed based on the 12 leverage points proposed by Meadows (2008). The systematic analysis identifies these points by reflecting them on the current situation of EPC in Czech Republic. However, only six out of 12 aspects reveal possibilities for broader dissemination. The opportunities identified reside in buffers, balancing and reinforcing feedback loops, self-organization, information flows and paradigm changes. They have been categorised by quantitative opportunities, thus increasing the number of projects and qualitative opportunities, increasing the savings at the level of already implemented projects. The opportunities for dissemination found propose solutions for overcoming the barriers identified in the literature.

Increase of the number of projects can be determined by ESCOs and consultancy companies which work to attract national and international funding for preliminary assessment of the public buildings, seeking to identify which are suited for EPC implementation. Representatives of the Ministry of Industry and trade can support these initiatives in their activities of implementation of the new energy efficiency directive (EED). The same actors have the power to introduce EPC projects in new departments of public buildings such as the Ministry of Interior and Defence, which are still untouched by EPC activity. Further, ESCOs posses the expertize for enhancing their activity in the industrial sector and it is in their power to seek opportunities for implementing more projects in this area. The members of the Association have the capacity to work together and develop strategies for joint advertisement and information delivery about their activity.

To enhance the productivity of running projects, ESCOs together with the clients can create adjustments in the performance guarantee phase. The customer's interest for achieving more energy savings can be increased by receiving more information on the status of savings and the mechanism that create it. Therefore, there is a strong indication that ESCOs can keep their customers informed and ask for feedback as often as possible.

The overall development of EPC in Czech Republic illustrates a complex system, which emerged from a few initial projects, having a bottom-up progress. It has proved significant potential in achieving its purpose, to generate energy savings. However, without the governmental support, thus a top-down enhancement, the EPC system shall further keep the slow speed of development and create significant changes in the contracted facilities, but never achieve its full potential, to create significant improvements in the national energy efficiency plan.

Chapter 8. Limitations and perspectives for further research

To capture the full complexity of energy performance contracting (EPC) system, all elements and subsystems together with their interrelations need to be taken into consideration. However, boundaries have been established for the account of clarity and relevance. This research focuses on the overall potential of EPC to achieve savings and provides a general vision of the mechanisms involved without exploring these mechanisms into depth. This may be one of the reasons why opportunities for dissemination were not found in all 12 points of the second model. Moreover, data collection sources strongly influence the results. This research only analysed the perspective of actors who have a professional interest in EPC dissemination. Further, the quantitative data introduced was extracted from studies conducted by companies, which are active in the Czech market and not official statistics because of a language barrier.

Overall, the generality of this research was necessary for getting a good overlook and capture the possibilities for dissemination. However, all the identified opportunities can be explored more into depth by actors in the market and every one of them provides fuel for further research. Further, this research only focuses on the situation in Czech Republic and it is not expected that same results would emerge in other countries. It does underline a few interesting points for thought but further adaptation and experimenting is needed.

References

ABB. 2011. Czech Republic. Energy Efficiency Report. http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/f35bb1ce76e1ff6ec12578b100233ab6/$file/czech%20republic.pdf

Abrahamse, W., Steg, L., Vlek, C. and Rothengatter, T. 2007. The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. Journal of Environmental Psychology 27, 265–276.

Paolo Bertoldi, Energy Service Companies (ESCOs) in Europe, European Commission, Directorate General, Milan, 16 December, 2005

Bleyl, A.W., Eikmeier, B. and Seefeldt, F. 2003. How much Energy Efficiency can Energy Contracting deliver in the Residential Sector in Germany? Transaction and Life Cycle Cost Analysis, Market Survey and Statistical Potential. Graz, Austria. <http://www.ieadsm.org/Files/Tasks/Task%2016%20-%20Competitive%20Energy%20Services%20(Energy%20Contracting,%20ESCo%20Services)/Publications/090709_T16_EC%20residential%20market_IAEE09%20abstract_GEA_Bleyl.pdf>

Brown, M.A., 2001. Market failures and barriers as a basis for clean energy policies. Energy Policy 29 (14), 1197–1207.

Chai, K. H. and Yeo, C. 2012. Overcoming energy efficiency barriers through systems approach. A conceptual framework. Energy Policy 46. 460–472.

Checkland, P. 1999. Systems Thinking, Systems Practice. West Sussex, England: John Wiley & Sons.

Dirckinck, H. K. 2013. Can energy utilities play a role in local political energy savings programs? Phd. diss., Copenhagen: Aalborg University.

Dobes, D. and de Palma, R. 2010. An integrated approach towards sustainable entrepreneurship – Experience from TEST project in transitional economies. Journal of Cleaner Production 18, 1807-1821.

Dobes, D. 2013. New tool for promotion of energy management and cleaner production on *no cure, no pay basis*. Journal of Cleaner Production 39, 255-264.

Dobes, D. 2013. Semi-structured interview. (19th June 2013) Prague.

EED. 2012. European Energy Efficiency Directive 2012/27/EU on 14 November 2012. Official Journal of the European Union. L 315. Vol. 55.

ENVIROS. 2012. Energy Efficiency Policies and Measures in Czech Republic. Monitoring of EU and national energy efficiency targets. Prague.

European Association of Energy Service Companies. 2012. Energy Contracting. Successful energy service business models. <http://www.eu-esco.org/>

European Commission. 2013. Czech Republic. <http://ec.europa.eu/energy/gas_electricity/doc/cz_energy_market_2011_en.pdf>
Euroheat & Power. 2011. District Heating and cooling. <http://www.euroheat.org/Czech-Republic-73.aspx>
European Commission. 2013. Member States' Energy Dependence: An Indicator-Based Assessment. <http://ec.europa.eu/economy_finance/publications/occasional_paper/2013/pdf/ocp145_en.pdf>
EUROSTAT. 2013. Manual on Government Deficit and Debt. Implementation of ESA95. Luxemburg: European Union. <http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-13-001>
Feng, W. S., Miller M. S. and Yeh, C. C. 2012. The effect of ESCOs on energy use, Energy Policy 51, 558-568
Gillingham, K., Newell, R.G. and Palmer, K. 2009. Energy Efficiency Economics and Policy. Discussion paper. Washington, DC.
Grindsted, A. 2005. Interactive resources used in semi-structured research interviewing. Journal of Pragmatics 37. 1015–1035
Haisler, P. 2011. How to write a good research paper. 1st ed. Frederiksberg: Samfundslitteratur.
Helenova, V. 2013. Semi-structured interview. ENVIROS. (19th June 2013) Prague.
Hidalgo, A. *et al.* 2013. EU Energy Efficiency Directive. Guidebook for Strong Implementation. The Coalition for Energy Savings
Hogan, W.W., 2005. On an "Energy Only" Electricity Market Design for Resource Adequacy.
<http://www.ksghome.harvard.edu/whogan/>
IEA, 2013. US Energy Information Administration <http://www.eia.gov/countries/country-data.cfm?fips=EZ>
IPCC. 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.
IPCC. 2012. Renewable Energy Sources and Climate Change Mitigation. Special report of the Intergovernmental Panel on Climate Change [Edenhofer, O., Madruga, R.P., Sokona, Y. (eds.)]. New York: Cambridge University Press, USA, 1059 pp.
Jaffe, A.B. Stavins, R.N., 1994. The energy-efficiency gap. What does it mean? Energy Policy 22 (10), 804–810.
Jonasova, M. and Cooke, S. 2012. Thinking Systematically about Scaling Up. Developing Guidance for Scaling Up World Bank-supported Agriculture and Rural Development Operations. Washington, DC: The World Bank.
Kaplowitz, D. M., Thorp. L., Coleman, K. and Yeboah, F. K. 2012. Energy conservation attitudes, knowledge, and behaviours in science laboratories. Energy Policy 50, 581–591
Kohoutek, R. 2013. Semi-structured interview. (18th June 2013) Prague.

Kuhn, T. S. 1996. The Structure of Scientific Revolutions. 3rd ed. Chicago and London: University of Chicago Press.
Margalef, R. 1968. Perspectives of Ecological Theory. University of Chicago Press.
Meadows, D. 2008. Thinking in Systems. A Primer. Wright, D. ed. Sustainability Institute. Chelsea Green Publishing Company.
Mingers, J. and White, L. 2010. A review of the recent contribution of systems thinking to operational research and management science. European Journal of Operational Research 207 (3), 1147–1161.
Muratore, G. 2011. Incentive based energy market design. European Journal of Operational Research 213, 422–429
Owens, S. and Driffill, L., 2008. How to change attitudes and behaviours in the context of energy. Energy Policy 36 (12), 4412–4418.
Painuly, J.P., Park, H. M., K. Lee and Noh, J. 2003. Promoting energy efficiency financing and ESCOs in developing countries: mechanisms and barriers, Journal of Cleaner Production 11, 659-665
Paulik, E. 2013. Semi-structured interview. (26th June 2013) Personal email.
Rohdin, P. and Thollander, P., 2006. Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden. Energy 31 (12), 1836–1844.
Sayer. 2000. Realism and Social Science. London: SAGE Publications.
Shank, G. 2008. Deduction. The Sage Encyclopedia of Qualitative Research Methods. California: SAGE Publications
Shapere, D. 1964. The Structure of Scientific Revolutions. The Philosophical Review, Vol. 73, No. 3. pp. 383-394. Duke University Press
Slavotionek, I. 2013. Semi-structured interview. ENESA. (17th June 2013)Prague.
Sochor, V. 2012. Energy Performance Contracting. Czech Business Opportunity. SEVEn presentation. Prague: Ministry of Industry and Trade. (18th October 2012)
Sochor, V. and Chudomelova, H. 2013. The benefits of using a combination of public and private finance to fund ESCO projects. Czech Business Opportunity. SEVEn presentation. Copenhagen (24th January 2013)
Sochor, V. 2013. Semi-structured interview. SEVEn. (21st June 2013) Prague.
Sorrell, S., Schleich, J., Scott, S., O'Malley, E.,Trace, F., Boede, U., Ostertag, K. and Radgen, P. 2000. Barriers to Energy Efficiency in Public and Private Organizations. Final Report to DG Research Under the Project' Barriers to Energy Efficiency in Public and Private Organizations'. SPRU—Science and Technology Policy Research, University of Sussex, Brighton.
Suchman, L. and Jordan, B. 1992. Validity and the collaborative construction of meaning in face-to-face surveys. In: Tanur, M. Judith (Ed.), Questions about Questions. New York: Russel Sage Foundation.
IPMVP. 2002. International Performance Measurement & Verification Protocol. Concepts and Options for Determining Energy and Water Savings. US Department of Energy. Revised 2002. Vol. 1.
Wang, J. and Chen, X. 2008. Estimation of the Risks of Energy Performance Contract Projects Based on the Unascertained Measure Model. Proceedings of the IEEE International Conference on Automation and Logistics. Qingdao, China.

Wilby, J. 2006. An Essay on Kenneth E. Boulding's General Systems Theory: The Skeleton of Science. Systems Research and Behavioral Science 23, 695-699. Wiley InterScience.
Williams, B. and Hummelbrunner, R. 2009. System Concepts in Action. A Practitioner's Toolkit. California: Stanford University Press.
Worrell, E., Bernstein, L., Roy, J., Price, L. and Harnisch, J. 2009. Industrial energy efficiency and climate change mitigation. Energy Efficiency 2, 109–123

Appendix

Semi-structured interview questions

Introduction:

Please present yourself and your organization:

1. What is the main activity of your company?
2. How many employees does your company have?
3. For how long has your company been using energy performance contracting (EPC)?
4. What share of your business is focused on EPC?
5. How many EPC projects does your organization conduct at the moment?
6. What motivated your company to adopt EPC?

Energy Performance Contracting

1. What policies and regulations support EPC development in Czech Republic? How would you describe their efficiency?
2. What are the financial opportunities for EPC projects? How accessible are they for your company?
3. How would you comment on the efficiency of technology used for EPC projects? Is there potential for upgrading this technology?
4. How are the results of energy savings communicated to your clients? Are there possibilities for making this information more open to public?
5. How would you describe the attitude of your potential clients towards EPC?
6. How do you manage risks related to operational factors (i.e. unexpected fluctuations in temperature, number of hours the equipment is used, maintenance practices, etc)?
7. How would you describe the contracts between you and your clients?
8. Are these contracts flexible enough to adapt to changing market situations? How could they be improved?
9. What do you consider to be the main barriers for larger implementation of EPC for your company?
10. What are your company's expectations and goals related to EPC for the future?
11. Have positive experiences with EPC in the past brought more projects? Under which circumstances?
12. What would be the most crucial points that could be changed in order to enlarge the EPC market in Czech Republic?
13. What are your possibilities to act upon the upper mentioned points (question 12)?