A strategy to setup energy services for business districts with small to medium sized companies: a case study of De Hurk

August 20th 2015 – Eindhoven University of Technology – Chris Driessen

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

Colophon

Name:	Chris Driessen
Title:	A strategy to setup energy services for business districts with small to medium sized companies
Subtitle:	a case study of De Hurk
Date of graduation:	august 20th 2015
University:	Eindhoven University of Technology
Faculty:	Construction Management and Engineering
Graduation Committee:	Prof.dr.ir. B. de Vries (TU/e) dr.ir. Q. Han (TU/e) ir. F. Dekkers (D-IA) ir. A. Verboom (municipality of Eindhoven)
Graduation Company:	Municipality of Eindhoven
Contact:	chris_driessen@hotmail.com

Preface

This master thesis elaborates on the subject of energy services for business districts and forms the final product of the master program Construction Management and Engineering at Eindhoven University of Technology. This research was conducted in cooperation with the Municipality of Eindhoven, the KENWIB foundation and Eindhoven University of Technology.

I want to thank my supervisors Qi Han, Frank Dekkers and Alfredo Verboom for the useful feedback, input and ideas to do this research. Furthermore I want to thank Michaël Liebregts, for providing the necessary information about his company and business district de Hurk. The respondents and interviewed companies I want to thank, for giving me different perspectives on the topic.

Finally, I want to thank my friends and family for the support and needed distraction during my graduation period. I hope you, as reader, will get inspired and enjoy the result of my graduation process.

Chris Driessen

August 2015

Table of Contents

1 Introduction

While Energy Service Companies (ESCos) exist for decades they are new in the Netherlands. Much is already written about them and most literature found on the topic of Energy Service Companies are market analysis analyses. Vine (2005), Hanssen (2010) and Okay (2010) gave an overview of the ESCo market worldwide. Bertoldi et al. (2005;2007;2010;2013) wrote several reports about the European market and on a national level Boonekamp (2009) described the Dutch market. According to these studies the biggest barrier for the ESCo market was the lack of governmental support. The studies of Marino (2011) and Pätäri and Sinkkonen (2013) gave policy recommendations to take away most barriers and according to Bertoldi et al. (2013) the Dutch market shows potential for energy services. According to van der Zanden (2013) business districts in particular show potential.

1.1 Problem definition

The municipality of Eindhoven wants to be energy neutral in 2045. This should be achieved by cooperating with the government, businesses and industry, research institutes and the citizens themselves because these are the important pillars in order to get the city of Eindhoven energy neutral (Ouden & Gal, 2014). To achieve this the municipality of Eindhoven set itself a clear goal:

''*The municipality has set itself the goal of achieving energy-neutrality between 2035 and 2045. By energy-neutrality, the municipality means that energy demand must be limited as far as possible, and the energy needs within the city's boundaries must be sustainable generated. The municipality has set itself the goal of achieving this ambition excluding mobility before 2035 and including mobility before 2045.*'' (municipality of Eindhoven, 2013).

In 2012, the total energy consumption in Eindhoven was 4,55 PJ of electricity and 8,60 PJ of gas. With 55% of the gas consumption and 78% of the total electricity consumption the industrial and institutional sector is responsible for the largest part and in the past years industrial energy consumption keeps increasing. (Energie-Nederland, 2011; municipality of Eindhoven, 2013)

Despite the enormous saving potential within business districts, developments regarding energy efficiency and renewable energy are slow and fragmented. Awareness of the possibilities is growing but development is often constrained by the complex environment of stakeholders and responsibilities, rules, regulations and uncertainties. In the face of rising energy prices and binding regulation, energy efficiency and renewable energy will inevitably become more important. Large companies have financial means to reach the set objectives individually but they represent only a small number on business districts. The majority of businesses, 99%, belongs to the category medium and small sized businesses (<250 employees). This category has less knowledge, time and money available to invest in any energy measures. This makes them lack behind on sustainable energy development and potentially endanger their business profitability and continuity. The high and concentrated energy use of these companies makes them interesting clients for the energy service industry. (van der Zanden, 2013)

1.2 Research question

The goal of this research is to find the most suitable type of ESCo to make business districts with small to medium companies more sustainable. This will result in lower CO_2 emissions and better use of renewable energy sources which will help to realize the "energy neutral in 2035-2045" target from the municipality of Eindhoven and it will give a financial benefit to the participants. The scope of this research will be business districts in the Netherlands and the case study will be of De Hurk.

This results in the following main question:
How can energy management by an Energy Service Company become feasible for business districts with small to medium sized companies?

And sub questions:
Which type of ESCo is suitable for business districts with small to medium sized companies?
How can the municipality convince business owners to participate in ESCo projects?

In order to answer the main question a case study will be conducted on business district De Hurk. This case study answers the following sub questions:

What is the energy saving potential of business district the Hurk?

What do business owners expect from the Energy Service Company?

Why should business owners participate and are they willing to participate in this project?

1.3 Research design

The research starts with a literature study on different topics. First current district ESCo projects are investigated giving an overview of what the possibilities are. This results in topics about ESCo contract forms and the funding options that need to be researched further. With a case study on De Hurk data can be collected about building quality and energy use, giving insight in the energy saving potential. This information will be acquired while interviewing the business owners about the expectations of energy services.

All This information results in different alternatives of how to build an ESCo project. A questionnaire distributed between business owners will find the most important criteria according to the business owners. With the help of the Quality Function Deployment (QFD) method the customer needs are translated to technical characteristics. QFD consists of making quality tables like the House of Quality (HOQ), a matrix used in the process that displays the customers' requirements versus the technical responses to meet them (Delgado-Hernandez, et al., 2007). An overview of the HOQ is given in

Figure 1.

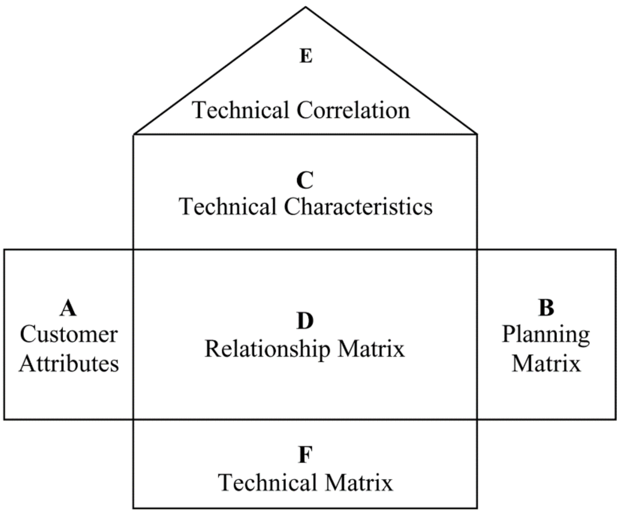


Figure 1: House of Quality

The relation between the customer requirements (A) and the technical characteristics (C) are given in the relationship matrix (D). The correlation between the characteristics is given in E and in the technical matrix (F) the value of the technical characteristics are given. The possible outcomes are rated in the planning matrix (B).

The data that is needed for the QFD are the customer requirements. These requirements can be gathered by the use of qualitative research like interviews, questionnaires and focus groups. These customer requirements are the important criteria which are found with the literature study and interviews with business owners.

When the customer requirements are known they need to be rated. This is done by a questionnaire that is distributed between business owners. One of the members is cooperating with this research and will provide a list with phone numbers and email addresses of the right persons to contact. This club consist of roughly 100 companies, because of this amount the questionnaire will be sent by email first. When the response is too low an appointment can be made for a personal visit.

The questionnaire used consists of three parts: business profile, energy saving potential and business preferences. The business profile gives the economic sector and business size while the energy saving potential gives an estimate of the feasibility of energy services for business district the Hurk. The last part, business preferences, gives pairwise comparisons of the customer requirements of energy services giving a rating that can be used by the HOQ.

Because there are a few large companies on de Hurk differences in outcomes are expected. Some larger companies already have energy services management and may therefore be less interested in this project. Also the energy consumption of companies will differ depending on their core business. Production companies have a higher energy consumption than service based companies. Therefor the dataset will be divided in several parts to see if there are significant differences. An overview of this research approach is given in Figure 2.

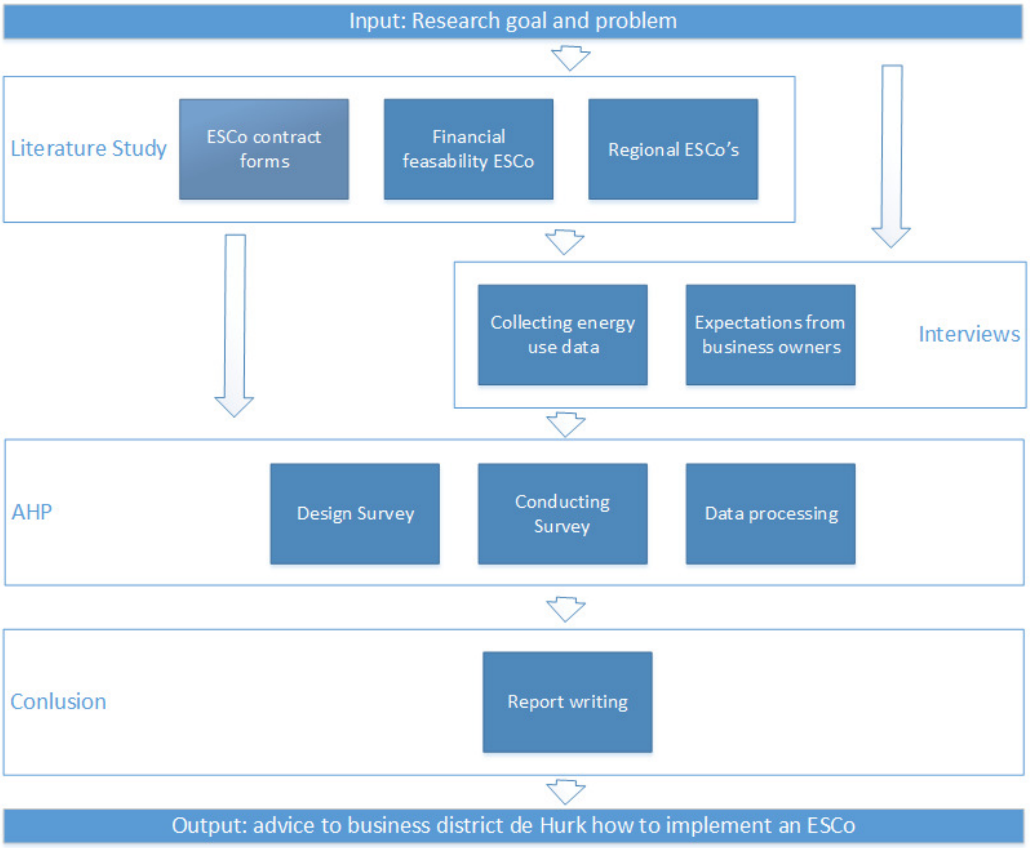


Figure 2: Research approach

1.4 Expected results

The result of this research should give an advice to the municipalities and business districts in the Netherlands how to construct an ESCo suitable for business districts with small to medium sized companies.

This research focusses on the feasibility of the ESCo and will tell which kind of ESCo is suitable for those business districts. Input will be asked from the business owners them self to see what they think is important and together with the literature study an advice will be put together.

Besides a general solution for business districts in the Netherlands this study will give recommendations to the municipality of Eindhoven how to promote this project in de Hurk. This advice should provide benefits for both parties, the municipality will gain a more sustainable business district and for the business owners an ESCo will give them a chance to be environmentally aware and have financial benefits due to a lower energy bill.

1.5 Reading guide

This master thesis gives a strategy how to setup energy services for business districts. This first chapter describes the problem this study will help to solve followed by the results of the literature review in chapter 2,3 and 4. Chapter 5 explains the research method and validates the data. The results are given in chapter 6 followed by the conclusion in chapter 7. Chapter 8 gives recommendations to the businesses and the municipality.

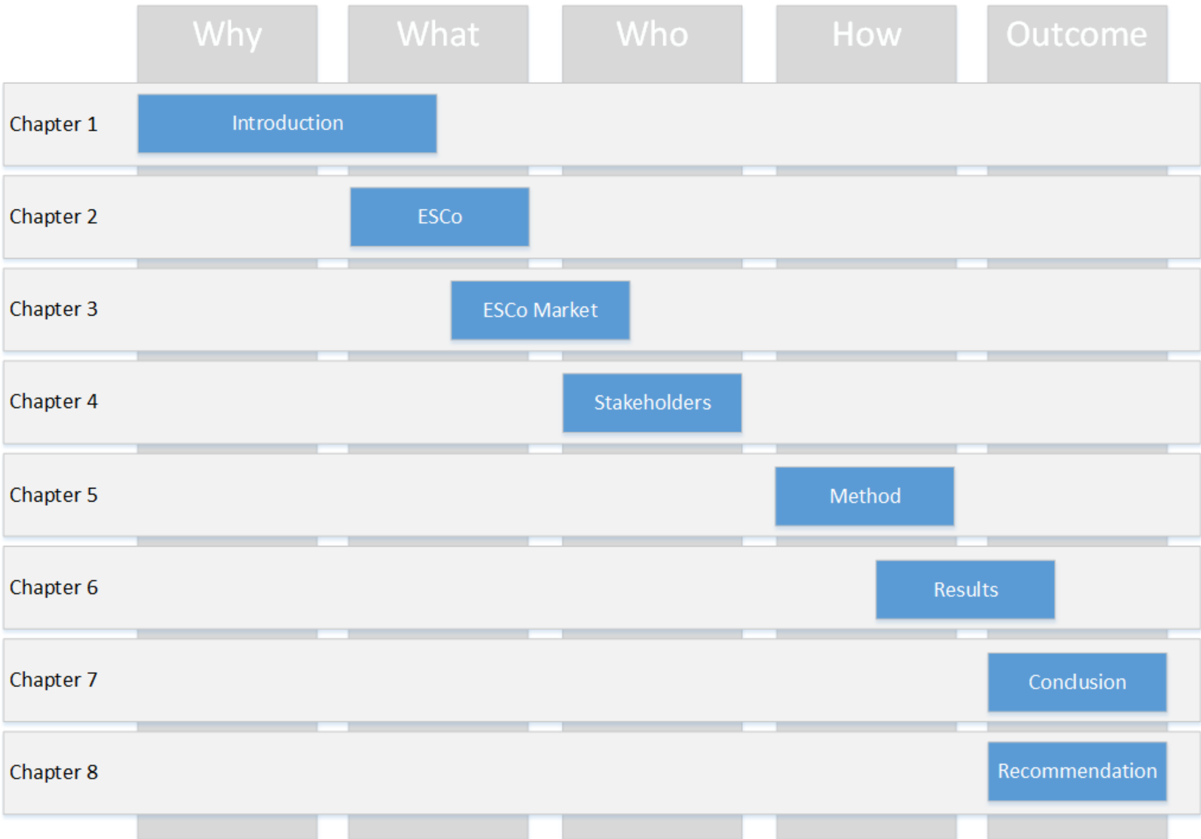


Figure 3: Reading guide

2 Energy Service Companies

ESCos (Energy Service Companies) are becoming more popular worldwide as a mean of saving energy in existing buildings. However, it is not always clear what the terms actually mean. Pätäri and Sinkkonen (2013) and Bertoldi et al. (2007) mention the definitional confusion, the variety and complexity of the offerings and the diversity of suppliers in the ESCo market. In this thesis the following definition is used (Bertoldi, et al., 2007):

> *"Energy Service Company: a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in doing so. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria."*

According to Bertoldi et al. (2014) this definition describes the three main characteristics of an ESCo:

- ESCos guarantee energy savings and/or provision of the same level of energy service at lower cost. This is referred to as a performance guarantee, which can take several forms. It can revolve around the actual flow of energy savings from a project, can stipulate that the energy savings will be sufficient to repay monthly debt service costs, or that the same level of energy service is provided for less money.
- The remuneration of ESCos is directly tied to the energy savings achieved;
- ESCos can finance, or assist in arranging financing for the operation of an energy system by providing a savings guarantee.

Next to ESCos, another type of energy service company can be distinguished: Energy Service Provider Companies (ESPCs). They also provide energy services but achieving energy demand reductions is not their main goal. Other goals, like operation & maintenance, reliability and safety of installations, are more important (Boonekamp & Vethman, 2009). ESPCs operate on a "design and build" or "turnkey" principle, by which compensation is mainly based on a predefined fee (Suntjens, 2014).

Unlike ESPCs, ESCos share or take over the customer's technical and/or financial risk of the project. The ESCo can cover the technical risk by guaranteeing the energy savings, which can lower the cost of financing. Under such an arrangement, the ESCo guarantees a certain level of energy savings and shields the client from any performance risk. The ESCo and the client can also split the technical risk in accordance with a prearranged percentage by introducing a shared savings scheme in the contract. The remuneration of the ESCo can also be directly tied to the energy savings achieved. Depending on the resources of the ESCo and on the market demand, ESCos may finance projects themselves or assist in the arrangement of project financing by means of providing performance guarantees. (Marino, et al., 2011)

ESCos and ESPCs are typically profit-oriented private (sometimes public) organizations. However, in recent years non-profit arrangements have come to existence. For example, an ESCo may be set up, run and owned by a community, whereas this company replaces the traditional energy supplier. A so called “Community ESCo” would not aim for profits, but would reinvest its gains in the local energy system (or in other parts of the local economy). (Bertoldi, et al., 2014)

For the client, The ESCo concept shifts the focus away from buying units of final energy, like fuel oil, gas or electricity, towards the desired benefits and services derived from the use of the energy, e.g. the lowest cost of keeping a room warm, air-conditioned or lit. (Bleyl-Androschin & Schinnerl, 2010)

2.1 Energy services

The energy services an ESCo delivers is a term that describes a variety of activities targeted at capturing revenue from organizations’ energy expenditures. This includes the provision of efficiency retrofits, distributed generation, energy management, energy procurement and energy consultancy. The services can be categorized into four basic pools (Bertoldi & Rezessy, 2005; Wagner, 2010; de Haan & Benner, 2005):

Analytical services:

- Consulting: energy and/or carbon audits often accompanied by a series of strategy recommendations concerning the design and implementation of the energy savings project
- Certification/compliance: the provision of certain certificates or an assessment of an organization’s energy or carbon footprint

Demand-focused services:

- Efficiency retrofit: implementation of efficiency upgrades
- Energy conservation: implementation of energy saving technologies

Supply-focused services:

- Energy procurement: energy infrastructure outsourcing
- Energy supply management: power generation and energy supply, particularly from onsite assets

Managerial services:

- Risk management
- Monitoring of the achieved energy savings
- Maintenance and control of the installed equipment
- Measurement and verification (M&V) of the savings over the financing term

These energy services are achieved by conducting energy efficiency measures (EEM). Most mentioned EEMs in literature are given in Table 1.

Table 1: Energy Efficiency Measures

Energy efficiency measures	Article
Measurement, verification and adjusting	(Baechler & Webster, 2011) (Den Dekker & van de Velde, 2013) (Bertoldi, et al., 2014) (Wagner, 2010)
Educate staff	(Baechler & Webster, 2011) (Bertoldi, et al., 2014)
collective energy purchasing	(Baechler & Webster, 2011) (Den Dekker & van de Velde, 2013) (Bertoldi, et al., 2014) (Provincie Gelderland, 2009)
upgrade lighting	(Korbee, 2013) (Agentschap NL, 2010)
upgrade isolation	(Korbee, 2013) (Wagner, 2010)
upgrade climate installations	(Korbee, 2013) (Bertoldi, et al., 2014)
Power generation (PV cells, Wind turbine)	(Bertoldi, et al., 2014) (Provincie Gelderland, 2009) (Wagner, 2010)

2.3 Energy contracting

Energy Contracting is a service that helps to make buildings more efficient. It facilitates a significant improvement in a building's energy efficiency, benefiting both the owner and the environment. The concept of energy contracting is a method and financial mechanism to support building refurbishment (european association of energy service companies, 2013). Energy contracts form the legal framework between an ESCo and the company. These relationships typically span multiple years and may include both energy management and other capital upgrades in the facility (Baechler & Webster, 2011).

In this chapter three contracting forms are described, Energy Supply Contracting, Energy Performance Contracting and Integrated Energy Contracting. Figure 4 shows the cohesion between these three.

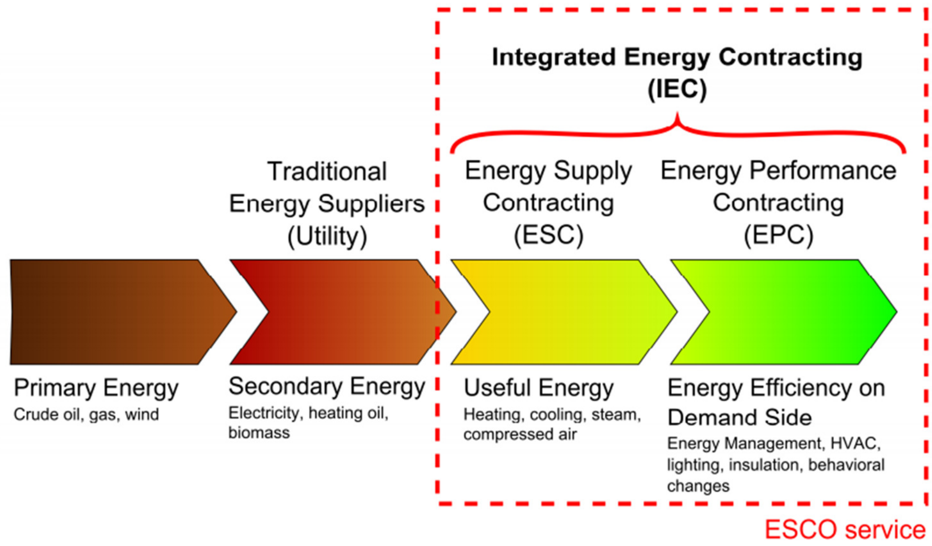


Figure 4: Energy Contracting models (Bleyl-Androschin, 2010)

2.3.1 Energy Supply Contracting (ESC)

Energy Supply Contracting is the efficient supply of energy. The contracting partner provides products such as heat, cooling, compressed air or electricity. The subject of the contract is not the energy value, like for example liters of oil, but the utility value – billed in Euros per volume items of heat, steam or compressed air. Financing, engineering design, planning, constructing, operation and maintenance of energy production plants as well as management of energy distribution are often all included in the complete service package. The ESC is a service primarily used in the commercial and industrial sectors however residential dwellings may also be included for example in a district heating scheme energy supply contract. The business model encompasses the entire process from the purchasing of fuel to the delivery and invoicing of energy. Combined Heat and Power (CHP) plants and renewable energy solutions frequently are also included in energy supply contracts. The benefits of ESC are a significant boost in efficiency, clear and optimized operational costs, more supply assurance and the usage of the most recent safety standards. The customer no longer needs to worry about their energy supply concerns and, in addition there is an increase in environmental performance. The focus of the ESC service model is on the efficiency of the energy supply with the aim to bring the efficiency to its maximum while at the same time providing security of supply (european association of energy service companies, 2013). The ESCo is not interested in increasing the energy efficiency at the demand side. But there is a constant incentive for optimization at the supply side and the installations that deliver the energy (Bleyl-Androschin & Schinnerl, 2010).

2.3.2 Energy Performance Contracting (EPC)

According to Bertoldi et al. (2014) energy performance contracting (EPC) can be defined as:

> *"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".*

This means EPC is a performance based business model. Within this business model, the ESCo will be remunerated based on the energy savings achieved through the EPC project. Characteristic of EPC is that the ESCo will guarantee a minimum savings level that they are then responsible to achieve. To determine the real savings, the energy baseline (energy usage without energy efficiency measures) is determined before the project start. The energy usage after the project implementation is then compared to the baseline to determine the amount of energy saved (van der Zanden, 2013). EPC allows facility owners and managers to upgrade ageing and inefficient assets without making capital investments. The ESCo takes the technical risk and guarantees the savings and is usually paid a management fee out of these savings (if there are no savings, there is no payment). If there is a savings shortfall it is usually obligated to repay mist savings over the life of the contract (Program Energy Efficiency Best Practice, 2000).

The intention is to keep the total energy consumption to a minimum by demand side energy efficiency methods. To ensure promised energy savings have been achieved over the contract duration, a procedure termed “measurement and verification” is used. Using an internationally recognized protocol such as the International Performance Measurement and Verification Protocol (IPMVP), customers can be assured that guaranteed savings have actually been delivered despite changes to the climate, the building and its use over time. This procedure is written in the EPC contract, regulating the partnership between the ESCo and the customer. The contract regulates general issues such as property rights, usage of the systems and partnership duration. Furthermore it stipulates the amount and structure of the investment, its implementation, how it is controlled as well as the maintenance of the energy saving measures which have been taken. It particularly determines the extent and distribution of the annual savings. The key benefits include risk transfer, the ability to modernize a building’s energy infrastructure without necessarily having the funds and accessing external expertise (Korbee, 2013). The key focus is on saving energy at the point of use first, before optimizing the supply of that energy (european association of energy service companies, 2013).

EPC is suited for large-scale projects where in most cases a number of buildings are involved. Instead of looking at buildings one by one, they are often grouped into pools. Comprehensive energy efficiency measures would not be economically profitable for many buildings if they were looked at individually. By grouping buildings into pools the transaction costs for the individual buildings are lowered and buildings which have a greater potential for energy saving can compensate for those with less (van der Zanden, 2013). If energy efficiency measures are looked at one by one it can often result in only the most profitable measures being carried out. If instead the measures are bundled together the ones with shorter payback period can help finance the ones with longer pay-back times, creating a more comprehensive set of measures. How many of the longer-termed investments are included in an EPC project varies from project to project. It can depend on how much money can be invested into the project regarding budgetary restrictions, payback time or risk acceptance (Bertoldi, et al., 2007). After the end of the contract term, the facility owner benefits from the full energy cost savings, but all operation and maintenance expenses are his to bear too. (Würtenberger, et al., 2012).

2.3.3 Integrated Energy Contracting (IEC)

The IEC model combines both the EPC and the ESC into a new model and provides two services.

- Reduction of energy demand through the implementation of energy efficiency measures in the field of building technology (HVAC, lighting), building shell and user motivation;
- Efficient supply of the remaining useful energy demand, preferable from renewable energy sources.

The IEC business model builds on ESC, which is known and applied in many energy end-use sectors such as public buildings, residential, commerce and industry. As compared to standard ESC, the range of services and thus the saving potential to be utilized is extended to the overall building or commercial enterprise. The model is intended to be used for all energy carriers and consumption media such as heat, electricity, water or compressed air. The results to be achieved by the energy efficiency service encompass modernization of the installations, lower consumption and maintenance costs and improvement of the energy indicators. In addition, non-energy benefits such as emission reductions or increase in comfort and image shall be achieved. Most energy efficiency projects differ in their contents and general conditions. Therefore, it proved to be necessary and sensible to adapt the scope of services specifically to the individual project. This also implies the building owner can define, depending on his own resources, what components of the energy service will be outsourced and which components he carries out himself (Bleyl-Androschin & Schinnerl, 2010). At the same time (methodological) problems of EPC, like creating and adapting baselines, high measurement and verification efforts or risk surcharges on the saving guarantee, are avoided or at least reduced (van der Zanden, 2013).

2.3.4 Most suitable energy contract

The EPC model is suitable for large-scale projects concerning a ‘’pool’’ of buildings. Though, this does not always result in lower transaction costs because of the remuneration method. A performance contract is set up which requires an energy cost base line. With regard to companies in a business district, these exact base lines are hard to assess since the energy use is very unstable due to changes in utilization of the enterprise. Therefore, this model is more suitable for public utility buildings that have a more constant base line.

These problems are not encountered with the ESC model, because no baseline is needed to measure savings. Therefore, ESC is more common in end-use sectors such as industry. However, demand side reduction measures are minimal and the ESCo profits come from selling energy units. A common issue that arises is the conflicting incentives for supply oriented companies (such as ESC or 'regular' energy companies) when they start looking at the demand side. If a company, that normally gets paid for selling energy units now promotes lowering the need for these energy units, the credibility might not be that high from the client point of view (van der Zanden, 2013).

The IEC model builds on the ESC model but implements extensive demand side reduction measures as well. The ESCo takes over the entire energy management, including the purchase from conventional energy sources. This results in a situation where the ESCo needs to install the most efficient measures to make profits. This takes away the credibility issue as described above (Wargert, 2011). The IEC model can lower transaction costs better considering the verification method of quality assurances instead of base line verification. Now, the remuneration of the ESCo consists of the measured real energy use. Clients are more involved because of this integral approach and synergy effects are more likely to arise. These can increase the effectiveness and the feasibility of the project. For these reasons, the IEC model appears to be the most promising for business districts. Therefore, it is adopted as the model of choice in this research. The further use of the term ESCo in this report refers to this specific business model.

2.4 Financing models

2.4.1 Customer financing

Customer financing implies that the customer (the energy user) uses internal funds to finance the upfront energy saving investments and the ESCo guarantees a certain savings level. The customer pays the ESCo a fixed amount of money in return for this guarantee; the exact amount depends on how much energy savings the ESCo is guaranteeing. Subsequently, all benefits from the achieved energy savings credit the customer. The investments of the customer are on-balance, which is one of the reasons for customers to choose one of the other contract types (Wagner, 2010).

2.4.2 ESCo financing

When the ESCo uses its funds to finance the upfront investment costs for the customer, the literature refers to ESCo financing. In this construction, both the customer and the ESCo profit from the energy savings because both parties depend on the achieved energy savings in order to be better off than in the original situation (de Haan & Benner, 2005).

2.4.3 Third Party Financing (TPF)

Third Party Financing is a contractual arrangement involving a third-party that provides capital for the upfront energy savings investments costs (). There are two conceptually different TPF structures (Figure 5): Shared Savings (SS) and Guaranteed Savings (GS). This distinction reflects the different distributions of investments, savings and risks between the client and the ESCo (Langlois & Hansen, 2012).

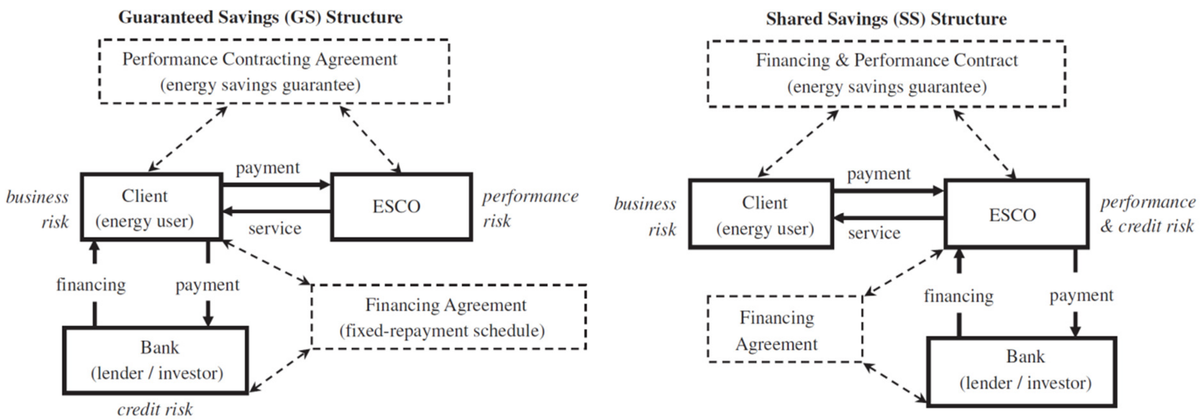


Figure 5: Shared Savings and Guaranteed Savings structure (Okay, et al., 2008)

The SS structure is comparable to the ESCo financing structure but in this case the ESCo borrows the financial resources necessary for project implementation. The ESCo and the customer share the savings resulting from the project in proportions as specified in the shared-savings contract. The ESCo makes debt service payments from its share of the savings: if the ESCos share of the actual savings is less than the debt-service payments, the ESCo covers the difference, and if there is a surplus, it keeps the profits. The ESCos' remuneration thus fully depends on the level of energy savings. Because the customer has no financial obligations during the term of the contract, its share of the savings is all benefit (Hopper, et al., 2005). The SS concept is a good introductory model in developing markets because customers assume no financial risk, which they like or even demand. The downturn of this structure is that it limits long-term market growth and competition between ESCos and between financing institutions because small and/or new ESCos with no previous experience in borrowing and with few resources of their own are unlikely to enter the market if such agreements dominate (Wagner, 2010; Bertoldi, et al., 2007).

The GS structure is comparable to customer financing with the difference that the customer does not use its own capital but borrows money from a third-party. In this structure, the arrangement between the customer and the financial institution is being backed by an energy savings guarantee, issued by the ESCo, with the purpose to demonstrate the financial institute that the project for which the customer borrows money will generate a positive cash flow. (Bertoldi & Rezessy, 2005; Jensen, et al., 2013; Wagner, 2010) The ESCos remuneration is a fixed amount, meaning it does not depend on the actually achieved energy savings but on the level of guaranteed savings. The customer benefits from the energy savings, thus in this structure the customer assumes financing risk. Usually, the ESCo is paid upfront for the turnkey costs, with service payments limited to operation and maintenance (O&M) and measurement and verification (M&V) costs. In a GS contract, the ESCo typically guarantees a minimum level of (financial or energy) savings to the customer, who is responsible for making debt-service payments to a third-party financial institution. If there is a shortfall in savings, the ESCo reimburses the customer. If savings exceed the ESCos guarantee, the excess is usually split between the ESCo and the customer. The difference between the GS and SS structure is that in the former model, the amount of final energy costs is fixed because the ESCo is guaranteeing the savings. The level of ESCo remuneration is a pre-defined fixed amount instead of a pre- defined fixed ratio, and does therefore not depend on the actual achieved savings. Strictly speaking, the SS and GS structure by definition imply TPF. However, in practice, when someone talks about GS, they often mean that the customer takes care of the investment, with or without the help of a third-party. The same holds for SS (de Boer, 2011).

Another structure of TPF is the 'first out' approach whereby the ESCo is paid 100% of the energy savings until the project costs – including the ESCo profit – are fully paid. The exact duration of the contract will actually depend on the level of savings achieved: the greater the savings, the shorter the contract (Bertoldi & Rezessy, 2005).

3 Overview of the ESCo Market

3.1 International ESCo market

Since the industrial revolution at the end of the 19th century, all the developing countries became energy dependent. The availability of energy and the costs of energy were not an issue. This came to an end in the period between 1970 and 1979. The oil crisis caused a heavy increase in oil prices and thus the prices of energy. Together with concerns about climate change and growing energy demand private companies in the United States were stimulated to reduce their energy consumption (Fang, et al., 2012). This was in the late of the 1970s the basis for the introduction of energy service companies (ESCos) (Coppens, 2013; van Oeveren, 2014).

Besides the introduction of ESCos in the United States, European countries and companies also discovered that phenomenon in the 1990s. In the case of Europe, the development of ESCos is strongly driven by governmental legislation. The Government of the United Kingdom, France and Italy introduced a saving obligation. In addition, France introduced in accordance with Germany interesting financing requirements along with investment funds. Especially the German and Belgian national government served as 'launching customer' (van Barneveld, 2011).

Germany has Europe's largest and most mature ESCo market which can be attributed to governmental vision and support. The German policy package includes both technical and financial support, nongovernmental programs and favorable conditions such as energy taxes. The implementation of a large number of municipal projects had a strong demonstration effect. According to the Berliner EnergieAgentur GmbH (Lamers, et al., 2008), the key reasons for ESCo successes in Germany are the large (public) building stock with the necessity to renovate, a lack of capital for energy refurbishments in the public sector, successful pilot projects, quality labels for ESCos and their services, and local support through energy agencies. The most influential market players are energy suppliers with a share of 66% and building equipment & control manufacturers with a market share of 26%. Most projects involve public and private commercial buildings, only a small part of the projects involve residential buildings and industry. The German experience with the ESCo market has led to standardized procedures and contract models, providing more confidence in the ESCo industry (Marino, et al., 2010).

Even though Belgium does not accommodate one of the largest ESCo markets in Europe (in absolute amounts), it is an interesting country to look at. In 2005, the Belgian government set up a state-owned ESCo called FedESCo. This company is bringing about retrofit projects in federal public buildings in cooperation with the 'Federale Regie der Gebouwen'; an organization that manages all federal state-owned buildings, comparable to the Dutch Rijksgebouwendienst. The organization helps arranging the (pre-) financing of ESCo projects by guaranteeing the future energy savings cash flow and has set up a debt fund for this purpose. Due to this measure, most projects are third-party financed (Marino, et al., 2010). Because the ESCo industry and the involved financial institutions had the opportunity to build up a track record through the FedESCo projects, financial institutions are now more willing to participate in ESCo projects focused on the private sector. Next to demand-side energy saving projects, FedESCo also stimulates supply-side projects. Public financial incentives like regional subsidies and federal tax reductions for energy efficiency projects are also used to stimulate the ESCo market. The federal ESCo mostly uses EPC contracts. Next to FedESCo, some technical service companies and building equipment & control manufacturers are active on the market and offer GS EPC contracts. In the public sector, mainly HVAC, control and cogeneration projects are implemented. The Belgian government stimulates the ESCo market not only by setting up a federal ESCo with a debt fund, it also tries to match demand and supply by creating a competence center for energy efficiency services. The knowledge-center's main task is to take away the mistrust from the clients, inform the market about EPC contracts and promote a regulatory ESCo framework (Marino, et al., 2010).

3.2 Dutch ESCo Market

Compared to other (European) nations, The Netherlands has an underdeveloped energy services market (Marino, et al., 2010; Bertoldi, et al., 2007; Bleyl-Androschin & Schinnerl, 2010; Vine, 2005; Okay & Akman, 2010). Although there are over a thousand ES companies presently operating in The Netherlands, only 50 of them consider energy efficiency as their core business (typifying them as an ES supplier), of which only 20 state to assume any kind of financial risk in delivering their services (typifying them as an ESCo) (Boonekamp & Vethman, 2009; Bertoldi, et al., 2014). Only two of these twenty companies are subsidiaries of energy companies, the larger part is a subsidiary of some large construction company and the rest is independently owned. Most of these companies deliver services of the thermal energy storage (TES) type, which has been on the rise in recent years (van Barneveld, 2011).

Commercial buildings and (central) government buildings are the largest customer groups of ESCos, however some specialized ES suppliers do exist, focusing on public swimming pools for example. When industrial customers are targeted, their core production processes are usually left untouched. Instead, focus lies on supporting facilities as compressed air, offices or other buildings. In general, Dutch ESCos tend to target energy consumers with bills from €200.000 up to €500.000. The main reason for this high threshold is the high transaction cost involved with EESC projects (Schneider, et al., 2011).

According to Bertoldi et al. (2014) The Dutch market is an example of how the ESCO concept can gain ground with favorable market conditions and few barriers from the regulatory framework (Figure 6). On the other hand, the Dutch market also shows the signs of a quick draw-back or slowing down, as the market has not yet been able to move forward its initial ignition. Technical aspects are provided and trusted, however the ESCOs experiences with complete ESCO packages is limited, and the financial schemes need to be more developed to earn the clients' trust. (Bertoldi, et al., 2014)

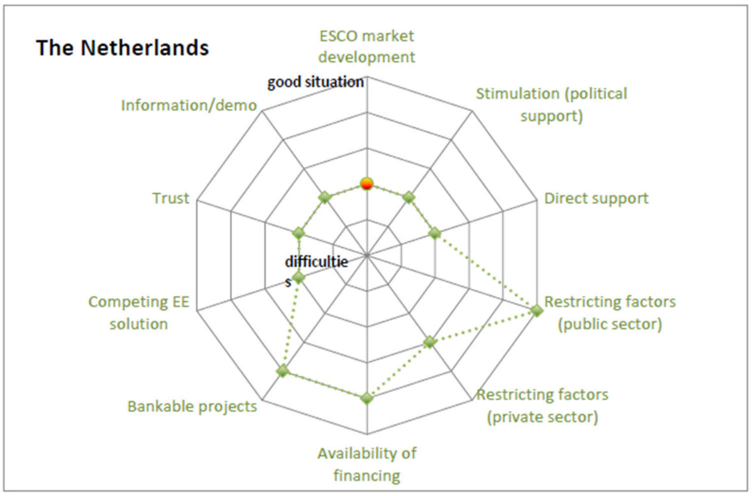


Figure 6: key features Dutch market (Bertoldi, et al., 2014)

3.3 Legislation

The European Union has some specific climate and energy objectives. A relatively unknown but very important target of the European Community is the Effort Sharing Decision which establishes annual binding greenhouse gasses (GHG) emission reduction targets for Member States for the period 2013-2020. The EU-wide target is to reduce the 2005 GHG emission level with 10% in 2020. For the Netherlands, this means a 16% reduction level. This target concerns the emissions from the sectors not included in the EU Emissions Trading System (ETS), such as buildings, agriculture, waste and transport (European Commission, 2011). In 2006, a European Commission Directive (ECD) was accepted which states that Member States must achieve an energy savings level of 9% by 2016 (). The purpose of the Directive is to enhance cost-effective energy efficiency improvements in the Member States and it provides the necessary indicative targets as well as mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections that hinder the implementation of these improvements. The ECD applies to providers of energy efficiency measures, energy distributors, distribution system operators and retail energy sales companies and all energy users except those involved in the EU Emission Trading Scheme.

In the EU Climate Action and Energy Package of 2008, the Member States commit themselves to (European Commission, 2010):

- Lower greenhouse gas (GHG) emissions by 20% in 2020 compared to 1990
- achieve a level of 20% renewable energy in 2020
- increase energy efficiency by 20% in 2020 with respect to 1990

Because buildings are responsible for 40% of the energy consumption and 36% of the European CO2 emissions, energy performance of buildings is the key to achieving the above listed objectives. In 2002, the European Parliament adopted Directive 2002/91/EC on the Energy Performance of Buildings (EPBD), inspired by the Kyoto protocol, and in May 2010 a recast of the EPBD was adopted (2010/31/EU). This directive is the main legislative instrument at EU level to achieve energy performance in buildings. Under this directive, the Member States must apply minimum requirements regarding the energy performance of new and existing buildings and ensure the certification of their energy performance

(European Commision, 2010). When existing buildings undergo 'major renovation', their energy performance should be upgraded in order to meet the minimum energy performance requirements. Member States shall furthermore develop policies to stimulate the transformation of existing buildings into nearly zero energy buildings. From 2019 on, Member States shall ensure that new buildings occupied and owned by public administrations are nearly zero-energy buildings. By 2021, all new buildings, including those privately owned, will have to be 'nearly zero energy' buildings (de Boer, 2011).

To achieve these targets the government has several instruments, the ''stimulering duurzame energieproductie'' (SDE+) subsidy stimulates the generation of renewable energy for companies. The price for generated renewable energy is still higher than the price of energy delivered by the energy suppliers. The SDE+ subsidy gives a remuneration to even out this difference. This difference is determined by the correction value and base value. The correction value is the average price for conventional energy given a certain year. The base value represents the costs per unit of generated renewable energy (RVO, 2015) . Another instrument is the Meer Jaren Afspraak (MJA), introduced in 1992 this voluntary agreement between the government and among others several branch organizations and individual organizations in the commercial and non-profit building sector also has the goal to reach energy efficiency improvements for final users (Vreeken, 2012). Companies that join a MJA have to draw up an Energy Efficiency Plan in which they state what kind of energy saving measures they are going to take. In general, only companies that are not involved in the EU ETS join MJAs; ETS companies have their own agreements with the Dutch government: Meer jaren afspraak Energie-efficiëntie ETS-ondernemingen (MEE). Because the built environment is not part of the energy intensive industry, companies in this sector are mostly not involved in ETS and can thus join MJAs. In the past, among others hospitals, universities, supermarkets and banks have saved energy by joining MJAs (RVO, 2014). The last instrument is tax benefit. Companies who invest in energy saving measures can apply for Energie-investeringsaftrek (EIA). In 2015, the total budget for the EIA is € 106 million. On average 10% of the invested amount can be recovered with this policy instrument (RVO, 2015). Two frequently heard criticisms are that companies can only apply for amounts that are too small to have a stimulating effect, and that the policy is changing so often that it does not create any certainty (de Boer, 2011).

3.4 Barriers

Several studies looked into the barriers of building an international ESCo market. Pätäri & Sinkkonen (2013) made an overview of articles that studied the main barriers limiting growth in the ESCo market (Figure 7).

The main barriers limiting growth in the ESCO market.

	Author(s)
External barriers	
Non-compatible legal frameworks, public procurement and accounting rules	Marino et al. (2010); Vine (2005); Westling (2003)
Lack of incentives due to low and subsidised energy prices	Price and McKane (2008); Ürge-Vorsatz et al. (2007); Vine (2005); Westling (2003)
Low governmental support for EPC	Bertoldi and Rezessy (2005); Taylor et al. (2008); Vine (2005)
Lack of appropriate forms of finance due to conservative lending practices and limited experience in and understanding of EE project financing	Bertoldi and Rezessy (2005); Hansen (2011); Marino et al. (2010); Taylor et al. (2008); Ürge-Vorsatz et al. (2007)
Low awareness and a lack of information about the ESCO concept among customers and financial institutions	Bertoldi and Rezessy (2005); Marino et al. (2010); Soroye and Nilsson (2010); Vine (2005); Westling (2003)
Low priority given to EE improvements since energy accounts for a small fraction of the overall costs, energy savings are not seen, or EE and financing opportunities are understood only partially	Bertoldi and Rezessy (2005); Ürge-Vorsatz et al. (2007); Vine (2005); Westling (2003)
EE projects compete for scarce capital with other investments, e.g., related to core processes. Projects are not always large enough to attract the interest of financial institutions	Vine (2005)
Clients' reluctance to accept risk, new technologies and service concepts. Clients may be concerned that EE interventions will compromise production processes thus jeopardising the core business, or they may be reluctant to outsource energy management, especially if there is in-house technical expertise	Bertoldi and Rezessy (2005); Marino et al. (2010)
A lack of confidence in ESCOs due to, e.g., a short track record, poor performance, missing ESCO and EPC standardisation and the absence of widely disseminated best practices	Hansen (2011); Marino et al. (2010)
Internal barriers	
Too heavy capital needs among ESCOs for project execution due to long project cycles	Taylor et al. (2008)
A lack of technical skills to control technical risks and to carry through a project with concrete results, a lack of business skills to market and sell projects, and of financial-management skills especially if the ESCO provides financing	Okay and Akman (2010); Taylor et al. (2008)
A lack of accepted and standardised measurement and verification procedures for savings, and uncertainty and volatility related to energy-saving estimates, measurement and verification	Kissock and Eger (2008); Marino et al. (2010); Mills et al. (2006); Vine (2005)
Decreasing proportion of highly cost-effective projects as fewer straightforward projects remain, especially in the public sector	Goldman et al. (2005); Ürge-Vorsatz et al. (2007)

Figure 7: Barriers development ESCo market (Pätäri & Sinkkonen, 2013))

According to Schneider et al. (2011) these barriers also apply to the Dutch market. Their findings largely overlap with the international findings and add two problems for the Dutch ESCo market. The first problem is the low priority given by potential purchasers of energy to energy savings. Various opportunities for energy savings are not used because of lack of awareness or priority. The second problem is that energy savings projects that are conducted do not use an ESCo. This has several reasons (Schneider, et al., 2011):

• The company does not need an ESCo. The knowledge and funding is available within the company and can invest in energy efficiency measures by itself.

• Unfamiliarity with ESCo services. The service is still too new and people have no knowledge of yet.

• Lack of confidence in ESCo services. There appears to be much confusion in the market about what the service is. Examples of uncertainty include:

-The ESCo service is seen as a vendor of hardware and not as a service supplier. Companies see the investment in hardware and the cost of maintenance as two separate things. They think in initial costs instead of total cost of ownership (TCO).

Thinking in energy services with the hardware and maintenance in one contract and in which a performance is guaranteed, requires a cultural change.

- Secondly, it happens that the client wants to go further than can be delivered. They expect to be care-free and to deal with the service provider on the basis of units for comfort (temperature, humidity, etc.). This is usually not possible yet.

• There is interest in ESCo services, but there are organizational barriers:
  - There is not enough knowledge and time to start an ESCo project.
  - There are 'split incentives' in case of multiple stakeholders in a building.
  - There already is facility manager who sees it as a threat.

Finally, given the large investments already carried out in the field of energy efficiency using alternative solutions, the low-hanging fruits have been implemented through own projects, using grants or soft loans, etc. This leaves the ESCOs with economically less attractive projects (Bertoldi, et al., 2014). All these barriers are compared in Figure 8.

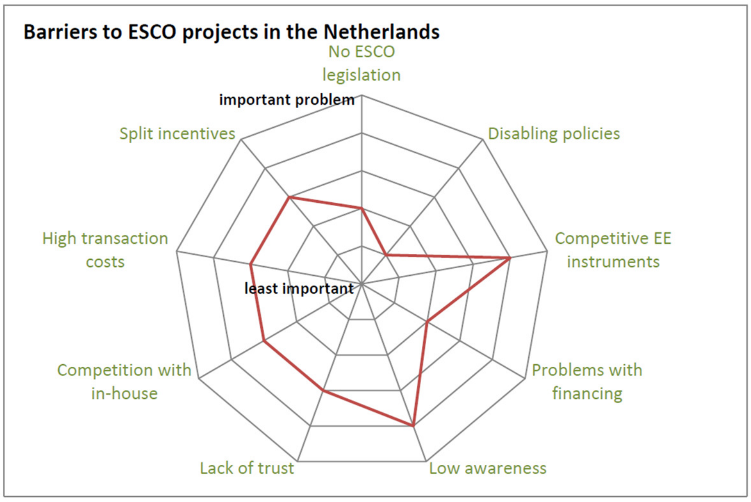


Figure 8: Barriers Dutch ESCo market (Bertoldi, et al., 2014)

4 Stakeholders

For energy service projects to succeed on business districts, the integral approach is important. There are many stakeholders that are important to consider when implementing energy services in business districts. For the implementation of collective energy management on a business district it's important to form a project organization that can manage the project for a longer period (Glumac, et al., 2014).

Van der Zanden (2013) made a power interest grid as part of his stakeholder analysis (Figure 9). As you can see the most important stakeholder is the ESCo, this is the company that has to take the risk and the initiative. Medium sized industry is more interested than large industry because they have not the means to invest in energy efficiency measures themselves. Park management has high interest in collective energy management projects in business districts because the quality of the area is increased when energy is managed in a better way. Although park management is suitable for arranging collective operational services, energy management demands more specialism. Therefore, park management can act as a first mediator between the potential ESCo clients on the district and the ESCo. This way, awareness of the possibilities for outsourcing energy services can be increased (PeGO, 2009).

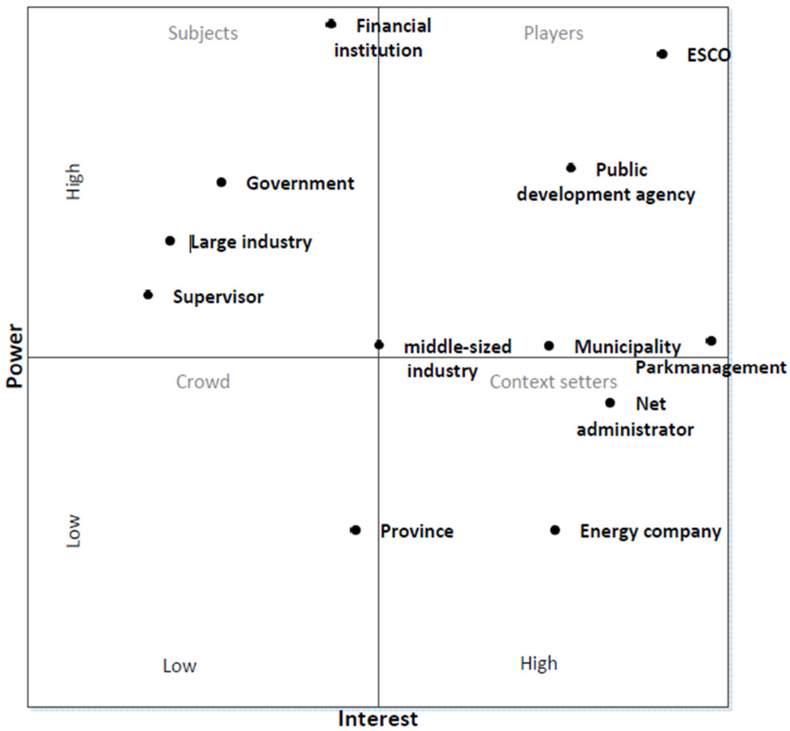


Figure 9: Power Interest grid (van der Zanden, 2013)

4.1 ESCo

As stated before, the key player in the context of implementing energy services in business districts is the ESCo. In the end, this is the company that has to take the risk and the initiative. The number of ESCos in the Netherlands is estimated at about 50. They are almost all private companies, varying from small to rather large companies and being independent companies or subsidiaries of (large) multinational companies. Some of these multinationals are energy companies, but most of them are companies involved in construction or engineering (Boonekamp & Vethman, 2009).

The independent ESCos can focus on maximum energy efficiency while the subsidiaries of multinational companies are bound to the products of the holding company like installations or the energy supply which can result in lower energy efficiency. Financial institutions are more willing to work with the subsidiaries of multinational companies because of their track record and size. Independent ESCos are mostly small and struggle to finance complex projects.

The last option is to use a public development agency, they will not only raise awareness of energy issues with the ESCo concept but also take the financial risk. They can release revolving funds and accept a lower return on investment, a downside is that these agencies have less knowledge about ESCos (van der Zanden, 2013).

4.2 Municipality

The municipality of Eindhoven has set itself the goal to be energy neutral in 2045. This goal should be achieved by cooperating with the government, businesses and industry, research institutes and the citizens themselves. These are the important pillars in order to get the city of Eindhoven energy neutral in 2045 (Ouden & Gal, 2014).

In 2012, the total energy consumption in Eindhoven was 4,55 PJ of electricity and 8,10 PJ of gas per year (household, industrial and institutional sector). With 55% of the gas consumption and 78% of total electricity consumption the industrial and institutional sector is responsible for the largest part of energy consumption (municipality of Eindhoven, 2013). Supporting industrial areas to become energy neutral is one of the tasks of the municipality.

4.3 Business districts

According to Ministerie van infrastructuur en milieu (2011) business districts can be described *as ''an area larger than 1 hectare, designated for trade, diligence, industry and business services. Not including: seaport areas, economic zones, office areas, areas used for the extraction of raw materials, area for agricultural purposes, areas for oil and gas extraction and landfill areas''.* The majority of these businesses, 99%, belongs to the category medium and small sized businesses (<250 employees). This category has less knowledge, time and money available to invest in any energy measures. This makes them lack behind on sustainable energy development and potentially endanger their business profitability and continuity. The high and concentrated energy use of these companies makes them interesting clients for the energy service industry (van der Zanden, 2013).

To make ESCo projects financial feasible for small and medium sized businesses project bundling is necessary to achieve sufficient economies of scale, a strategy is required that allows for the aggregation of individual projects, technologies, service offers, and investments in to a larger and more comprehensive lot, which could be interesting for ESCos financial institutions (Marino, et al., 2011).

Due to economies of scale project bundling will result in reduced installation, fuel and maintenance costs (Maes, et al., 2010). Other non-financial advantages are that companies do not have to manage the process and can focus on their core business, all the knowledge is available at one spot and savings stay in the area and can be reinvested (Den Dekker & van de Velde, 2013; Spaan, 2014).

ESCo services for small and medium sized companies are new in the Netherlands. An example is ESCo Plaspoelpolder in Rijswijk. The high vacancy of this business district was reason for the municipality to search for solutions to invest in sustainability to make the business district attractive again. Research proved 10 to 30% of the energy consumption could be saved without doing any financial investments. Free energy scans were offered to the real estate and business owners to make these opportunities visible. An ESCo was established together with two consultancy firms (DWA and APPM) to utilize these opportunities. The first step was buying energy collectively, now they are searching for funds to implement more energy efficiency measures (Den Dekker & van de Velde, 2013).

Another example is business district Lage Weide. 24 November 2014 10 companies singed a commitment agreement to reduce their CO2 emissions by 30% in 2020. Warmtebouw Utrecht made a master plan with promising energy efficiency measures. This collective makes sure all low investment measures will be implemented and gives economies of scale. They are still investigating future sustainable energy solutions together with the municipality of Utrecht and DWA (vastgoed journaal, 2014).

The Belgium government initiated four consortia to inform small and medium sized companies about the possibilities of ESCo projects. They monitor the companies to determine the potential energy savings. When potential is high they will try to establish an ESCo. These pilot projects are iSave, ESCo4FvT, ESCo4Gent and ESCo4Oost-Vlaanderen (Agentschap Ondernemen, 2014). Each project is bound to a region, iSave focusses on the IGEMO region and companies with a yearly energy bill of €20.000,- to €250.000,- (IGEMO, 2014). ESCo4FVT is for medium sized companies in west Flanders. They should have a yearly energy bill of €50.000,- or higher. One of the initiators is Dalkia NV, who is experienced in big industrial ESCo projects. In this pilot project they try to scale down their experience with big companies to medium sized ones (Tobback, 2014; Provinciale Ontwikkelingsmaatschappij West-Vlaanderen, 2014). ESCo4Gent uses park manager Quares as initiator. The two business districts Quares is active in Gent have a wide diversity of companies, which increases the scalability to other business districts in Flanders (de Smedt, 2014). The last pilot project is ESCo4Oost-Vlaanderen, here the focus is on making the ESCo concept easy to understand by small business cases and clear communication (Dewettinck, 2014).

In this study business district De Hurk is used as a case study. This is a versatile business district and has a total size of more than 200 hectares. The site was founded in the fifties and has, thanks to good connections to the main infrastructure (A2 / N2) and the Beatrix Canal, developed into the largest industrial area of Eindhoven. There are over 300 established businesses, which employ about 15,000 people. This contributes to the industrial 10% to the total employment in Eindhoven (OK de Hurk, 2012).

62% of all business districts are mixed industry districts and are designated for regular businesses (Glumac, et al., 2014). Also business district De Hurk can be defined as a mixed industry district with most companies belonging to the small and medium business category.

4.4 Business owners

The last important stakeholder are the business owners themselves. They have several reasons to improve their sustainability: improve profits, reduce resource cost, responding to customer needs and reduce environmental impact. Due to the current economic situation they focus on short-term goals in order to survive. (van Son, 2014). Reasons why they cooperate with ESCos are given in Table 2.

Table 2: customer requirements

Customer requirements	Article
Corporate social responsibility	(Verhoog, 2011) (van Son, 2014) (van der Klauw, 2014)
Increase organizational efficiency	(Verhoog, 2011) (van Son, 2014) (Bertoldi, et al., 2014)
Improve reputation	(van Son, 2014) (van der Klauw, 2014)
Avoid wastage	(Verhoog, 2011)
Lower energy bill	(Verhoog, 2011) (Bertoldi, et al., 2014) (van der Klauw, 2014)
No investment necessary	(Korbee, 2013) (Bertoldi, et al., 2014) (Agentschap NL, 2010)
Short term of contract	(Korbee, 2013) (de Haan & Benner, 2005)

5 Research Method

5.1 Research design

An excellent method to do research with the use of customer requirements is the Quality Function Deployment (QFD) method. QFD is a system used for translating and prioritizing customers' needs and market demands into suitable technical characteristics and ensuring that important ones are prioritized in the design (Sullivan, 1986). QFD consists of making quality tables like the House of Quality (HOQ), a matrix used in the process that displays the customers' requirements versus the technical responses to meet them (Delgado-Hernandez, et al., 2007). An overview of the HOQ is given in Figure 10. The relation between the customer and technical requirements come from the literature study.

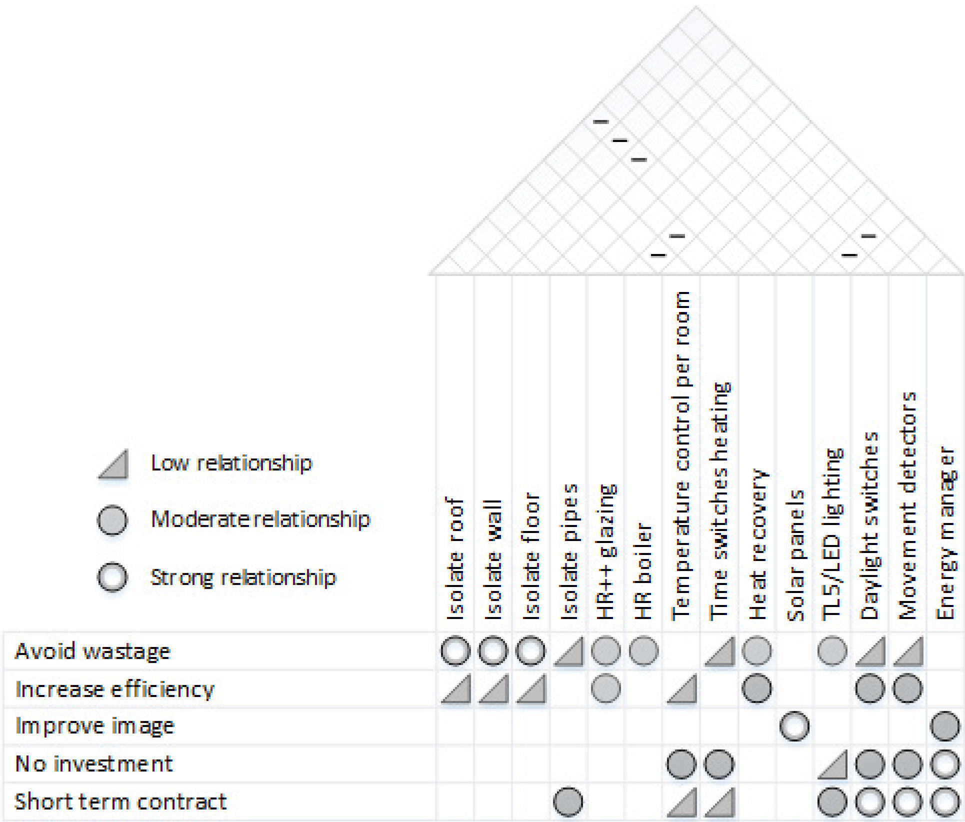


Figure 10: House of Quality

Next step is to rate the customer requirements. This will be done by the questionnaire that is distributed to business owners. The design of the survey and the processing of the data are done on the basis of the AHP method.

The Analytic Hierarchy Process (AHP) is developed by Saaty in 1980. It is a decision support tool for processes that involve multiple alternatives. On top of the AHP stands the goal of the process, followed by criteria and sub criteria, and at the bottom the different alternatives. The criteria can be weight by pair wise comparisons and the best alternative to suit the goal can be calculated. (Saaty, 1988)

All judgments of the various pairwise comparisons are summarized in a Comparison Matrix. In real-life decision problems, pairwise comparison matrices are rarely consistent. Nevertheless, decision makers are interested in the level of consistency of the judgments, which somehow expresses the goodness or “harmony” of pairwise comparisons totally, because inconsistent judgments may lead to senseless decisions.

The customer requirements are related to the technical characteristics. With the use of the house of quality the most important technical characteristics are calculated. This information is used to calculate the financial feasibility together with the energy saving potential from the questionnaire. This is done with ten different data sets expecting different outcomes because of the different energy saving potential and weight customer requirements.

5.2 Questionnaire

The questionnaire (Appendix A) used for this study consist of three parts: business profile, energy saving potential and business preferences. The business profile gives the economic sector and business size while the energy saving potential gives an estimate of the feasibility of energy services for business district the Hurk. The last part, business preferences, gives pairwise comparisons of the customer requirements of energy services which are divided in three groups:

Corporate social responsibility: Companies can have several reasons to take responsibility for their impact on society. This is focused on four main aspects: meeting objectives that produce long-term profits, using business power in a responsible way, integrating social demands and contributing to a good society by doing what is ethically correct (Garriga & Melé, 2004). Working with an ESCo will address those points by avoiding wastage, increase organizational efficiency and improve the company’s image.

Financial aspects: As stated before there are two options for financing an ESCo project customer or ESCo financing (with or without help of a third party). If the companies do the investments they will get the highest profit but not all companies have the means to do the investment or do not want to take the risk.

Term of contract: The efficiency measures have different payback periods. You can divide them in three groups: short-term (0-5 years), mid-term (5-10 years) and long-term (10-15 years) contracts.

The technical characteristics used in this study are the energy efficiency measures (EEM) which the ESCo can accommodate. The energy saving potential part of the questionnaire asks the companies which of these EEM's are already implemented and which are desired. Table 3 shows the available EEM's according to the literature.

Table 3: energy efficiency measures

EEM	Costs	Energy saving
Isolate roof	+ +	+ +
Isolate wall	+ +	+ +
Isolate floor	+ +	+ +
Isolate pipes	+	-
HR++ glazing	+ +	+
HR boiler	+	-
Temperature control per room	-	-
Time switches heating	-	+
Heat recovery	+	+
Solar panels	+ +	- -
TL5/LED lighting	+/-	+/-
Daylight switches	-	-
Movement detectors	-	-
Energy manager	- -	+ +

5.3 Participant Characteristics

The focus of this study is on small to medium sized companies. The European Commission (2003) defines three categories as stated in Table 4. In this study the number of employees is used to determine the company size.

Table 4: small to medium sized businesses

Category	employees	turnover	balance
Micro	< 10	≤ € 2 mln.	≤ € 2 mln.
Small	< 50	≤ € 10 mln.	≤ € 10 mln.
Medium	< 250	≤ € 50 mln.	≤ € 43 mln.

As seen in Figure 11 of all businesses located on business districts in the Netherlands 79.000 businesses are micro sized, 29.000 are small, 8.000 are medium and 1.000 are large.

Relatieve en absolute verdeling van vestigingen op bedrijventerreinen over grootteklassen, 1999-2006

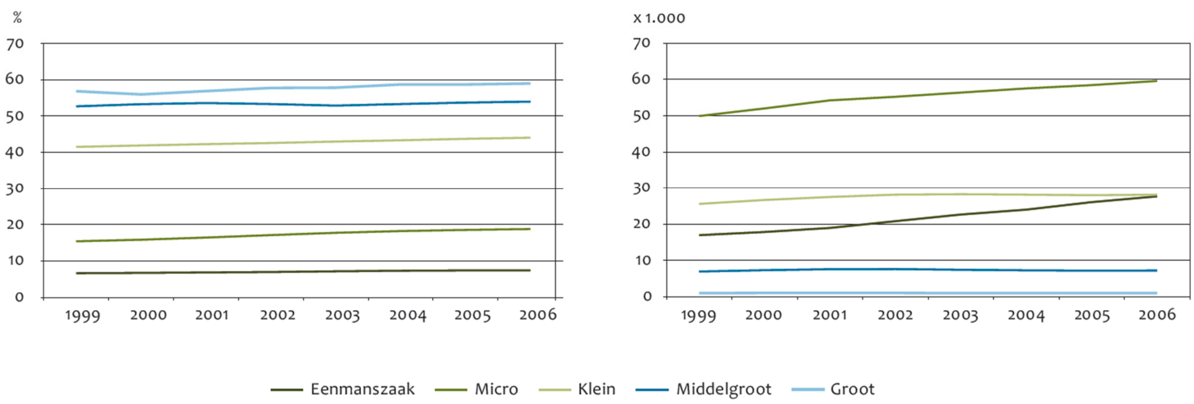


Figure 11: distribution size categories on business districts (Weterings, Knoben, & van Amsterdam, 2008)

As stated before business district de Hurk is a mixed business district. This means a district of at least one hectares with business active in commercial, trade and production industry. Some businesses may be active in commercial or non-commercial services but this group should be a minority. (Ministerie van infrastructuur en milieu, 2013)

A list with contact information of 114 businesses on business district de Hurk is used to send out a questionnaire. 27 of them belong to the micro sized category, 43 are small sized and 28 are Medium sized. Adding this up gives 98 businesses meaning 16 are large companies.

Of the 114 sent questionnaires 23 were filled in completely giving a response of 20%. Of these 23 companies seven were micro, eight small, five medium and three large sized. To see differences in preferences 10 different datasets are used:

1. all data
2. micro and small sized companies
3. medium and large sized companies
4. building owners
5. renter
6. micro and small sized companies owning the building
7. micro and small sized companies renting the building
8. medium and large sized companies owning the building
9. medium and large sized companies renting the building
10. all companies interested in ESCos

5.4 Data check

First step in the data processing is checking if the data set is complete. With the use of SPSS 22 Table 5 is created showing all 23 participants filled in all the questions and all the answers are in the range of 1-2 (first 3 questions) or 1-9 (the customer preferences).

Table 5: Descriptive Statistics (SPSS)

	N	Minimum	Maximum
size_small_medium	23	1	2
owner_rentee	23	1	2
ESCo_yes_no	23	1	2
Voorkeur11	23	1	7
Voorkeur12	23	3	7
Voorkeur13	23	1	7
Voorkeur21	23	1	8
Voorkeur22	23	1	7
Voorkeur23	23	1	6
Voorkeur31	23	1	8
Voorkeur41	23	1	9
Voorkeur42	23	1	9
Voorkeur43	23	1	9
Valid N (listwise)	23		

5.4.1 business profile

Second is looked at the independence of the first three answers. SPSS is used to discover if there is a relationship between two categorical variables with the use of Pearson's chi-square test.

When you choose to analyze your data using a chi-square test for independence, you need to make sure that the data you want to analyze "passes" two assumptions, if it does not, you cannot use a chi-square test for independence. These two assumptions are:

Your two variables should be measured at an ordinal or nominal level (i.e., categorical data). With company size belonging to the ordinal level and interest in ESCo and owner/renter to the nominal level this is passed.

Your two variable should consist of two or more categorical, independent groups. This is also true, all variables consist of two independent groups.

For six datasets the dependence of interest in ESCo on company size and owner/renter is calculated. An example is given in Table 6 of all the data for the owner/renter and interest in ESCo. When reading this table we are interested in the results of the "Pearson Chi-Square" row. We can see here that $\chi(1) = 5{,}316$, $p = {,}021$. This tells us that there is a statistically significant association between being owner or renter and interest in ESCo. Because more than 20% of the cells have a count of less than 5 you should look at the Fisher's Exact which is below 0,05, meaning the association is still significant.

Table 6: Chi-Square test interest in ESCo against owner/renter (SPSS)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5,316[a]	1	,021		
Continuity Correction[b]	3,527	1	,060		
Likelihood Ratio	5,555	1	,018		
Fisher's Exact Test				,036	,029
Linear-by-Linear Association	5,085	1	,024		
N of Valid Cases	23				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 4,30.

b. Computed only for a 2x2 table

To determine the strength of the association the Cramer's V is calculated (Table 7). The value of .481 indicates a very strong positive association, meaning when more companies are owner of their building more companies are interested in ESCos.

Table 7: Crames's V interest in ESCo against owner/renter (SPSS)

		Value	Approx. Sig.
Nominal by Nominal	Phi	,481	,021
	Cramer's V	,481	,021
N of Valid Cases		23	

5.4.2 Business preferences

Next step is to look at the consistency of the business preferences. When the decision maker thinks A > B and B > C, it should be that A > C. Saaty (1980) developed a method to calculated the inconsistency of the pairwise comparison matrices:

$$CR_n = \frac{\frac{\lambda_{max} - n}{n - 1}}{RI_n}$$

The inconsistency ratio (CR_n) is influenced by the Random Index (RI_n). This is the average consistency index of 100 randomly generated pairwise comparisons matrices. The value of RI_n for each value of n is given in Table 8.

Table 8: Random Index (*RI*)

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Saaty (1980) concluded that an inconsistency ratio of about 10% or less may be considered as acceptable. Ho , Newell and Walker (2005) state that for non-expert responds the CR could be relaxed to 0.20, making it easier to answer the pairwise comparisons. Of the 23 filled in questionnaires four proofed to be inconsistent. They are removed from the dataset. Table 9 gives the comparison matrix and CR of all consistent questionnaires combined.

Table 9: comparison matrix and consistency ratio of all data

	A	B	C	CR

A: CSR	1,00	1,04	1,47	0,000
B: financial aspects	0,96	1,00	1,45	
C: term of contract	0,68	0,69	1,00	
A: avoid wastage	1,00	1,04	1,08	0,003
B: increase efficiency	0,97	1,00	1,26	
C: improve reputation	0,93	0,80	1,00	
A: own investment	1,00	0,76		0,000
B: investment by ESCo	1,31	1,00		
A: short-term contract	1,00	1,78	1,93	0,008
B: mid-term contract	0,56	1,00	1,45	
C: long-term contract	0,52	0,69	1,00	

Last data check is about the robustness of the AHP. The absolute ranking is a quantitative indices for robustness (Deok-Hwan & Kwang-Jae, 2009). The influence of uncertainty on this ranking will determine the robustness of the research. The uncertainty has been simulated using normal distributed random variables with the initial value as mean with different standard deviations (Ghiya, et al., 1999). Figure 12 shows this uncertainty has a low influence on the ranking of the AHP, only from a standard deviation of 0,4 and onwards you see the ranking shifts. This makes the AHP robust.

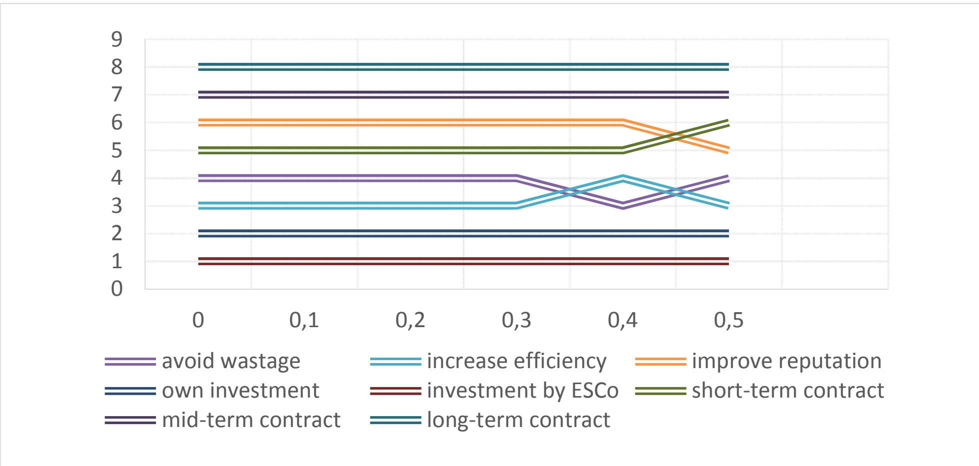


Figure 12: ranking AHP with different standard deviations (all data)

Figure 13 shows the robustness of the QFD. The robustness is low but you see groups. Most important is the energy manager followed by movement detectors and daylight switches and 4th is TL5/LED lighting.

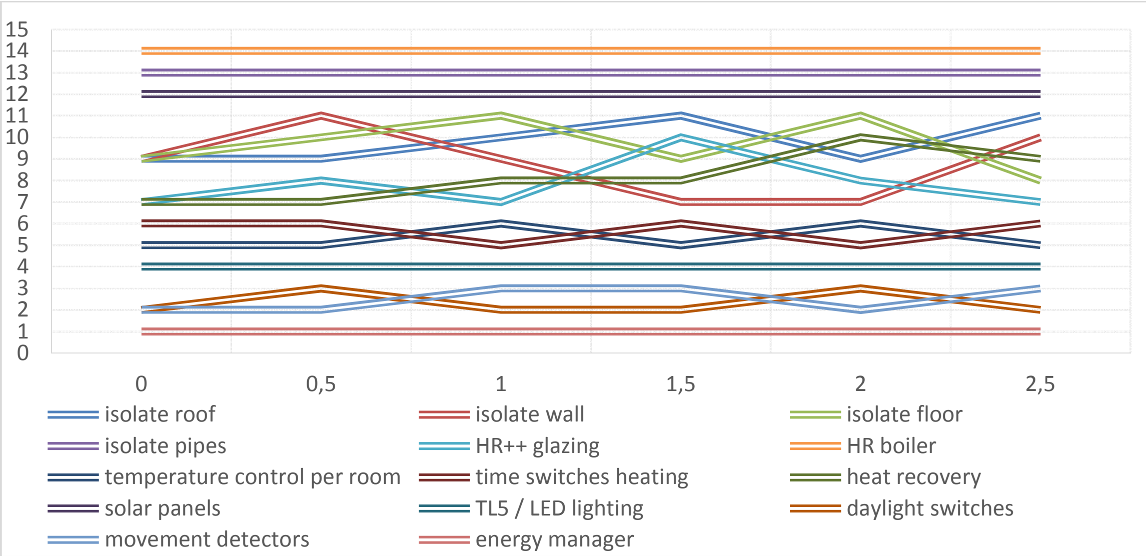


Figure 13: ranking QFD with different standard deviations (all data)

6 Results

6.1 Questionnaire

Table 10 shows the size of the different datasets and how many are interested in ESCos. Of all 23 companies 11 said to be interested, which is almost 50%. The questionnaire was send out to 144 businesses on de Hurk.

Table 10: datasets

	All	micro small	medium large	renter	owner	micro small - renter	micro small - owner	Medium large - renter	Medium large - owner	ESCo interested
population	23	15	8	14	9	9	6	5	3	11
ESCo interested	11	8	3	4	7	2	6	2	1	11
percentage	47,83	53,33	37,5	28,57	77,78	22,22	100	40	33,33	100

Chapter 5.4.1 showed there is a relation between being building owner and interest in ESCo. The chi-square test on the other data sets proved an even stronger relation between micro/small building owners and interest in ESCos (Table 11). But due to the small amount of values the significance is doubtful (see Fisher Exact Table 12).

Table 11: Cramer's V interest in ESCo by building owners against business size

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	,756	,023
	Cramer's V	,756	,023
N of Valid Cases		9	

Table 13 and Table 14 show there is a significant relation between the interest in ESCos by micro/small companies against owner/renter. This means when more micro/small companies are owner of their building, more micro/small companies are interested in ESCos. Processing all other datasets proved there is no relation between the other variables.

The target group for the ESCo should be the micro and small companies who own their building.

Table 12:Chi-square test interest in ESCo by building owners against business size

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5,143[a]	1	,023		
Continuity Correction[b]	2,009	1	,156		
Likelihood Ratio	5,716	1	,017		
Fisher's Exact Test				,083	,083
Linear-by-Linear Association	4,571	1	,033		
N of Valid Cases	9				

a. 4 cells (100,0%) have expected count less than 5. The minimum expected count is ,67.

b. Computed only for a 2x2 table

Table 13: Cramer's V interest in ESCo by micro/small companies against owner/renter

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	,764	,003
	Cramer's V	,764	,003
N of Valid Cases		15	

Table 14: Chi-Square test interest in ESCo by micro/small companies against owner/renter

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8,750[a]	1	,003		
Continuity Correction[b]	5,904	1	,015		
Likelihood Ratio	11,193	1	,001		
Fisher's Exact Test				,007	,006
Linear-by-Linear Association	8,167	1	,004		
N of Valid Cases	15				

a. 4 cells (100,0%) have expected count less than 5. The minimum expected count is 2,80.

b. Computed only for a 2x2 table

6.2 Analytic Hierarchy Process

The final result of the AHP is given in Table 15. Looking at the three main criteria you see micro and small businesses as well as renters see Corporate social responsibility as most important while medium and large businesses as well as building owners find the financial aspects most important.

If you look closer at the financial aspects the group of medium and large businesses who own the building is the only one interested in investing themselves. Most of these businesses also stated not to be interested in ESCos, so the focus should be on investments by ESCos.

Concerning the term of contract the short-term contract is the most favorable. But the earlier determined target group of micro and small businesses who own the building have no real preference on term of contract.

Table 15: final weight criteria different datasets

	All	micro small	medium large	renter	owner	micro small - renter	micro small - owner	Medium large - renter	Medium large - owner	ESCo interested
CSR	0,38	0,41	0,33	0,40	0,35	0,44	0,37	0,35	0,28	0,30
financial aspects	0,37	0,29	0,48	0,33	0,41	0,28	0,31	0,40	0,60	0,40
term of contract	0,25	0,30	0,20	0,27	0,24	0,28	0,32	0,25	0,13	0,30
avoid wastage	0,13	0,13	0,13	0,14	0,11	0,13	0,12	0,15	0,09	0,13
increase efficiency	0,13	0,14	0,12	0,17	0,09	0,20	0,09	0,13	0,09	0,08
Improve reputation	0,11	0,14	0,08	0,09	0,15	0,11	0,17	0,07	0,10	0,09
own investment	0,16	0,12	0,23	0,14	0,19	0,14	0,08	0,13	0,45	0,11
investment by ESCo	0,21	0,18	0,24	0,19	0,23	0,14	0,22	0,27	0,15	0,29
short-term contract	0,12	0,13	0,11	0,13	0,11	0,15	0,11	0,11	0,08	0,11
mid-term contract	0,08	0,10	0,05	0,07	0,08	0,08	0,12	0,07	0,03	0,10
long-term contract	0,06	0,07	0,04	0,06	0,05	0,05	0,09	0,07	0,01	0,09

6.3 Quality function deployment

With the information of the AHP the house of quality can be filled in. Looking at Table 16 you see two scores, the adjusted score is the normal score scaled from 0 to 1 to make it easier to compare. For all data the best efficiency measure is appointing an energy manager which is given the highest score. The last two rows show of the 23 only 4 appointed an energy manager and only one company is interested to appoint one. The customer requirements used can be found in Table 15. Chosen is for investment by ESCo and a short term contract because those are most important according to the companies.

Table 16: House of quality for all data

		Isolate roof	Isolate wall	isolate floor	isolate pipes	HR++ glazing	HR boiler	temperature control per room	time switches heating	heat recovery	solar panels	TL5 / LED lighting	daylight switches	movement detectors	energy manager
avoid wastage	0,13	5	5	5	1	3	3		1	3		3	1	1	
increase efficiency	0,13	1	1	1		3		1		3			3	3	
improve image	0,11										5				3
Investment by ESCo	0,21							3	3			1	3	3	5
short term contract	0,12				3			1	1			3	5	5	5
score		0,79	0,79	0,79	0,50	0,79	0,39	0,88	0,88	0,79	0,57	0,96	1,77	1,77	1,99
adjusted score		0,25	0,25	0,25	0,07	0,25	0,00	0,31	0,30	0,25	0,11	0,36	0,86	0,86	1,00
Already implemented		10	7	7	8	11	15	12	12	5	1	13	3	10	4
desired		6	8	3	1	5	3	2	3	2	9	7	1	3	1

Figure 14 shows the final outcome of the QFD for all the company forms. You see clearly the energy manger is best suited for most companies and micro to small sized renters prefer the daylight switches and movement detectors slightly more. After the energy manager movement detector and daylight switches there is a large group equal important: TL5/led lighting, time switches for heating, and temperature control per room.

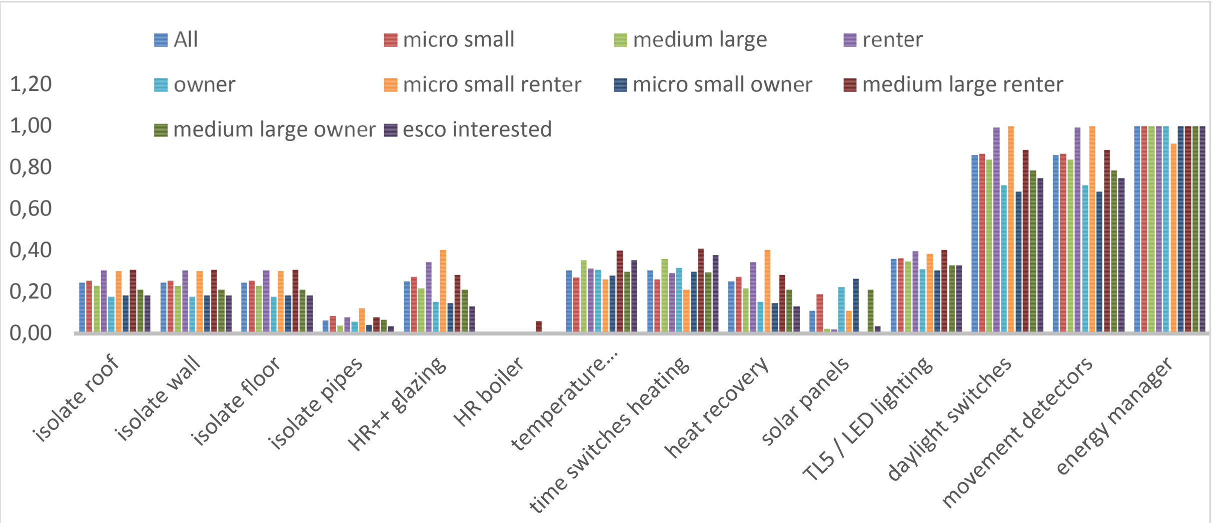


Figure 14: outcome QFD

6.4 Feasibility study

RETScreen 4 is used to determine if the business case of all interested companies is feasible. This is an Excel-based clean energy project analysis software tool that helps decision makers determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration (combined heat & power) projects. Users conduct a five step analysis, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis.

The data used for this tool are energy use of the companies, used square meters and the costs and effects of the energy efficiency measures (Table 17). First the energy use was taken from the questionnaire but this information was incomplete, so the average energy use per sector is used. These numbers match with the known energy use of whole the business district.

Table 17: variables RETScreen

measure	reduction	€/m²	source
Energy manager			
- **Collective buy in**	10 – 30 % on energy price	0,00	(Spaan, 2015)
- **Efficient use**	5 – 10 % on total energy use	0,00	(E.ON, 2015)
T-5 lighting	50 % on lighting energy use	7,85	(Agentschap NL, 2011)
Daylight sensors	20 % on lighting energy use	6,42	(Agentschap NL, 2011)
Movement detection	10 – 30 % on lighting energy use	4,00	(Agentschap NL, 2011)

Table 18: energy use per sector (Meijer & Verweij, 2009)

Office	85 kWh/m²
wholesale	27 kWh/m²
Store without cooling	70 kWh/m²
workshop	47 kWh/m²

The results (appendix B) show the emission reduction and financial analyze of all the ESCo interested companies. Together they can save €75.000,- yearly on their energy bill if they invest €397.000,- in adapting their lighting system with daylight switches, movement sensors, energy efficient lighting and appointing an energy manager. The payback time of these investments will be less than 7 years. Doing so they will reduce their CO_2 emissions with 60,4 tCO_2. Which is equivalent 5,6 hectares of forest absorbing carbon. The energy saving potential of these 11 companies is 351 MWh, which is 16% of their total electricity use.

7 Conclusion

The conclusion is drawn up by answering the sub-questions formulated in chapter 1. These answers will help answering the main question: *how can you make energy management by an Energy Service company feasible for business districts with small to medium sized companies?*

What is an ESCo and which type of ESCo is suitable for business districts with small to medium sized companies?
ESCo stands for energy service company and in this research the following definition is used (Bertoldi, et al., 2007):

> *"Energy Service Company: a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in doing so. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria."*

The three main types of ESCo are Energy Performance Contracting (EPC), Energy Supply Contracting (ESC) and Integrated Energy Contracting (IEC). The EPC model is suitable for large-scale projects concerning a ''pool'' of buildings. Though, this does not always result in lower transaction costs because of the remuneration method. A performance contract is set up which requires an energy cost base line. With regard to companies in a business district, these exact base lines are hard to assess and result in high transaction costs.

These problems are not encountered with the ESC model, because no baseline is needed to measure savings. Therefore, ESC is more common in end-use sectors such as industry. However, demand side reduction measures are minimal and the ESCo profits come from selling energy units. If a company, that normally gets paid for selling energy units now promotes lowering the need for these energy units, the credibility might not be that high from the client point of view.

The IEC model builds on the ESC model but implements extensive demand side reduction measures as well. The ESCo takes over the entire energy management, including the purchase from conventional energy sources. This results in a situation where the ESCo needs to install the most efficient measures to make profits. This takes away the credibility issue as described above. Also the transaction costs are lower than with EPC because it does not need a base line to calculate energy savings but only measures the performance of the new efficiency measures. For these reasons, the IEC model appears to be the most promising for business districts (van der Zanden, 2013).

How can the municipality convince business owners to participate in ESCo projects?
During the interviews it turned out that the ESCo concept is not known by most companies. After explaining it several were interested. The municipality can help increase the awareness of the ESCo concept by organizing lectures or workshops.

What is the energy saving potential of business district the Hurk?
Retscreen 4 is used to calculate the energy saving potential of the 11 ESCo interested companies. 337 MWh of electricity can be saved by implementing the following efficiency measures: appointing an energy manager, changing the lighting system and adding movement sensors and daylight switches. The questionnaire is send to one third of all companies on business district the Hurk, making the energy saving potential of this business district around 1000 MWh.

What do business owners expect from the Energy Service Company?
One of the questions of the questionnaire was why the company was interested in energy services. Most answered the cost reduction was important as well as the reduction on CO_2 emission. Chapter 6.3 shows the companies expect the ESCo will do the investment and will work with short term contracts. They also expect the ESCo will increase their corporate social responsibility.

Why should business owners participate and are they willing to participate in this project?
An ESCo will give companies with no capital and little knowledge about energy services an opportunity to reduce their energy use and save money (Bertoldi, et al., 2014). Of all 23 companies 11 said to be interested, which is almost 50%. Most of them belong to the micro/small category and own their buildings.

How can you make energy management by an Energy Service Company feasible for business districts with small to medium sized companies?

There is potential for ESCos for business districts. The focus should be on micro and small sized businesses who own the building. This group has no funds and knowledge to implement energy services but are willing to do so. Companies who rent the building face a split incentive between them and the building owner, this makes the process more difficult (van der Zanden, 2013). The awareness about ESCos should be increased by starting with short term contracts and efficiency measures that do not need any investments to let the companies get used to the concept (Bertoldi, et al., 2014). Chapter 8 gives recommendations to the business owners and municipality how to increase the awareness of the ESCo concept.

7.1 discussion

This study gives insight is energy services by an ESCo for business districts. However, this study has some limitations and thereby some opportunities for further research.

If you look at the distribution between micro, small, medium and large companies you see a difference between the distribution in the Netherlands and the distribution of the companies who responded on the questionnaire. This means the findings of this research can't be scaled up to whole the Netherlands.

23 companies responded on the questionnaire, which is a small sample. By dividing the sample in two groups like owner/renter or micro-small/medium-large, the reliability of the answers is just enough. Dividing the sample in four groups; micro-small owner, micro-small renter, medium-large owner and medium-large renter made the sample too small to give a reliable answer.

According to the questionnaire the most desired energy efficiency measure is solar panels while the literature states this is not financially feasible due to governmental rules and legislation. Also the given numbers of energy use seem odd in comparison to average energy use numbers of business district the Hurk. I expect the people filling in the questionnaire did not know the numbers and did not investigate the feasibility of solar energy. This corresponds with the low awareness of their energy saving potential and the advantages an ESCo could give them.

8 Recommendations

One of the companies active in energy services for business districts is DWA. According to them the ESCo concept can be successful because:

1. it focuses on realization of energy efficiency measures instead of only conducting scans
2. the collective approach, a proper mix of large and small sized companies make it interesting for small companies to participate
3. guided by an independent party, resulting in best quality for the lowest price
4. take away the pressure of the process like financing or tendering
5. continuous process due to monitoring
6. revolving approach, investing the profits into the same district.

The following 6 steps will help setting up an ESCo:

Step 1. Involve companies

The awareness of the ESCo concept is still low, informing companies about the advantages will increase the number of interested companies. A way to involve companies is to use a free (or reduced price) energy scan. Companies are willing to conduct an energy scan with energy label because it is required by the government. After the scan you can inform them about the advantages the ESCo can deliver.

Step 2. Run energy scans

While conducting the energy scans the following activities are performed:

1. Data collection. The following information is necessary:

- Gas and electricity use of the last three years;
- Energy bill;
- Building Data (m^2);
- Drawings (plans);
- If available: installation drawings and installation data;
- Maintenance contracts for installations (cleaning filters, periodic inspections, etc.).

2. Inspection of the location.

3. Analysis of the data

4. Report with current energy use and possible energy efficiency measures to reduce energy use.

Step 3. develop a business case

A business case is drafted for each company based on the energy scan. In this business case potential savings and the costs of implementing the measures are shown to the participant. In dialogue with the company this business case will be made final and the role of the company within the ESCo will be discussed.

Step 4. agreement of intent

With the participating companies, an agreement of intent is signed when the outcome of the energy scan is positive. This agreement will consist of:

1. Companies / owners cooperate in providing the necessary data.
2. Distribution own investment/investment by ESCo
3. Distribution of financial benefit because of the lower energy bill. This will depend on the distribution own investment/investment by ESCo
4. term of contract. This depends on the type of efficiency measure but typically 5 to 15 years.
5. Agreements related to monitoring. How is the energy use measured and when.
6. penalties. What are the consequences when goals are not achieved by ESCo or participant.

Step 5. establish ESCo

When there are enough companies that agree with the proposal to take part in the ESCo, the ESCo is founded. The most appropriate legal form will be chosen based on the results of the analyzes and the wishes of the participants.

Step 6. implement modifications

The energy efficiency measures can be tendered and due to the economies of scale the costs are as low as possible. This way the skills and knowledge of the market are used and the risks will be covered by the ESCo.

This report suggest to start the ESCo with the following energy efficiency measures: Energy manager, adapt lighting system, movement sensors and daylight switches. An energy manager will monitor the energy use with the help of smart meters and an online tool. This can be done by the ESCo or an employee of the company. By comparing this data with example data sets you already can save energy. For example by adjusting the configuration of the heating installation an energy cost reduction of 5 to 15% can be achieved.

Lighting is after heating the biggest energy user for companies. In many commercial buildings they still use an old type of TL-lighting. Replacing these with energy efficient versions can reduce the energy use up to 40%. The problem is that these new versions do not fit in the old lamp socket. Investments are needed to adapt these sockets which is a barrier for the companies. Typically these investments are earned back within 4 years. Installing movement sensors and daylight switches will reduce the energy use even more. Movement sensors in toilets and small rooms can save up to 80% of the energy use and daylight switches close to the façade can save up to 70%.

As shown in chapter 6.4 the ESCo interested companies together can save €75.000,- yearly on their energy bill if they invest €397.000,- in adapting their lighting system with daylight switches, movement sensors, energy efficient lighting and appointing an energy manager. These calculations are also made for the companies separately.

Table 19: summary RET screenTable 19 shows a summary and the reports of RET screen can be found in appendix B. As you can see the payback time differs with each company, maybe other efficiency measures are more suitable for them or they are already energy efficient. The energy scans will help choosing the right energy measures.

Information about the four projects DWA is working on at the moment can be found on www.gebiedsesco.nl.

Table 19: summary RET screen

	Surface (m^2)	sector	Energy use (MWh)	Energy manager	TL5 lighting	Movement sensor	Daylight switch	CO_2 emission reduction (tCO_2)	€ saved yearly	Incremental costs (€)
1	500	Store	35	x				0,5	1.092,-	0,-
2	3750	Office	318	x	x	x		10,3	12.665,-	44.437,-
3	7500	Workshop	352	x				5,2	10.982,-	0,-
4	10000	Workshop	470	x		x	x	11,2	16.738,-	104.200,-
5	1750	Workshop	82	x			x	1,5	2.706,-	11.235,-
6	3750	Workshop	176	x	x		x	8,2	8.234,-	53.512,-
7	3750	Office	318		x		x	6,4	3.132,-	53.512,-
8	1750	Wholesale	47	x			x	1,0	1.615,-	11.235,-
9	3750	Workshop	176	x	x	x	x	8,9	8.558,-	68.513,-
10	1750	Store	122	x		x	x	2,5	4.157,-	18.235,-
11	1750	Store	122	x	x	x	x	4,7	5.244,-	31.972,-
All	40000		2218	10	5	5	8	60,4	75.123,-	396.852,-

List of tables and figures

References

Agentschap NL, 2010. *Energiebesparing te koop,* Utrecht: Agentschap NL.

Agentschap NL, 2011. *Energiezuinige Verlichting voor Detailhandel,* Utrecht: Agentschap NL.

Agentschap Ondernemen, 2014. Energie efficiëntie en ESCO. *ECOTIPS*, december-januari, pp. 20-23.

Baechler, M. & Webster, L., 2011. *A Guide to Preformance Contracting with ESCOs,* Washington: U.S. Department of Energy.

Bertoldi, P., Boza-Kiss, B., Panev, S. & Labanca, N., 2014. *ESCO Market Report 2013,* Luxemburg: European Commission.

Bertoldi, P., Boza-Kiss, B. & Rezessy, S., 2007. *Latest Development of Energy Service Companies across Europe: A European ESCo Update,* Luxembourg: European Commission, Joint Research Center (JRC).

Bertoldi, P. & Rezessy, S., 2005. *European Energy Service Companies Status Report 2005,* Ispra, Italy: European Commission, Joint Research Center (JRC).

Bleyl-Androschin, J. & Schinnerl, D., 2010. *Competitive Energy Services,* Graz: International Energy Agency (IEA).

Boonekamp, P. & Vethman, P., 2009. *National Report on the Energy Efficiency Service Business in the Netherlands,* Petten: Change Best.

Coppens, R., 2013. *Energy Performance Contracting: A risk management decision model for the promotion of energy efficiency by using Monte Carlo simulation,* Eindhoven: TU/e.

Council on energy end-use efficiency and energy services, 2006. *Directive 2006/32/EC.* s.l.:European Parliament.

de Boer, S., 2011. *Views on the emerging Dutch ESCo market: can it become successful?,* Utrecht: Utrecht University.

de Haan, F. & Benner, J., 2005. *Energiediensten voor de industrie,* Delft: CE.

de Haan, F. & Benner, J., 2005. *Energiediensten voor de industrie: de Potentiële meerwaarde van Energy Service Companies (ESCO's) en inpassing in de Nederlandse situatie,* Delft: CE.

de Smedt, B., 2014. *ESCO4Gent Project.* [Online]
Available at: http://www.agentschapondernemen.be/artikel/esco4gent-project
[Accessed 10 4 2015].

Delgado-Hernandez, D. J., Bampton, K. E. & Elaine, A., 2007. Quality function deployment in construction. *Construction Management and Economics,* Volume 25:6, pp. 597-609.

Den Dekker, L. & van de Velde, B., 2013. *ESCo Plaspoelpolder Rijswijk,* Rijswijk: Studio Brederoo.

Deok-Hwan, K. & Kwang-Jae, K., 2009. Robustness indices and robust prioritization in QFD. *Expert Systems with Applicaionts,* Volume 36, pp. 2651-2658.

Dewettinck, T., 2014. *ESCO4Oost-Vlaanderen.* [Online]
Available at: http://www.agentschapondernemen.be/artikel/esco4oost-vlaanderen
[Accessed 10 4 2015].

E.ON, 2015. *E.ON EnergieManager.* [Online]
Available at: http://www.eon.nl/zakelijk/nl/besparen/energiemanager.html
[Accessed 31 July 2015].

Energie-Nederland, 2011. *energie in nederland 2011,* Den Haag: Energie-Nederland.

ESCoNetwerk, 2013. *Wat is een ESCo.* [Online]
Available at: http://www.esconetwerk.nl/Wat-is-een-ESCo
[Accessed 5 2 2015].

european association of energy service companies, 2013. *Energy Contracting,* Brussels: eu.ESCO.

European Commision, 2003. *Directive (2003/361/EG),* s.l.: s.n.

European Commision, 2010. *2010/30/EU,* Brussels: European Commision.

European Commission, 2011. *PROGRESS TOWARDS ACHIEVING THE KYOTO OBJECTIVES,* Brussels: European Commission.

Fang, W. S., Miller, S. M. & Yeh, C.-C., 2012. The effect of ESCOs on energy use. *Energy Policy,* pp. 558-568.

Garriga, E. & Melé, D., 2004. Corporate Social Responsibility Theories: Mapping the Territory. *Journal of Business Ethics,* pp. 51-71.

Ghiya, K. K., Bahill, A. T. & Chapman, W. L., 1999. QFD: Validation Robustness. *Quality Engineering,* 11(4), pp. 593-611.

Glumac, B., van der Zanden, H. & Schaefer, W., 2014. *Energy services for business districts.* Eindhoven, TU/e, pp. 1-10.

Hansen, S. J., 2010. ESCOs Around the World. *Strategic Planning for Energy and Environment,* pp. 9-15.

Ho, D., Newell, G. & Walker, A., 2005. The importance of property-specific attributes in assessing CBD office quality. *Journal of Property Investment & Finance,* pp. 424-444.

Hopper, N. et al., 2005. *Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance,* Berkeley: Lawrence Berkeley National Laboratory.

IGEMO, 2014. *iSave.* [Online]
Available at: http://www.igemo.be/bedrijven/isave/
[Accessed 10 4 2015].

Jensen, J. O., Nielsen, S. B. & Hansen, J. R., 2013. Greening Public Buildings: ESCO-Contracting in Danish Municipalities. *energies,* pp. 2407-2427.

Korbee, H., 2013. *ESCo voor wederzijds voordeel en gratis energiebesparing,* Utrecht: Agentschap NL.

Lamers, P., Kuhn, V. & Krechting, A., 2008. *International Experiences with the Devolopment of the ESCO Markets,* Berlin: Berliner Energieagentur GmbH.

Langlois, P. & Hansen, S. J., 2012. *World ESCO Outlook.* Lilburn, GA: Fairmont Press.

Maes, T. et al., 2010. Energy management on industrial parks in Flanders. *Renewable and Sustainable Energy Reviews,* pp. 1988-2005.

Marino, A., Bertoldi, P. & Rezessy, S., 2010. *Energy Service Companies Market in Europe: status report 2010,* Ispra, Italy: European Commission Joint Research Centre Institute for Energy (JRC).

Marino, A., Bertoldi, P., Rezessy, S. & Boza-Kiss, B., 2011. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. *Energy Policy,* pp. 6190-6198.

Meijer, P. & Verweij, R., 2009. *Energie verbruik per functie,* Den Haag: SenterNovem.

Ministerie van Economische Zaken, L. &. I., 2011. *Energierapport 2011,* Den Haag: Rijksoverheid.

Ministerie van infrastructuur en milieu, 2011. *IBIS werklokaties,* Den Haag: Arcadis.

Ministerie van infrastructuur en milieu, 2013. *IBIS werklocaties,* Arnhem: Arcadis.

municipality of Eindhoven, 2013. *Eindhoven Energie neutraal,* Eindhoven: Gemeente Eindhoven.

OK de Hurk, 2012. *over de hurk.* [Online]
Available at: http://www.okdehurk.nl/Over-de-hurk.aspx
[Accessed 3 2 2015].

Okay, E., Okay, N., Konukman, A. E. S. & Akman, U., 2008. Views on Turkey's impending ESCO market: Is it promising?. *Energy Policy,* pp. 1821-1825.

Okay, N. & Akman, U., 2010. Analysis of ESCO Activities Using Country Indicators. *Renewable and Sustainable Energy Reviews,* pp. 2790-2771.

Ouden, E. d. & Gal, R., 2014. *Vision and Roadmap Eindhoven Energy-Neutral 2045,* Eindhoven: Technical University Eindhoven.

Pätäri, S. & Sinkkonen, 2013. Energy companies and energy performance contracting: is there a need to renew the business model? Insights from a Delphi study. *Journal of cleaner production,* pp. 1-8.

PeGO, 2009. *Besparingspotentieel bedrijventerreinen,* s.l.: TNO.

Program Energy Efficiency Best Practice, 2000. *A Best Practice Guide to Energy Performance Contracts,* Canberra: Commonwealth of Australia.

Provinciale Ontwikkelingsmaatschappij West-Vlaanderen, 2014. *ESCO4FVT.* [Online]
Available at: http://pomwvl.be/esco4fvt
[Accessed 10 4 2015].

Provincie Gelderland, 2009. *Parkmanagement - Draaiboek duurzame energie,* Enschede: Ontwikkelingsmaatschappij Oost Nederland NV.

RVO, 2014. *Resultatenbrochure covenanten Neerjarenafspraken energie-efficiëntie,* Utrecht: Rijksdienst voor Ondernemend Nederland.

RVO, 2015. *Energie Investeringsaftrek (EIA): Energielijst 2015,* Zwolle: Rijksdienst voor Ondernemend Nederland.

RVO, 2015. *SDE+ zo vraagt u subsidie aan voor de productie van duurzame energie,* Zwolle: Rijksdienst voor Ondernemend Nederland.

Saaty, T. L., 1988. What is the Analtic Hierarchy Proces?. *Mathematical Models for Decision Support,* Issue 48, pp. 109-121.

Schneider, H., Steenbergen, P.-J., Hardenbol, S. & Logemann, M., 2011. *Marktstudie CO2-besparingspotentieel ESCo's in utiliteitsbouw,* Delft: BuildDesk Benelux.

Spaan, M., 2014. Collectieve aanpak verduurzaming bedrijventerrein. *RO magazine*, September, pp. 32-33.

Spaan, M., 2015. *GebiedsESCo.* [Online]
Available at: http://gebiedsesco.nl/#varianten
[Accessed 31 July 2015].

Sullivan, 1986. Quality function deployment. *Quality Progress,* Volume 19, pp. 39-50.

Suntjens, S., 2014. *Overcoming internal barriers in the Dutch ESCo market for office buildings,* Eindhoven: Tu/e.

Tobback, S., 2014. *ESCO4FVT Project.* [Online]
Available at: http://www.agentschapondernemen.be/artikel/esco4fvt-project
[Accessed 10 4 2015].

U.S. Department of Energy, 2011. *A Guide to Performance Contracting with ESCOs,* Washington: Pacific Northwest National Laboratory.

van Barneveld, J., 2011. *Energy Services in The Netherlands: current status and how to stimulate development,* Utrecht: Utrecht University.

van der Klauw, J., 2014. *MVO leeft in het MKB,* Utrecht: MVO Nederland.

van der Zanden, H., 2013. *Energy services for business districts,* Eindhoven: TU/e.

van Oeveren, C., 2014. *Hoe samenwerking, verandering en voorlichting zorgen voor meer en betere ESCo projecten in Nederland,* Delft: Technische Universiteit Delft.

van Schijndel, P., 2012. *ESCo brengt duurzaamheid binnen handbereik,* Utrecht: Strukton.

van Son, H., 2014. *Hoe duurzaam is de duurzame ondernemer in het MKB,* Tilburg: Tilburg Universiteit.

van Swigchem, J., de Keizer, I., Croezen, H. & Mulders, R., 2003. *Energieverkenning bestaande bedrijventerreinen in Zuid-Holland,* Delft: CE.

vastgoed journaal, 2014. *Collectieve aanpak biedt kans op grootschalige verduurzaming bedrijventerreinen.* [Online]
Available at: http://www.vastgoedjournaal.nl/news/16542/57/Collectieve-aanpak-biedt-kans-op-grootschalige-verduurzaming-bedrijventerreinen/
[Accessed 20 4 2015].

Verhoog, W., 2011. *Verduurzaming MKB: Drijfveren en de rol van gemeenten,* 2011: Agentschap NL.

Vine, E., 2005. an international survey of the energy service company (ESCO) industry. *Energy Policy,* pp. 691-704.

Vreeken, R., 2012. *The developed energy service company markets in the european union,* Utrecht: Utrecht University.

Wagner, L., 2010. *Energy Service Companies (ESCO) Monetization of energy efficiency,* s.l.: Mora Associates.

Wargert, D., 2011. *Energy contracting models in Germany and Sweden,* Lund: Lund University.

Weterings, A., Knoben, J. & van Amsterdam, H., 2008. *Werkgelegenheidsgroei op bedrijven terreinen,* Den Haag: Plan bureau voor de Leefomgeving.

Würtenberger, L. et al., 2012. *Business models for renewable energy in the build environment,* s.l.: Energy research Centre of the Netherlands (ECN).

Appendix

Appendix A: Questionnaire

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Welkom!

Ik ben Chris Driessen, student aan de Technische Universiteit Eindhoven. Dit onderzoek is onderdeel van mijn afstudeer scriptie over de mogelijkheden van Energy Services voor bedrijventerreinen.

Deze enquête bestaat uit drie delen, eerst wordt er een bedrijfsprofiel aangemaakt, in deel 2 wordt het energiebesparingspotentieel bepaald en als laatste wordt uw mening gevraagd aan de hand van vier afwegingen.

Wanneer u vragen of opmerkingen heeft kunt u contact met mij opnemen via c.driessen@eindhoven.nl

Door deelname aan dit onderzoek helpt u mij met mijn afstudeerscriptie. Daarvoor wil ik u alvast hartelijk danken!

Uw gegevens zullen niet gepubliceerd of voor commerciële doeleinden gebruikt worden. Ze worden vertrouwelijk verwerkt en enkel voor dit afstudeeronderzoek gebruikt.

[volgende]

Berg Enquête System © 2007 Design Systems

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Het eerste deel van deze enquête gaat over uw bedrijfsprofiel.

Gegevens bedrijf:

Bedrijfsnaam:
Contact persoon:
Email:

Tot welke economische sector behoort uw bedrijf?
(indien meerdere activiteiten van toepassing, de belangrijkste aanduiden)

- Industrie, productie
- Bouwnijverheid
- Groothandel
- Transport en logistiek
- Kleinhandel
- Drukkerij
- Diensten commercieel (ICT, ...)
- Diensten niet commercieel (overheid, opleidingen, ...)
- Andere sector

namelijk:

Hoeveel personen werken er in het bedrijf (uzelf meegerekend)?

- 1 persoon
- 2 - 9 personen
- 10 - 49 personen
- 50 - 249 personen
- 250 of meer personen

Wat is het bruto vloer oppervlak (BVO) van het bedrijf?

- 0 m² tot 500 m²
- 500 m² tot 1.000 m²
- 1.000 m² tot 2.500 m²
- 2.500 m² tot 5.000 m²
- 5.000 m² tot 10.000 m²
- 10.000 m² of meer

[vorige] [volgende]

Berg Enquête System © 2007 Design Systems

EINDHOVEN

Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Hoelang is uw bedrijf al gevestigd op dit terrein?

- 20 jaar of langer
- 10 - 19 jaar
- 5 - 9 jaar
- 2 - 4 jaar
- korter dan 2 jaar

Wat is het bouwjaar van het gebouw, of het grootste gebouw indien er meerdere zijn?

Heeft u concrete plannen voor uitbreiding of verplaatsing van de bedrijfsruimte in de komende 2 jaar?

- Nee
- Ja, uitbreiding van de huidige bedrijfsruimte
- Ja, verplaatsing binnen het bedrijventerrein
- Ja, verplaatsing buiten het bedrijventerrein
- Er zijn wel plannen , maar ze zijn nog niet concreet
- Weet ik niet

Bent u eigenaar of huurder van het pand?

- Eigenaar
- Huurder

Welk type energiecontract heeft u op dit moment?

- Vast op 2 jaar of langer
- Jaarlijks aanpasbaar
- Variabel tarief
- Aangesloten bij een energie collectief
- Anders

vorige | volgende

EINDHOVEN

Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Deel 2 zal het energiebesparingspotentieel van uw bedrijf bepalen aan de hand van 9 vragen. Hiermee wordt bepaald waar kansen liggen voor energiebesparing. Voor deze vragen is het handig een jaarafrekening van de energieleverancier erbij te pakken. Mocht u deze niet bij de hand hebben kunt u een schatting maken.

Kunt u een inschatting geven van het jaarlijkse elektriciteitsverbruik van uw bedrijf?

- minder dan 10.000 kWh
- van 10.000 kWh tot 50.000 kWh
- van 50.000 kWh tot 100.000 kWh
- van 100.000 kWh tot 500.000 kWh
- van 500.000 kWh tot 1.000.000 kWh
- meer dan 1.000.000 kWh
- niet bekend

Kunt u een inschatting geven van het jaarlijkse gasverbruik van uw bedrijf?

- minder dan 4.000 m^3
- van 4.000 m^3 tot 20.000 m^3
- van 20.000 m^3 tot 50.000 m^3
- van 50.000 m^3 tot 100.000 m^3
- van 100.000 m^3 tot 250.000 m^3
- meer dan 250.000 m^3
- niet bekend

Hoe groot is het aandeel van de energiekosten ten opzichte van de totale bedrijfsomzet?

- minder dan 2%
- 2 tot 4,9%
- 5 tot 9,9%
- meer dan 10%
- geen idee

Wat is het piektarief (exclusief BTW, energiebelasting en andere toeslagen) voor elektriciteit?

- lager dan 4 ct./kWh
- 4 ct./kWh tot 5,9 ct./kWh
- 6 ct./kWh tot 8,9 ct./kWh
- meer dan 9 ct./kWh
- geen idee

vorige | volgende

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Rangschik de belangrijkste energieverbruikers die van toepassing zijn binnen het bedrijf van groot naar klein. Geef de grootste verbruiker het cijfer 1 en tel zo verder.

- ▼ Verwarming
- ▼ Koeling
- ▼ Ventilatie
- ▼ Verlichting
- ▼ Perslucht
- ▼ Stoom productie
- ▼ Proces, namelijk: ______
- ▼ Anders, namelijk: ______
- ☐ geen idee

Welke energiebesparende aanpassingen zijn aanwezig in het gebouw?
(meerdere opties zijn mogelijk)

- ☐ Goede isolatie dak
- ☐ Goede isolatie muur
- ☐ Goede isolatie vloer
- ☐ Leiding isolatie
- ☐ HR++ ramen
- ☐ HR CV-ketel
- ☐ Temperatuur geregeld per ruimte
- ☐ Schakelklokken voor verwarming
- ☐ Warmte terug win installatie voor ventilatie
- ☐ Warmte koude opslag
- ☐ Zonnepanelen
- ☐ TL5 of LED verlichting
- ☐ Daglichtregeling
- ☐ Bewegingsschakelaars
- ☐ Energie verantwoordelijke, iemand die het energie verbruik monitort.
- ☐ Anders, namelijk: ______

Welke van de onderstaande energiebesparende aanpassingen hebben volgens u het meeste potentie voor uw bedrijf?
(meerdere opties zijn mogelijk)

- ☐ Goede isolatie dak
- ☐ Goede isolatie muur
- ☐ Goede isolatie vloer
- ☐ Leiding isolatie
- ☐ HR++ ramen
- ☐ HR CV-ketel
- ☐ Temperatuur geregeld per ruimte
- ☐ Schakelklokken voor verwarming
- ☐ Warmte terug win installatie voor ventilatie
- ☐ Warmte koude opslag
- ☐ Zonnepanelen
- ☐ TL5 of LED verlichting
- ☐ Daglichtregeling
- ☐ Bewegingsschakelaars
- ☐ Energie verantwoordelijke, iemand die het energie verbruik monitort.
- ☐ Anders, namelijk: ______

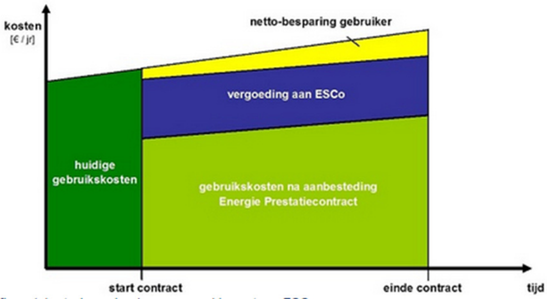
[vorige] [volgende]

EINDHOVEN

Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Deze maatregelen kunnen uitgevoerd worden met de hulp van een Energy Service Company (ESCo). Voor een tijdsduur van 5 tot 15 jaar wordt er dan een overeenkomst gesloten waarin de ESCo een lager energieverbruik garandeert. Met het verschil in energierekening kan de ESCo zichzelf financieren (figuur 1). Aan het eind van het contract heeft de ESCo zich terug verdiend en heeft u een lagere energierekening.



figuur 1: kostenbesparing door samenwerking met een ESCo

Zou u overwegen een overeenkomst aan te gaan met een ESCo waneer u voldoende besparingspotentieel heeft?

- Ja
- Nee

reden:

vorige | volgende

EINDHOVEN

Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

In deel 3 worden steeds twee begrippen met elkaar vergeleken die te maken hebben met energiebesparing met ESCo's. Eerst worden de begrippen beschreven waarna u ze twee aan twee kunt vergelijken qua mate van belang voor u.

Maatschappelijk verantwoord ondernemen (MVO):
Steeds meer bedrijven zien de noodzaak en voordelen van maatschappelijk verantwoord ondernemen. Dat betekent dat zij rekening houden met de effecten van hun bedrijfsvoering op mens, milieu en maatschappij.

Financiële aspecten:
Investeren in duurzame energiebesparingsmaatregelen kan prijzig zijn maar binnen acceptabele termijn zijn veel aanpassingen terug te verdienen. Wanneer er samen gewerkt wordt met een ESCo is er geen investering nodig maar wordt de kostenbesparing op de energierekening ook uitgesteld.

Tijdsduur contract:
ESCo contracten zijn er in verschillende soorten. Over het algemeen zorgen langdurige contracten voor meer energiebesparing terwijl aan de kortere contracten minder risico zit.

In onderstaand schema kunt u aangeven wat u het belangrijkste vindt aan energiebesparing met ESCo's. Is maatschappelijk verantwoord ondernemen een belangrijke drijfveer of zijn de financiële aspecten en de tijdsduur van het contract belangrijker voor u?

	extreem belangrijker	fors belangrijker	sterk belangrijker	matig belangrijker	even belangrijk	matig belangrijker	sterk belangrijker	fors belangrijker	extreem belangrijker	
Criteria	**9**	**7**	**5**	**3**	**1**	**3**	**5**	**7**	**9**	**Criteria**
MVO	○	○	○	○	○	○	○	○	○	Financiële aspecten
MVO	○	○	○	○	○	○	○	○	○	Tijdsduur contract
Financiële aspecten	○	○	○	○	○	○	○	○	○	Tijdsduur contract

vorige | volgende

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Maatschappelijk verantwoord ondernemen
Maatschappelijk verantwoord ondernemen kan op verschillende manieren, door gebruik te maken van een ESCo worden drie punten aangepakt:

Verspilling tegen gaan:
Door betere isolatie wordt bijvoorbeeld het gasverbruik teruggedrongen, ook een lager energieverbruik heeft een positieve invloed op het milieu.

Rendement verbeteren:
De duurzame aanpassingen verbeteren ook het rendement van uw bedrijf, door de lagere energierekening worden de vaste lasten lager.

Imago verbeteren:
Een ESCo kan u helpen uw imago te verbeteren, zichtbare aanpassingen zoals zonnepanelen laten zien dat u denkt aan het milieu.

	extreem belangrijker	fors belangrijker	sterk belangrijker	matig belangrijker	even belangrijk	matig belangrijker	sterk belangrijker	fors belangrijker	extreem belangrijker	
Criteria	9	7	5	3	1	3	5	7	9	Criteria
Verspilling tegengaan	○	○	○	○	○	○	○	○	○	Rendement verbeteren
Verspilling tegengaan	○	○	○	○	○	○	○	○	○	Imago verbeteren
Rendement verbeteren	○	○	○	○	○	○	○	○	○	Imago verbeteren

vorige | volgende

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Financiële aspecten
Ervan uitgaande dat u een overeenkomst sluit met een ESCo, welk financieel aspect vindt u belangrijker: dat u zelf geen investering hoeft te doen of dat u uiteindelijk een lagere energierekening heeft? Geef het aan in onderstaand schema.

Zelf investeren:
Wanneer u zelf investeert geeft de ESCo een garantie af dat u energie gaat besparen in ruil voor een maandelijkse toelage. Het financiële voordeel van de energiebesparing is volledig voor u.

ESCo investeert:
Wanneer de ESCo investeert zal het financiële voordeel van de energiebesparing gedeeld worden tussen u en de ESCo. Hierdoor loopt u minder financieel risico maar is de kostenbesparing kleiner tijdens de looptijd van het contract.

	extreem belangrijker	fors belangrijker	sterk belangrijker	matig belangrijker	even belangrijk	matig belangrijker	sterk belangrijker	fors belangrijker	extreem belangrijker	
Criteria	9	7	5	3	1	3	5	7	9	Criteria
Zelf investeren	○	○	○	○	○	○	○	○	○	ESCo investeert

vorige | volgende

Berg Enquête System © 2007 Design Systems

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Tijdsduur contract
De contractduur wordt bepaald door de investering die gedaan wordt door de ESCo, deze zijn te verdelen in drie groepen:

Korte contractduur (0 – 5 jaar):
Aanpassingen die weinig of geen investering nodig hebben kunnen snel terugverdiend worden, hierbij kun je denken aan collectief energie inkopen, personeel informeren hoe ze energiezuinig kunnen werken of aanpassen van oude TL verlichting. Dit levert maar een kleine energiebesparing op.

Gemiddelde contractduur (5 – 10 jaar):
Aanpassen van de installaties van een gebouw vragen om hogere investeringen, hierdoor zal het contract langer duren. Hiermee wordt er meer energie bespaard.

Lange contractduur (10 – 15 jaar):
Aanbrengen van isolatie en andere aanpassingen aan de gebouwschil is het meest arbeidsintensief en vraagt om een lange contractduur. Dit bespaart de meeste energie.

Een langere contractduur zal uiteindelijk een hogere besparing opleveren maar brengt ook extra risico's met zich mee, hoe ziet uw bedrijf er over 15 jaar uit? Bevindt het zich nog op de zelfde locatie? In onderstaand schema kunt u aangeven welke contractduur interessant is voor u.

	extreem belangrijker	fors belangrijker	sterk belangrijker	matig belangrijker	even belangrijk	matig belangrijker	sterk belangrijker	fors belangrijker	extreem belangrijker	
Criteria	**9**	**7**	**5**	**3**	**1**	**3**	**5**	**7**	**9**	**Criteria**
Korte contractduur	○	○	○	○	○	○	○	○	○	Gemiddelde contractduur
Korte contractduur	○	○	○	○	○	○	○	○	○	Lange contractduur
Gemiddelde contractduur	○	○	○	○	○	○	○	○	○	Lange contractduur

vorige | volgende

EINDHOVEN

TU/e Technische Universiteit Eindhoven University of Technology

energie besparing door ESCo

Einde enquête

Allereerst wil ik u bedanken voor uw tijd en moeite om deze enquête in te vullen.

Kent u andere bedrijven in Eindhoven die geïnteresseerd kunnen zijn in ESCo's? U bent vrij om de link van de enquête door te sturen.

Dank u voor uw medewerking!

Chris Driessen

Als u nog vragen heeft dan kunt u een e-mail sturen naar: c.driessen@eindhoven.nl

Appendix B: feasibility study

All companies

Karakeristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
all	-	-	79	100.485	5.069	0	19,8	☑
beweging en daglicht	-	-	85	122.435	3.046	0	40,2	☑
beweging en tl5	-	-	54	44.437	3.132	0	14,2	☑
daglicht en verlichting	-	-	108	107.025	6.264	0	17,1	☑
daglicht	-	-	25	22.470	504	0	44,6	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
energy manager	1.603	0	0	0	50.008	0	0,0	☑
correctie	-297	0	0	0	-28.512	0	0,0	☑
correctie	297	0	0	0	35.640	0	0,0	☑
Totaal	1.603	0	351	396.852	75.151	0	5,28	

Samenvatting ☑ Toon gegevens

	Brandstof			Referentie			Voorgesteld systeem			Besparing brandstofkosten		
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik		Brandstofkosten	Brandstofverbruik		Brandstofkosten	Bespaarde brandstof		Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	54,0	€	5.184	1.646,0	€	158.012	-1.592,0	€	(152.828)
Elektriciteit	MWh	€	120,000	1.899,8	€	227.979	0,0	€	-	1.899,8	€	227.979
Totaal					€	233.163		€	158.012		€	75.151

Projectverificatie

Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		54,0	
Elektriciteit	MWh		1.899,8	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	1.603		351	1.954
Brandstofgebruik- voorgesteld systeem	1.483		163	1.646
Bespaarde brandstof	120		188	308
Bespaarde brandstof - %	7,5%		53,5%	15,8%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

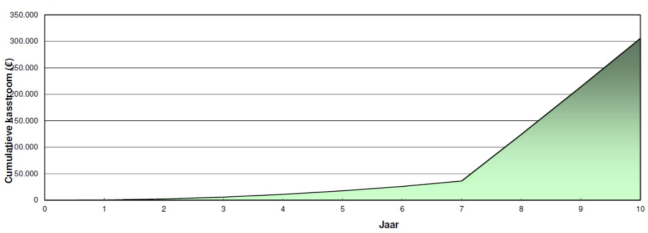
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	383,5			
Voorgesteld systeem	tCO2	323,1			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	60,4			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	60,4	is equivalent aan	5,6	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	7	
Initiële kosten			
Energiebesparingsmaatregelen	€	396.852	100,0%
Anders	€		0,0%
Totale initiële kosten	€	396.852	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	158.012	
Aflossing en rente - 7 jaren	€	76.224	
Anders	€		
Totale jaarlijkse kosten	€	234.237	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	233.163	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	233.163	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	-3,0%	
Simpele terugverdientijd	jaar	5,3	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 1

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Bespaarde energie	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	3	0	0	0	1.092	0	0,0	☑
Totaal	3	0	0	0	1.092	0	0,00	

Samenvatting ☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	**Brandstof-verbruik - eenheid**	**Brandstof-prijs**	**Brandstofverbruik**	**Brandstofkosten**	**Brandstofverbruik**	**Brandstofkosten**	**Bespaarde brandstof**	**Besparing brandstofkosten**
Elektriciteit	MWh	€ 96,000	0,0	€ -	32,4	€ 3.108	-32,4	€ (3.108)
Elektriciteit	MWh	€ 120,000	35,0	€ 4.200	0,0	€ -	35,0	€ 4.200
Totaal				€ 4.200		€ 3.108		€ 1.092

Projectverificatie **Brandstoftype**	**Brandstof-verbruik - eenheid**	**Brandstofgebruik-historisch**	**Brandstofverbruik** **Referentie**	**Brandstofgebruik-verschil**
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		35,0	

Brandstofverbruik	**Warmte** **MWh**	**Koeling** **MWh**	**Elektriciteit** **MWh**	**Totaal** **MWh**
Brandstofgebruik- referentiesysteem	35			35
Brandstofgebruik- voorgesteld systeem	32			32
Bespaarde brandstof	3			3
Bespaarde brandstof - %	7,5%			7,5%

☐ **Toon gegevens** Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

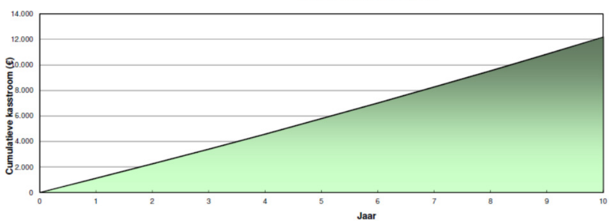
Krachtopwekking referentiesysteem (baseline BKG) **Land - regio**	**Brandstoftype**	**BKG-emissiefactor zonder transport- en distributie-verliezen)** **tCO_2/MWh**	**T&D verliezen** **%**	**BKG-emissie-factor** **tCO_2/MWh**
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO_2	6,9			
Voorgesteld systeem	tCO_2	6,4			
Bruto jaarlijkse BKG-emissie-reductie	tCO_2	0,5			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO_2	0,5	is equivalent aan	0,0	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO_2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	5	
Initiële kosten			
Energiebesparingsmaatregelen	€	0	
Anders	€		
Totale initiële kosten	€	0	0,0%
Stimuleringspremies en subsidies	€		
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	3.108	
Aflossing en rente - 5 jaren	€	0	
Anders	€		
Totale jaarlijkse kosten	€	3.108	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	4.200	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	4.200	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	positief	
Simpele terugverdientijd	jaar	0,0	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 2

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
beweging en tl5	-	-	54	44.437	3.132	0	14,2	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	264	0	0	0	8.237	0	0,0	☑
	-54	0	0	0	-5.184	0	0,0	☑
	54	0	0	0	6.480	0	0,0	☑
Totaal	264	0	54	44.437	12.665	0	3,51	

Samenvatting ☑ Toon gegevens

	Brandstof			Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik	Brandstofkosten	Brandstofverbruik	Brandstofkosten	Bespaarde brandstof	Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	0,0	€ -	265,6	€ 25.495	-265,6	€ (25.495)
Elektriciteit	MWh	€	120,000	318,0	€ 38.160	0,0	€ -	318,0	€ 38.160
Totaal					€ 38.160		€ 25.495		€ 12.665

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		318,0	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	264		54	318
Brandstofgebruik- voorgesteld systeem	244		21	266
Bespaarde brandstof	20		33	52
Bespaarde brandstof - %	7,5%		60,4%	16,5%

☐ Toon gegevens   Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

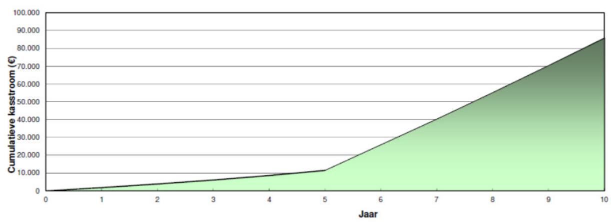
BKG-emissie					
Referentie	tCO2	62,4			
Voorgesteld systeem	tCO2	52,1			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	10,3			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	10,3	is equivalent aan	0,9	Hectares bos die koolstof absorberen

Inkomen uit BKG-reductie		
Vergoeding BKG-emissiereductie	€/tCO2	

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	5	
Initiële kosten			
Energiebesparingsmaatregelen	€	44.437	100,0%
Anders	€		0,0%
Totale initiële kosten	€	44.437	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	25.495	
Aflossing en rente - 5 jaren	€	11.130	
Anders	€		
Totale jaarlijkse kosten	€	36.625	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	38.160	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	38.160	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	9,6%	
Simpele terugverdientijd	jaar	3,5	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 3

Karakteristieken faciliteit

☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Bespaarde energie	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	26	0	0	0	10.982	0	0,0	☑
Totaal	26	0	0	0	10.982	0	0,00	

Samenvatting

☑ Toon gegevens

	Brandstof			Referentie			Voorgesteld systeem			Besparing brandstofkosten		
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik		Brandstofkosten	Brandstofverbruik		Brandstofkosten	Bespaarde brandstof		Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	0,0	€	-	325,6	€	31.258	-325,6	€	(31.258)
Elektriciteit	MWh	€	120,000	352,0	€	42.240	0,0	€	-	352,0	€	42.240
Totaal					€	42.240		€	31.258		€	10.982

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		352,0	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	352			352
Brandstofgebruik- voorgesteld systeem	326			326
Bespaarde brandstof	26			26
Bespaarde brandstof - %	7,5%			7,5%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

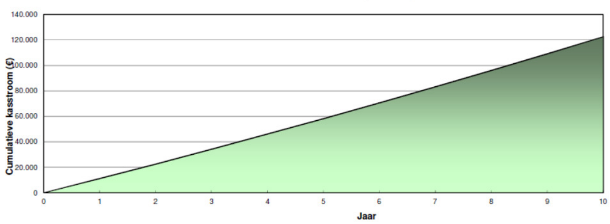
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	69,1			
Voorgesteld systeem	tCO2	63,9			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	5,2			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	5,2	is equivalent aan	0,5	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	5	
Initiële kosten			
Energiebesparingsmaatregelen	€	0	
Anders	€		
Totale initiële kosten	€	0	0,0%
Stimuleringspremies en subsidies	€		
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	31.258	
Aflossing en rente - 5 jaren	€	0	
Anders	€		
Totale jaarlijkse kosten	€	31.258	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	42.240	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	42.240	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	positief	
Simpele terugverdientijd	jaar	0,0	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 4

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
beweging en daglicht	-	-	72	104.200	2.592	0	40,2	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	398	0	0	0	12.418	0	0,0	☑
	-72	0	0	0	-6.912	0	0,0	☑
	72	0	0	0	8.640	0	0,0	☑
Totaal	398	0	72	104.200	16.738	0	6,23	

Samenvatting ☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	Brandstof-verbruik - eenheid	Brandstof-prijs	Brandstofverbruik	Brandstofkosten	Brandstofverbruik	Brandstofkosten	Bespaarde brandstof	Besparing brandstofkosten
Elektriciteit	MWh	€ 96,000	0,0	€ -	413,2	€ 39.662	-413,2	€ (39.662)
Elektriciteit	MWh	€ 120,000	470,0	€ 56.400	0,0	€ -	470,0	€ 56.400
Totaal				€ 56.400		€ 39.662		€ 16.738

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		470,0	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	398		72	470
Brandstofgebruik- voorgesteld systeem	368		45	413
Bespaarde brandstof	30		27	57
Bespaarde brandstof - %	7,5%		37,5%	12,1%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

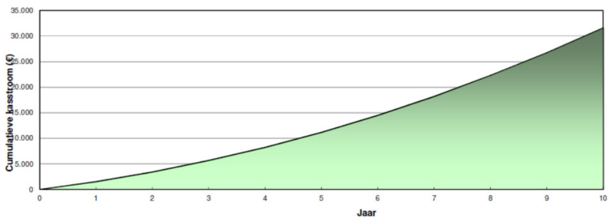
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	92,3			
Voorgesteld systeem	tCO2	81,1			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	11,2			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	11,2	is equivalent aan	1,0	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	104.200	100,0%
Anders	€		0,0%
Totale initiële kosten	€	104.200	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	39.662	
Aflossing en rente - 10 jaren	€	15.529	
Anders	€		
Totale jaarlijkse kosten	€	55.191	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	56.400	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	56.400	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	-15,6%	
Simpele terugverdientijd	jaar	6,2	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 5

Karakeristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
daglicht	-	-	13	11.235	252	0	44,6	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	69	0	0	0	2.152	0	0,0	☑
	-13	0	0	0	-1.210	0	0,0	☑
	13	0	0	0	1.512	0	0,0	☑
Totaal	69	0	13	11.235	2.706	0	4,15	

Samenvatting ☑ Toon gegevens

	Brandstof			Referentie			Voorgesteld systeem			Besparing brandstofkosten		
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik		Brandstofkosten	Brandstofverbruik		Brandstofkosten	Bespaarde brandstof		Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	0,0	€	-	73,8	€	7.086	-73,8	€	(7.086)
Elektriciteit	MWh	€	120,000	81,6	€	9.792	0,0	€	-	81,6	€	9.792
Totaal					€	9.792		€	7.086		€	2.706

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		81,6	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	69		13	82
Brandstofgebruik- voorgesteld systeem	64		10	74
Bespaarde brandstof	5		3	8
Bespaarde brandstof - %	7,5%		20,8%	9,5%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

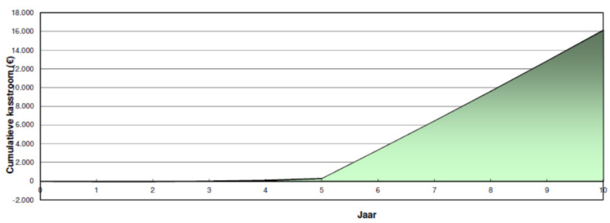
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	16,0			
Voorgesteld systeem	tCO2	14,5			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	1,5			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	1,5	is equivalent aan	0,1	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	5	
Initiële kosten			
Energiebesparingsmaatregelen	€	11.235	100,0%
Anders	€		0,0%
Totale initiële kosten	€	11.235	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	7.086	
Aflossing en rente - 5 jaren	€	2.814	
Anders	€		
Totale jaarlijkse kosten	€	9.900	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	9.792	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	9.792	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	167,9%	
IRV voor belasting - bezittingen	%	4,7%	
Simpele terugverdientijd	jaar	4,2	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 6

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
daglicht en verlichting	-	-	54	53.512	3.132	0	17,1	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	122	0	0	0	3.806	0	0,0	☑
	-54	0	0	0	-5.184	0	0,0	☑
	54	0	0	0	6.480	0	0,0	☑
Totaal	122	0	54	53.512	8.234	0	6,50	

Samenvatting ☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	Brandstof-verbruik - eenheid	Brandstof-prijs	Brandstofverbruik	Brandstofkosten	Brandstofverbruik	Brandstofkosten	Bespaarde brandstof	Besparing brandstofkosten
Elektriciteit	MWh	€ 96,000	0,0	€ -	134,2	€ 12.886	-134,2	€ (12.886)
Elektriciteit	MWh	€ 120,000	176,0	€ 21.120	0,0	€ -	176,0	€ 21.120
Totaal				€ 21.120		€ 12.886		€ 8.234

Projectverificatie

Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		176,0	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	122		54	176
Brandstofgebruik- voorgesteld systeem	113		21	134
Bespaarde brandstof	9		33	42
Bespaarde brandstof - %	7,5%		60,4%	23,7%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark

Energie-eenheid	kWh
Referentie-eenheid	m²

☑ Emissieanalyse

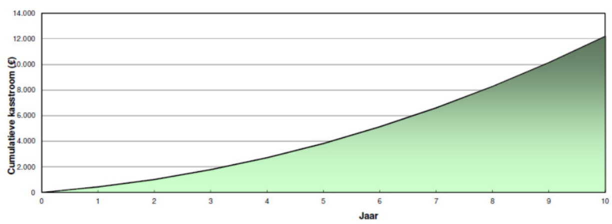
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	34,5			
Voorgesteld systeem	tCO2	26,3			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	8,2			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	8,2	is equivalent aan	0,8	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	53.512	100,0%
Anders	€		0,0%
Totale initiële kosten	€	53.512	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	12.886	
Aflossing en rente - 10 jaren	€	7.975	
Anders	€		
Totale jaarlijkse kosten	€	20.860	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	21.120	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	21.120	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	-18,2%	
Simpele terugverdientijd	jaar	6,5	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 7

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
daglicht en verlichting	-	-	54	53.512	3.132	0	17,1	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
Totaal	0	0	54	53.512	3.132	0	17,09	

Samenvatting ☑ Toon gegevens

	Brandstof			Referentie			Voorgesteld systeem			Besparing brandstofkosten		
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik		Brandstofkosten	Brandstofverbruik		Brandstofkosten	Bespaarde brandstof		Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	54,0	€	5.184	21,4	€	2.052	32,6	€	3.132

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		54,0	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem			54	54
Brandstofgebruik- voorgesteld systeem			21	21
Bespaarde brandstof			33	33
Bespaarde brandstof - %			60,4%	60,4%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

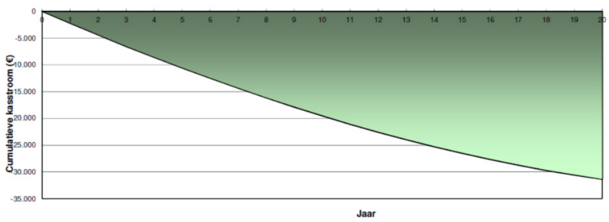
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	10,6			
Voorgesteld systeem	tCO2	4,2			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	6,4			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	6,4	is equivalent aan	0,6	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	20	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	20	
Initiële kosten			
Energiebesparingsmaatregelen	€	53.512	100,0%
Anders	€		0,0%
Totale initiële kosten	€	53.512	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	2.052	
Aflossing en rente - 20 jaren	€	5.450	
Anders	€		
Totale jaarlijkse kosten	€	7.502	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	5.184	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	5.184	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	negatief	
IRV voor belasting - bezittingen	%	negatief	
Simpele terugverdientijd	jaar	17,1	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 8

Karakeristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
daglicht	-	-	13	11.235	252	0	44,6	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	34	0	0	0	1.061	0	0,0	☑
	-13	0	0	0	-1.210	0	0,0	☑
	13	0	0	0	1.512	0	0,0	☑
Totaal	34	0	13	11.235	1.615	0	6,96	

Samenvatting ☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	Brandstof-verbruik - eenheid	Brandstof-prijs	Brandstofverbruik	Brandstofkosten	Brandstofverbruik	Brandstofkosten	Bespaarde brandstof	Besparing brandstofkosten
Elektriciteit	MWh	€ 96,000	0,0	€ -	41,4	€ 3.977	-41,4	€ (3.977)
Elektriciteit	MWh	€ 120,000	46,6	€ 5.592	0,0	€ -	46,6	€ 5.592
Totaal				€ 5.592		€ 3.977		€ 1.615

Projectverificatie

Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		46,6	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	34		13	47
Brandstofgebruik- voorgesteld systeem	31		10	41
Bespaarde brandstof	3		3	5
Bespaarde brandstof - %	7,5%		20,8%	11,1%

☐ Toon gegevens Zie benchmarkdatabase

Benchmark

Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

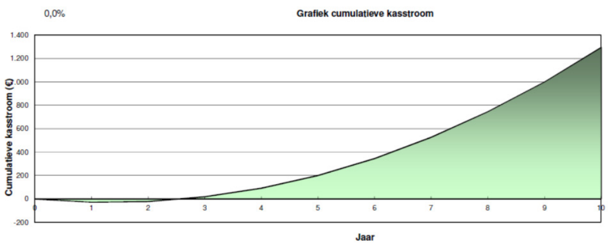
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	9,1			
Voorgesteld systeem	tCO2	8,1			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	1,0			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	1,0	is equivalent aan	0,1	Hectares bos die koolstof absorberen

Inkomen uit BKG-reductie		
Vergoeding BKG-emissiereductie	€/tCO2	

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	11.235	100,0%
Anders	€		0,0%
Totale initiële kosten	€	11.235	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	3.977	
Aflossing en rente - 10 jaren	€	1.674	
Anders	€		
Totale jaarlijkse kosten	€	5.651	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	5.592	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	5.592	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	124,2%	
IRV voor belasting - bezittingen	%	-23,2%	
Simpele terugverdientijd	jaar	7,0	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	



Company 9

Karakteristieken faciliteit ☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
all	-	-	54	68.513	3.456	0	19,8	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	122	0	0	0	3.806	0	0,0	☑
	-54	0	0	0	-5.184	0	0,0	☑
	54	0	0	0	6.480	0	0,0	☑
Totaal	122	0	54	68.513	8.558	0	8,01	

Samenvatting ☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	**Brandstof-verbruik - eenheid**	**Brandstof-prijs**	**Brandstofverbruik**	**Brandstofkosten**	**Brandstofverbruik**	**Brandstofkosten**	**Bespaarde brandstof**	**Besparing brandstofkosten**
Elektriciteit	MWh	€ 96,000	0,0	€ -	130,9	€ 12.562	-130,9	€ (12.562)
Elektriciteit	MWh	€ 120,000	176,0	€ 21.120	0,0	€ -	176,0	€ 21.120
Totaal				€ 21.120		€ 12.562		€ 8.558

Projectverificatie

Brandstoftype	**Brandstof-verbruik - eenheid**	**Brandstofgebruik-historisch**	**Brandstofverbruik Referentie**	**Brandstofgebruik-verschil**
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		176,0	

Brandstofverbruik	**Warmte MWh**	**Koeling MWh**	**Elektriciteit MWh**	**Totaal MWh**
Brandstofgebruik- referentiesysteem	122		54	176
Brandstofgebruik- voorgesteld systeem	113		18	131
Bespaarde brandstof	9		36	45
Bespaarde brandstof - %	7,5%		66,7%	25,7%

☐ Toon gegevens *Zie benchmarkdatabase*

Benchmark

Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

Krachtopwekking referentiesysteem (baseline BKG) Land - regio	**Brandstoftype**	**BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh**	**T&D verliezen %**	**BKG-emissie-factor tCO2/MWh**
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	34,5			
Voorgesteld systeem	tCO2	25,7			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	8,9			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	8,9	is equivalent aan	0,8	Hectares bos die koolstof absorberen

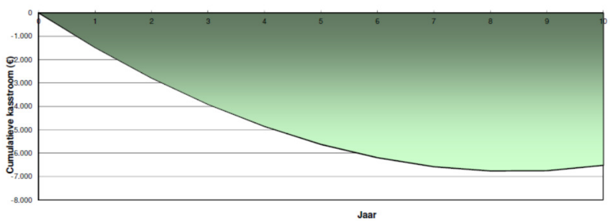
Inkomen uit BKG-reductie

Vergoeding BKG-emissiereductie	€/tCO2	

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	68.513	100,0%
Anders	€		0,0%
Totale initiële kosten	€	68.513	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	12.562	
Aflossing en rente - 10 jaren	€	10.210	
Anders	€		
Totale jaarlijkse kosten	€	22.772	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	21.120	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	21.120	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	negatief	
IRV voor belasting - bezittingen	%	negatief	
Simpele terugverdientijd	jaar	8,0	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Company 10

Karakteristieken faciliteit

☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
beweging en daglicht	-	-	13	18.235	454	0	40,2	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	109	0	0	0	3.401	0	0,0	☑
	-13	0	0	0	-1.210	0	0,0	☑
	13	0	0	0	1.512	0	0,0	☑
Totaal	109	0	13	18.235	4.157	0	4,39	

Samenvatting

☑ Toon gegevens

	Brandstof		Referentie		Voorgesteld systeem		Besparing brandstofkosten	
Brandstoftype	Brandstof-verbruik - eenheid	Brandstof-prijs	Brandstofverbruik	Brandstofkosten	Brandstofverbruik	Brandstofkosten	Bespaarde brandstof	Besparing brandstofkosten
Elektriciteit	MWh	€ 96,000	0,0	€ -	108,7	€ 10.435	-108,7	€ (10.435)
Elektriciteit	MWh	€ 120,000	121,6	€ 14.592	0,0	€ -	121,6	€ 14.592
Totaal				€ 14.592		€ 10.435		€ 4.157

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		121,6	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	109		13	122
Brandstofgebruik- voorgesteld systeem	101		8	109
Bespaarde brandstof	8		5	13
Bespaarde brandstof - %	7,5%		37,5%	10,6%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

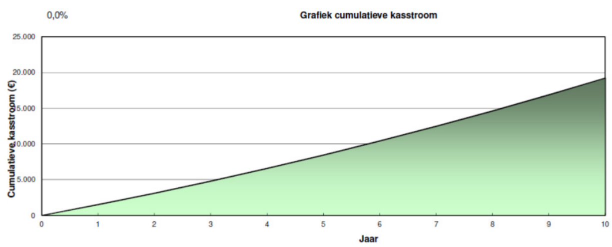
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	23,9			
Voorgesteld systeem	tCO2	21,3			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	2,5			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	2,5	is equivalent aan	0,2	Hectares bos die koolstof absorberen

Inkomen uit BKG-reductie		
Vergoeding BKG-emissiereductie	€/tCO2	

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	18.235	100,0%
Anders	€		0,0%
Totale initiële kosten	€	18.235	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	10.435	
Aflossing en rente - 10 jaren	€	2.718	
Anders	€		
Totale jaarlijkse kosten	€	13.153	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	14.592	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	14.592	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	0,9%	
Simpele terugverdientijd	jaar	4,4	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	



Company 11

Karakteristieken faciliteit

☑ Toon gegevens

Tonen:	Warmte	Koeling	Elektriciteit	Incrementele initiële kosten	Besparing brandstofkosten	Incrementele besparingen op O&M	Simpele terugverdientijd	Maatregel meenemen?
Brandstofgebruik- referentiesysteem	MWh	MWh	MWh	€	€	€	jaar	☐
Warmte-installatie								
	0	-	-	0	0	0	-	☑
	0	-	-	0	0	0	-	☑
Koelsysteem								
Gebouwschil								
Ventilatie								
Lampen								
all	-	-	25	31.972	1.613	0	19,8	☑
Elektrische apparatuur								
Warm water								
Pompen								
Ventilatoren								
Motoren								
Proceselektriciteit								
Proceswarmte								
Processtoom								
Stoomverliezen								
Warmteterugwinning								
Gecomprimeerde lucht								
Koeling								
Anders								
	97	0	0	0	3.026	0	0,0	☑
	-25	0	0	0	-2.419	0	0,0	☑
	25	0	0	0	3.024	0	0,0	☑
Totaal	97	0	25	31.972	5.244	0	6,10	

Samenvatting

☑ Toon gegevens

	Brandstof			Referentie			Voorgesteld systeem			Besparing brandstofkosten		
Brandstoftype	Brandstof-verbruik - eenheid		Brandstof-prijs	Brandstofverbruik		Brandstofkosten	Brandstofverbruik		Brandstofkosten	Bespaarde brandstof		Besparing brandstofkosten
Elektriciteit	MWh	€	96,000	0,0	€	-	98,1	€	9.420	-98,1	€	(9.420)
Elektriciteit	MWh	€	120,000	122,2	€	14.664	0,0	€	-	122,2	€	14.664
Totaal					€	14.664		€	9.420		€	5.244

Projectverificatie Brandstoftype	Brandstof-verbruik - eenheid	Brandstofgebruik-historisch	Brandstofverbruik Referentie	Brandstofgebruik-verschil
Elektriciteit	MWh		0,0	
Elektriciteit	MWh		122,2	

Brandstofverbruik	Warmte MWh	Koeling MWh	Elektriciteit MWh	Totaal MWh
Brandstofgebruik- referentiesysteem	97		25	122
Brandstofgebruik- voorgesteld systeem	90		8	98
Bespaarde brandstof	7		17	24
Bespaarde brandstof - %	7,5%		66,7%	19,7%

☐ Toon gegevens

Zie benchmarkdatabase

Benchmark		
Energie-eenheid	kWh	
Referentie-eenheid	m²	

☑ Emissieanalyse

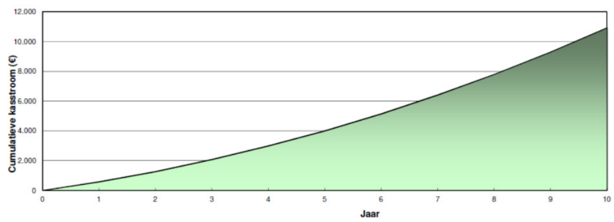
Krachtopwekking referentiesysteem (baseline BKG) Land - regio	Brandstoftype	BKG-emissiefactor zonder transport- en distributie-verliezen) tCO2/MWh	T&D verliezen %	BKG-emissie-factor tCO2/MWh
Canada	Alle types	0,196		0,196

BKG-emissie					
Referentie	tCO2	24,0			
Voorgesteld systeem	tCO2	19,3			
Bruto jaarlijkse BKG-emissie-reductie	tCO2	4,7			
Transactie-kosten BKG emissie-credits	%				
Netto jaarlijkse BKG-emissiereductie	tCO2	4,7	is equivalent aan	0,4	Hectares bos die koolstof absorberen
Inkomen uit BKG-reductie					
Vergoeding BKG-emissiereductie	€/tCO2				

Financiële Analyse

Financiële parameters			
Inflatie	%	2,0%	
Projectduur	jaar	10	
Schuldratio	%	100%	
Rentevoet lening	%	8,00%	
Looptijd lening	jaar	10	
Initiële kosten			
Energiebesparingsmaatregelen	€	31.972	100,0%
Anders	€		0,0%
Totale initiële kosten	€	31.972	100,0%
Stimuleringspremies en subsidies	€		0,0%
Jaarlijkse kosten en aflossingen			
Kosten (besparingen) op O&M	€	0	
Brandstofkosten - Voorgestelde installatie	€	9.420	
Aflossing en rente - 10 jaren	€	4.765	
Anders	€		
Totale jaarlijkse kosten	€	14.185	
Jaarlijkse besparingen en inkomsten			
Brandstofkosten - Referentie-installatie	€	14.664	
Anders	€		
Totale jaarlijkse besparingen en inkomsten	€	14.664	
Financiële levensvatbaarheid			
IRV voor belasting - eigen vermogen	%	positief	
IRV voor belasting - bezittingen	%	-14,4%	
Simpele terugverdientijd	jaar	6,1	
Terugverdienen op eigen vermogen	jaar	onmiddellijk	

Grafiek cumulatieve kasstroom



Summaries

A STRATEGY TO SETUP ENERGY SERVICES FOR BUSINESS DISTRICTS WITH SMALL TO MEDIUM SIZED COMPANIES

A case study of de Hurk

Chris Driessen

Graduation program:
Construction Management and Urban Development 2014-2015

Graduation committee:
Prof.dr.ir. B. de Vries (TU/e)
dr.ir. Q. Han (TU/e)
ir. F. Dekkers (D-IA)
ir. A. Verboom (municipality of Eindhoven)

Date of graduation:
20-8-2015

ABSTRACT
Business districts with small to medium sized companies show high energy saving potential. Because of lack of knowledge and funds this potential is not used. Combining these small and medium sized companies together will make them interesting for Energy Service Companies (ESCos). This paper selects which type of ESCo is most suitable for these companies. With the help of the Analytic Hierarchy Process (AHP) and Quality Function Deployment (QFD) the most suited from of ESCo is found. This ESCo should focus on appointing an energy manager and adapting the lighting system with movement sensors and daylight switches.

Keywords: energy services, small and medium sized companies, ESCo, energy efficiency measures, QFD, AHP

INTRODUCTION
The municipality of Eindhoven wants to be energy neutral in 2045. This should be achieved by cooperating with the government, businesses and industry, research institutes and the citizens themselves because these are the important pillars in order to get the city of Eindhoven energy neutral. To achieve this the municipality of Eindhoven set itself a clear goal:

''*The municipality has set itself the goal of achieving energy-neutrality between 2035 and 2045. By energy-neutrality, the municipality means that energy demand must be limited as far as possible, and the energy needs within the city's boundaries must be sustainable generated. The municipality has set itself the goal of achieving this ambition excluding mobility before 2035 and including mobility before 2045.*''

In 2012, the total energy consumption in Eindhoven was 4,55 PJ of electricity and 8,60 PJ of gas. With 55% of the gas consumption and 78% of the total electricity consumption the industrial and institutional sector is responsible for the largest part and in the past years industrial energy consumption keeps increasing.

Despite the enormous saving potential within business districts, developments regarding energy efficiency and renewable energy are slow and fragmented. Awareness of the possibilities is growing but development is often constrained by the complex environment of stakeholders and responsibilities, rules and regulations and uncertainties. In the face of rising energy prices and binding regulation, energy efficiency and renewable energy will inevitably become more important. Large companies have financial means to reach the set objectives individually but they represent only a small number on business districts. The majority of businesses, 99%, belongs to the category medium and small sized businesses (<250 employees). This category has less knowledge, time and money available to invest in any energy measures. This makes them lack behind on sustainable energy development and potentially endanger their business profitability and continuity. The high and concentrated energy use of these companies makes them interesting clients for the energy service industry. (van der Zanden, 2013)

Energy Sercive Companies
An energy service company (ESCo) is specialized in delivering energy services and can relieve these companies from implementing and financing energy efficiency measures and renewable energy sources.

The first ESCos were created in the late 1970s and early 1980s. However, most ESCo activity occurred in the late 1980s and 1990s (Vine, 2005). ESCos have proven their benefit for the industrial sector in foreign countries such as the USA and Germany. In the Netherlands, ESCos can take away the barriers to the implementation of energy savings and renewable energy as well. In Europe, Germany, Italy and France have a large number of ESCos while in the Netherlands only a few ESCos are established. Nevertheless the Dutch ESCo market shows stable growth and focusses on Energy systems in medium-sized and large non-residential new building projects. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

Unlike other energy service providers, equipment providers or facility managers, ESCos share or take over the customer's technical and/or financial risk of the project. The ESCo can cover the technical risk by guaranteeing the energy savings, which can lower the cost of financing. Under such an arrangement, the ESCo guarantees a certain level of energy savings and shields the client from any performance risk. The ESCo and the client can also split the technical risk in accordance with a pre-arranged percentage by introducing a shared savings scheme in the contract. The remuneration of the ESCo can also be directly tied to the energy savings achieved.1 Depending on the resources of the ESCo and on the market demand, ESCos may finance projects themselves or assist in the arrangement of project financing by means of providing performance guarantees. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

ESCos give companies multiple advantages like: lower energy bill, no financial risk, no investment necessary, PR/image improvement and it makes it possible to achieve environmental targets. But as mentioned earlier small and middle sized companies have less knowledge, time and money available to invest in any energy measures. Combining those companies in one district ESCo gives the following extra advantages: Due to scale benefits energy tariffs will be lower, companies do not have to manage the process and can focus on their core business, all the knowledge is available at one spot and savings stay in the area and can be reinvested.

Successful project bundling strategies can help overcome many of the key barriers to financing ESCo projects. To achieve sufficient economies of scale, a strategy is required that allows for the aggregation of individual projects, technologies, service offers, and investments in to a larger and more comprehensive lots, which could be interesting for ESCos financial institutions. (Marino, Bertoldi, Rezessy, & Boza-Kiss, 2011)

Despite the opportunities ESCos offer the development of the ESCo market in the Netherlands is slow. The major barriers in this development are the lack of information and understanding of the opportunities that energy efficiency offer; lack of culture for project financing; public procurement rules that prevent the use of ESCOs; safety and reliability concerns that hinder the introduction of new technologies; burdensome administrative procedures that allow only very large projects to be carried out; and limited understanding of energy efficiency and performance contracting by financial institutions. (Vine, 2005)

Research question

The goal of this research is to find the most suitable type of ESCo to make business districts with small to medium companies more sustainable. This will result in lower CO_2 emissions and better use of renewable energy sources which will help to realize the "energy neutral in 2035-2045" target from the municipality of Eindhoven. It will also give a financial benefit to the participants. The scope of this research will be business districts in the Netherlands and the case study will be of De Hurk.

This results in the following main question:
How can energy management by an Energy Service Company become feasible for business districts with small to medium sized companies?

And sub questions:
Which type of ESCo is suitable for business districts with small to medium sized companies?
How can the municipality convince business owners to participate in ESCo projects?

In order to answer the main question a case study will be conducted on business district De Hurk. This case study answers the following sub questions:
What is the energy saving potential of business district the Hurk?
What do business owners expect from the Energy Service Company?
Why should business owners participate and are they willing to participate in this project?

RESEARCH METHOD

An excellent method to do research with the use of customer requirements is the Quality Function Deployment (QFD) method. QFD is a system used for translating and prioritizing customers' needs and market demands into suitable technical characteristics and ensuring that important ones are prioritized in the design. QFD consists of making quality tables like the House of Quality (HOQ), a matrix used in the process that displays the customers' requirements versus the technical responses to meet them (Figure 1). The relation between the customer and technical requirements come from a literature study.

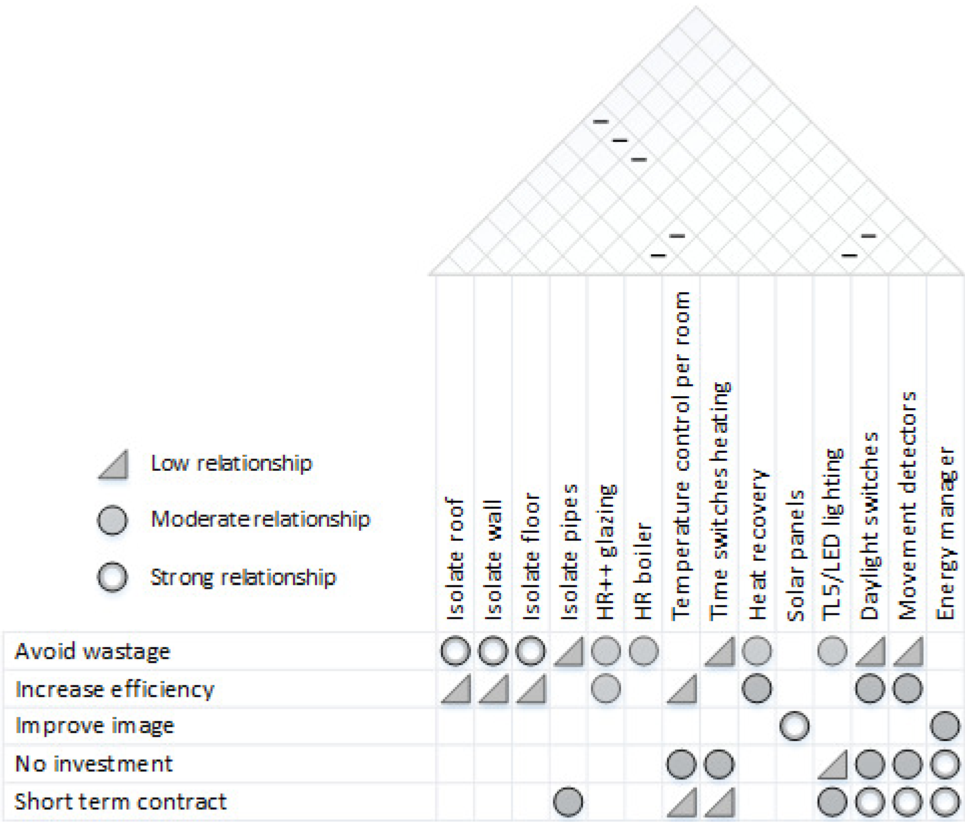


Figure 1: House of Quality

Next step is to rate the customer requirements. This will be done by the questionnaire that is distributed to business owners. The design of the survey and the processing of the data are done on the basis of the AHP method.

The Analytic Hierarchy Process (AHP) is developed by Saaty in 1980. It is a decision support tool for processes that involve multiple alternatives. On top of the AHP stands the goal of the process, followed by criteria and sub criteria, and at the bottom the different alternatives. The criteria can be weight by pair wise comparisons and the best alternative to suit the goal can be calculated. (Saaty, 1988)

All judgments of the various pairwise comparisons are summarized in a Comparison Matrix. In real-life decision problems, pairwise comparison matrices are rarely consistent. Nevertheless, decision makers are interested in the level of consistency of the judgments, which somehow expresses the goodness or “harmony” of pairwise comparisons totally, because inconsistent judgments may lead to senseless decisions.

The customer requirements are related to the technical characteristics. With the use of the house of quality the most important technical characteristics are calculated. This information is used to calculate the financial feasibility together with the energy saving potential found with a questionnaire. This is done with ten different data sets expecting different outcomes because of the different energy saving potential and weight customer requirements.

The questionnaire used for this study consist of three parts: business profile, energy saving potential and business preferences. The business profile gives the economic sector and business size while the energy saving potential gives an estimate of the feasibility of energy services for business district the Hurk. The last part, business preferences, gives pairwise comparisons of the customer requirements of energy services which are divided in three groups:

Corporate social responsibility: Companies can have several reasons to take responsibility for their impact on society. This is focused on four main aspects: meeting objectives that produce long-term profits, using business power in a responsible way, integrating social demands and contributing to a good society by doing what is ethically correct . Working with an ESCo will address those points by avoiding wastage, increase organizational efficiency and Improve the company's image.

Financial aspects: As stated before there are two options for financing an ESCo project customer or ESCo financing (with or without help of a third party). If the companies do the investments they will get the highest profit but not all companies have the means to do the investment or do not want to take the risk.

Term of contract: The efficiency measures have different payback periods. You can divide them in three groups: short-term (0-5 years), mid-term (5-10 years) and long-term (10-15 years) contracts.

The technical characteristics used in this study are the energy efficiency measures (EEM) which the ESCo can accommodate. The energy saving potential part of the questionnaire asks the companies which of these EEM's are already implemented and which are desired.
A list with contact information of 114 businesses on business district de Hurk is used to send out a questionnaire. 27 of them belong to the micro sized category, 43 are small sized and 28 are Medium sized. Adding this up gives 98 businesses meaning 16 are large companies.

FINDINGS

Data collection

Of the 114 sent questionnaires 23 were filled in completely giving a response of 20%. Of these 23 companies seven were micro, eight small, five medium and three large sized. To see differences in preferences 10 different datasets are used:

1. all data
2. micro and small sized companies
3. medium and large sized companies
4. building owners
5. renter
6. micro and small sized companies owning the building
7. micro and small sized companies renting the building
8. medium and large sized companies owning the building
9. medium and large sized companies renting the building
10. all companies interested in ESCos

Analysis
First step in the data processing is checking if the data set is complete. With the use of SPSS 22 is checked if all 23 participants filled in all the questions and all the answers are in the range of 1-2 (first 3 questions) or 1-9 (the customer preferences).

Second is looked at the independence of the first three answers. SPSS is used to discover if there is a relationship between two categorical variables with the use of Pearson's chi-square test.

When you choose to analyze your data using a chi-square test for independence, you need to make sure that the data you want to analyze "passes" two assumptions, if it does not, you cannot use a chi-square test for independence. These two assumptions are:
Your two variables should be measured at an ordinal or nominal level (i.e., categorical data). With company size belonging to the ordinal level and interest in ESCo and owner/renter to the nominal level this is passed.
Your two variable should consist of two or more categorical, independent groups. This is also true, all variables consist of two independent groups.

For six datasets the dependence of interest in ESCo on company size and owner/renter is calculated. This tells us that there is a statistically significant association between being owner or renter and interest in ESCo.
To determine the strength of the association the Cramer's V is calculated. The value of .481 indicates a very strong positive association, meaning when more companies are owner of their building more companies are interested in ESCos.

The next data check is about the consistency of the business preferences. When the decision maker thinks A > B and B > C, it should be that A > C. Saaty (1980) developed a method to calculated the inconsistency of the pairwise comparison matrices. Saaty (1980) concluded that an inconsistency ratio of about 10% or less may be considered as acceptable. For non-expert responds the CR could be relaxed to 0.20, making it easier to answer the pairwise comparisons. Of the 23 filled in questionnaires four proofed to be inconsistent. They are removed from the dataset.

Last step is to look at the robustness of the AHP. The absolute ranking is an quantitative indices for robustness (Deok-Hwan & Kwang-Jae, 2009). The influence of uncertainty on this ranking will determine the robustness of the research. The uncertainty has been simulated using normal distributed random variables with the initial value as mean with different standard deviations (Ghiya, et al., 1999). This uncertainty has a low influence on the ranking of the AHP, only from a standard deviation of 0,4 and onwards you see the ranking shifts. This makes the AHP robust.

Results
The final result of the AHP is given in Table Table 151. Looking at the three main criteria you see micro and small businesses as well as renters see Corporate social responsibility as most important while medium and large businesses as well as building owners find the financial aspects most important.

If you look closer at the financial aspects the group of medium and large businesses who own the building is the only one interested in investing themselves. Most of these businesses also stated not to be interested in ESCos, so the focus should be on investments by ESCos.

Concerning the term of contract the short-term contract is the most favorable. But the earlier determined target group of micro and small businesses who own the building have no real preference on term of contract.

Table 1: final weight criteria different datasets

	All	micro small	medium large	renter	owner	micro small - renter	micro small - owner	Medium large - renter	Medium large - owner	ESCo interested
CSR	0,38	0,41	0,33	0,40	0,35	0,44	0,37	0,35	0,28	0,30
financial aspects	0,37	0,29	0,48	0,33	0,41	0,28	0,31	0,40	0,60	0,40
term of contract	0,25	0,30	0,20	0,27	0,24	0,28	0,32	0,25	0,13	0,30
avoid wastage	0,13	0,13	0,13	0,14	0,11	0,13	0,12	0,15	0,09	0,13
increase efficiency	0,13	0,14	0,12	0,17	0,09	0,20	0,09	0,13	0,09	0,08
Improve reputation	0,11	0,14	0,08	0,09	0,15	0,11	0,17	0,07	0,10	0,09
own investment	0,16	0,12	0,23	0,14	0,19	0,14	0,08	0,13	0,45	0,11
investment by ESCo	0,21	0,18	0,24	0,19	0,23	0,14	0,22	0,27	0,15	0,29
short-term contract	0,12	0,13	0,11	0,13	0,11	0,15	0,11	0,11	0,08	0,11
mid-term contract	0,08	0,10	0,05	0,07	0,08	0,08	0,12	0,07	0,03	0,10
long-term contract	0,06	0,07	0,04	0,06	0,05	0,05	0,09	0,07	0,01	0,09

Figure 2 shows the final outcome of the QFD for all the company forms. You see clearly the energy manger is best suited for most companies and micro to small sized renters prefer the daylight switches and movement detectors slightly more. After the energy manager movement detector and daylight switches there is a large group equal important: TL5/led lighting, time switches for heating, and temperature control per room.

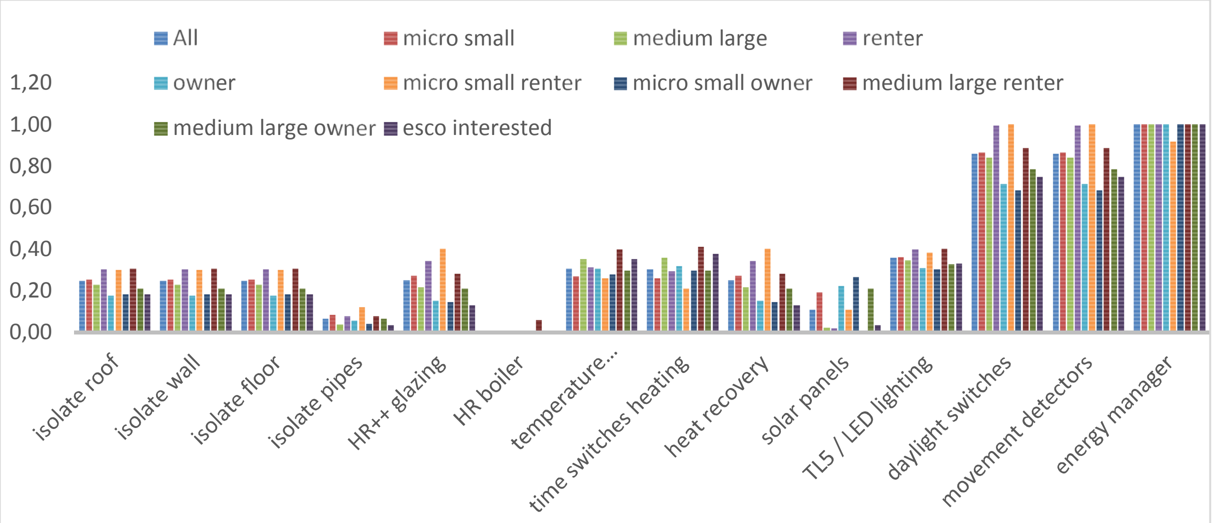


Figure 2: outcome QFD

RETScreen 4 is used to determine if the business case of all interested companies is feasible. This is an Excel-based clean energy project analysis software tool that helps decision makers determine the technical and financial viability of potential renewable energy, energy efficiency and cogeneration (combined heat & power) projects. Users conduct a five step analysis, including energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis.

The data used for this tool are energy use of the companies, used square meters and the costs and effects of the energy efficiency measures. First the energy use was taken from the questionnaire but this information was incomplete, so the average energy use per sector is used. These numbers match with the known energy use of whole the business district.

The results show the emission reduction and financial analyze of all the ESCo interested companies. Together they can save €75.000,- yearly on their energy bill if they invest €397.000,- in adapting their lighting system with daylight switches, movement sensors, energy efficient lighting and appointing an energy manager. The payback time of these investments will be less than 7 years. Doing so they will reduce their CO_2 emissions with 60,4 tCO_2. Which is equivalent 5,6 hectares of forest absorbing carbon. The energy saving potential of these 11 companies is 351 MWh, which is 16% of their total electricity use.

CONCLUSION

RETscreen 4 is used to calculate the energy saving potential of the 11 ESCo interested companies. 351 MWh of electricity can be saved by implementing the following efficiency measures: appointing an energy manager, changing the lighting system and adding movement sensors and daylight switches. The questionnaire is send to one third of all companies on business district the Hurk, making the energy saving potential of this business district around 1000 MWh.

One of the questions of the questionnaire was why the company was interested in energy services. Most answered the cost reduction was important as well as the reduction on CO_2 emission. The research shows the companies expect the ESCo will do the investment and will work with short term contracts. They also expect the ESCo will increase their corporate social responsibility.

An ESCo will give companies with no capital and little knowledge about energy services an opportunity to reduce their energy use and save money (Bertoldi, et al., 2014). Of all 23 companies 11 said to be interested, which is almost 50%. Most of them belong to the micro/small category and own their buildings.

There is potential for ESCos for business districts. The focus should be on micro and small sized businesses who own the building. This group has no funds and knowledge to implement energy services but are willing to do so. Companies who rent the building face a split incentive between them and the building owner, this makes the process more difficult (van der Zanden, 2013). The awareness about ESCos should be increased by starting with short term contracts and efficiency measures that do not need any investments to let the companies get used to the concept (Bertoldi, et al., 2014).

DISCUSSION

This study gives insight is energy services by an ESCo for business districts. However, this study has some limitations and thereby some opportunities for further research.

If you look at the distribution between micro, small, medium and large companies you see a difference between the distribution in the Netherlands and the distribution of the companies who responded on the questionnaire. This means the findings of this research can't be scaled up to whole the Netherlands.

23 companies responded on the questionnaire, which is a small sample. By dividing the sample in two groups like owner/renter or micro-small/medium-large, the reliability of the answers is just enough. Dividing the sample in four groups; micro-small owner, micro-small renter, medium-large owner and medium-large renter made the sample too small to give a reliable answer.

According to the questionnaire the most desired energy efficiency measure is solar panels while the literature states this is not financially feasible due to governmental rules and legislation. Also the given numbers of energy use seem odd in comparison to average energy use numbers of business district the Hurk. I expect the people filling in the questionnaire did not know the numbers and did not investigate the feasibility of solar energy. This corresponds with the low awareness of their energy saving potential and the advantages an ESCo could give them.

REFERENCES

Bertoldi, P., Boza-Kiss, B., Panev, S. & Labanca, N., 2014. *ESCO Market Report 2013,* Luxemburg: European Commission.
Bertoldi, P., Boza-Kiss, B. & Rezessy, S., 2007. *Latest Development of Energy Service Companies across Europe: A European ESCo Update,* Luxembourg: European Commission, Joint Research Center (JRC).
Deok-Hwan, K. & Kwang-Jae, K., 2009. Robustness indices and robust prioritization in QFD. *Expert Systems with Applicaionts,* Volume 36, pp. 2651-2658.
Ghiya, K. K., Bahill, A. T. & Chapman, W. L., 1999. QFD: Validation Robustness. *Quality Engineering,* 11(4), pp. 593-611.
Marino, A., Bertoldi, P., Rezessy, S. & Boza-Kiss, B., 2011. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. *Energy Policy,* pp. 6190-6198.
Saaty, T. L., 1988. What is the Analtic Hierarchy Proces?. *Mathematical Models for Decision Support,* Issue 48, pp. 109-121.
van der Zanden, H., 2013. *Energy services for business districts,* Eindhoven: TU/e.
Vine, E., 2005. an international survey of the energy service company (ESCO) industry. *Energy Policy,* pp. 691-704.

Chris Driessen

Born in 1989 in Druten. Chris began his engineering career in Eindhoven at Eindhoven University of Technology in 2008, graduating as Bachelor of Science in 2013. Willing to study further, Chris decided to focus on the management aspect within the construction industry. Arising from this he has successfully completed the Master Construction Management and Engineering at the Eindhoven University of Technology in 2015.

2008 – 2013 Bachelor Bouwkunde
2013 – 2015 Master Construction Management and Engineering
2015 – 2015 Internship municipality of Eindhoven

EEN STRATEGIE VOOR ENERGY SERVICES VOOR BEDRIJVENTERREINEN MET MIDDEN EN KLEIN BEDRIJF

Een case study van de Hurk

Auteur: Chris Driessen

Afstudeer programma:
Construction Management and Urban Development 2014-2015

Afstudeer comité:
Prof.dr.ir. B. de Vries (TU/e)
dr.ir. Q. Han (TU/e)
ir. F. Dekkers (D-IA)
ir. A. Verboom (Gemeente Eindhoven)

Datum van afstuderen:
20-8-2015

ABSTRACT
Bedrijven terreinen met midden tot klein bedrijf tonen grote potentie voor energie besparing maar door een gebrek aan kennis en geld wordt dit potentieel niet gebruikt. Door deze kleine bedrijven samen te voegen wordt het interessant voor Energy Service Companies (ESCo's) om in te stappen. Deze paper selecteert welk type ESCo het meest geschikt is. Aan de hand van het Analytic Hierachy Process (AHP) en Quality Function Deployment (QFD) de best passende ESCo is gevonden. Deze ESCo moet focussen op het aanstellen van energie managers en het aanpassen van het verlichting systeem met bewegingssensors en daglicht regelaars.

Trefwoorden: energy services, midden en klein bedrijf, ESCo, energie efficiënte aanpassingen, QFD, AHP

INTRODUCTIE

Gemeente Eindhoven heeft de ambitie om in 2045 energie neutraal te zijn. Dit betekend dat het energiegebruik van de stad en duurzame opwekking van energie in evenwicht zijn. Hiervoor moet de energievraag van inwoners, bedrijven en gemeentelijke instellingen geminimaliseerd worden terwijl de energie die nodig is, duurzaam wordt opgewekt.

Het minimaliseren van de energievraag kan behaald worden door gebruik te maken van een Energy Service Company (ESCo). Hierbij besteedt een eigenaar of gebruiker van een gebouw de energievoorziening en het management daarvan uit aan een externe partij met als doel te besparen op energiekosten en de eigen organisatie te ontlasten. De contractpartner die de installaties, het energiebeheer en -management, etc. overneemt is meestal een consortium van partijen bestaande uit een technisch team en een financier. De investeringen worden terugbetaald met de besparingen op de energie rekening gedurende de looptijd van het contract. Er is niet een vaste vorm voor een ESCo, de exacte vorm van installaties en invulling van andere afspraken zoals financiering, looptijden, etc. zal afhangen van het type project en de wensen van de eigenaar of gebruiker.

Onderzoeksvraag

Het doel van dit onderzoek is het vinden van een geschikte ESCo vorm voor bedrijven terreinen met midden en klein bedrijf. Dit zal resulteren in een lagere CO_2 emissie en lager energy verbruik, wat ook een financieel voordeel met zich mee brengt. Hiermee komt de gemeente Eindhoven dichter bij het doel om energie neutraal te zijn in 2045. Dit onderzoek maakt gebruik van een case study over bedrijven terrein de Hurk.

Dit onderzoek beantwoordt de volgende onderzoeksvraag:

Hoe maak je energie management door een Energy Service Company haalbaar voor bedrijven terreinen met midden tot klein bedrijf?

ONDERZOEKSMETHODE

In dit onderzoek is gebruik gemaakt van Quality Function Deployment. Dit is een methode om de wensen van de klant om te zetten in technische eigenschappen van een product. De wensen van de klant zijn verzameld aan de hand van een enquête.

Deze enquête bestaat uit drie delen: Bedrijfsprofiel, energie besparingspotentieel en bedrijfsvoorkeuren. De voorkeuren zijn ingedeeld in drie groepen:

Maatschappelijk verantwoord ondernemen: Bedrijven kunnen verschillende redenen hebben om verantwoording te nemen voor hun impact op de samenleving en milieu zoals: behalen van doelen die in de toekomst winst opleveren, verantwoordelijk gebruik van de macht van het bedrijf en doen wat ethisch correct is. Samenwerken met een ESCo pakt deze punten aan door verspilling tegen te gaan, efficiëntie te vergroten en het imago van het bedrijf te verbeteren

Financiële aspecten: Er zijn twee mogelijkheden, het bedrijf doet de investering zelf en de ESCo geeft advies en voort de aanpassingen uit of de ESCo neemt zowel de financiering en werkzaamheden voor zijn rekening.

Contract duur: De verschillende aanpassingen hebben ook verschillende terugverdien tijden. Deze zijn grofweg in te delen in drie groepen: kort (0-5 jaar), gemiddeld (5-10 jaar) en lang (10-15 jaar).

De technische eigenschappen gebruikt in dit onderzoek zijn de energie efficiëntie aanpassingen welke de ESCo aan kan bieden.

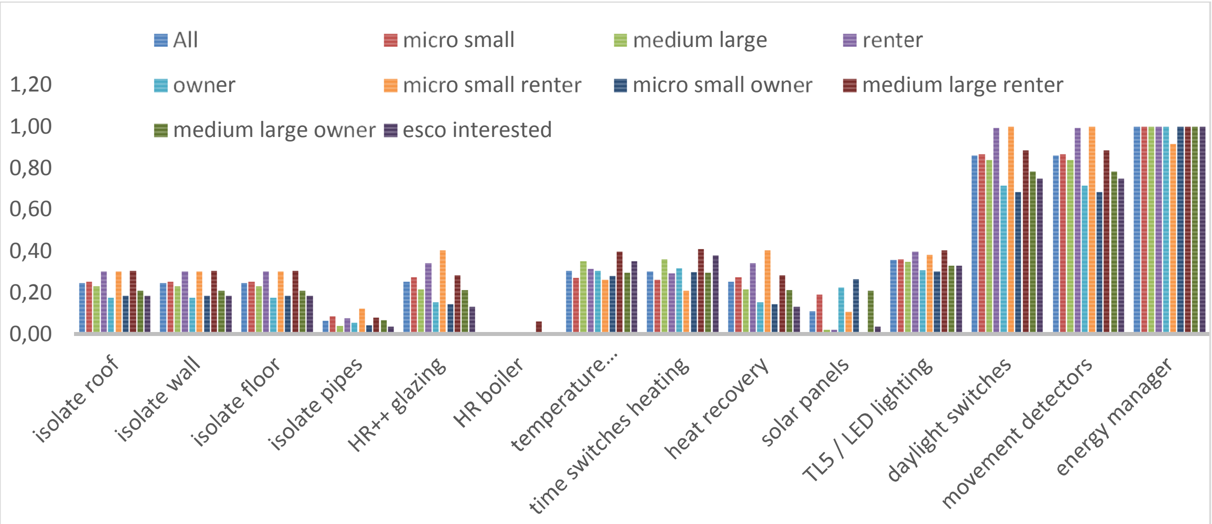
RESULTATEN

Een lijst met contact informatie van 114 bedrijven op de Hurk is gebruikt om de enquête naar te sturen. Van deze 114 zijn er 23 volledig ingevuld, dit geeft een respons van 20%. Hiervan waren 7 bedrijven van het micro formaat (<10 werknemers), 8 klein formaat (<50 werknemers), 5 midden formaat (<250 werknemers) en 3 van groot formaat.

De resultaten van de AHP geven aan dat kleine bedrijven en huurders maatschappelijk verantwoord ondernemen het belangrijkst vinden, terwijl eigenaren en grote bedrijven meer letten op het financiële aspect. Wanneer je kijkt naar het financiële aspect zie je dat alleen de grote bedrijven die eigenaar zijn zelf willen investeren. Deze bedrijven hebben ook aangegeven in de enquête dat ze niet geïnteresseerd zijn in ESCo services. De focus zal dus gericht moeten zijn op investeringen door de ESCo.

De AHP geeft ook duidelijk aan dat er een voorkeur is voor de korte contract duur. De kleine bedrijven die eigenaar zijn hebben geen sterke voorkeur voor een bepaalde contract duur. Uit het onderzoek blijkt dat deze groep het meest geïnteresseerd is in ESCo services. Dit is dat ook de doelgroep wanneer een ESCo opgezet gaat worden.

Met de informatie uit de AHP is de QFD ingevuld met 10 verschillende data sets (Figuur 1). De QFD wijst de energie manager aan als beste energie efficiëntie aanpassing gevolgd door daglicht schakelaars en bewegingssensors. Daarna volgt een grote groep met gelijk belang.



Figuur 1: resultaat QFD

Met behulp van RETScreen 4 is er gekeken of deze aanpassingen ook financieel haalbaar zijn. Dit is een gratis programma dat energie project analyses kan uitvoeren. Het kijkt naar technische en financiële mogelijkheden aan de hand van vijf stappen: energie analyse, kosten analyse, emissie analyse en risico analyse.

In dit programma de data is gebruikt die uit de enquête komt zoals energie verbruik en aantal vierkante meters bedrijfshal. Dit is aangevuld met gemiddelde kosten en verwacht rendement van de aanpassingen. De uitkomst van de analyse geeft aan dat de geïnteresseerde bedrijven gezamenlijk €75.000,- per jaar kunnen besparen als ze €397.000,- investeren in het aanstellen van een energie manager en het aanpassen van het verlichting systeem met daglichtschakelaars en bewegingssensors. De terugverdien tijd van deze aanpassingen zal minder dan 7 jaar bedragen.

Hiermee kunnen ze hun CO_2 uitstoot verminderen met 60,4t wat gelijk is aan de CO_2 absorptie van 5,6 hectare bos. Verder besparen ze gezamenlijk 351 MWh aan elektriciteit, wat 16% van hun energie verbruik is.

CONCLUSIE
Met gebruik van RETScreen 4 de energie besparingspotentie van de 11 bedrijven geïnteresseerd in ESCos is berekend. 351 MWh elektriciteit kan bespaard worden door de volgende aanpassingen te doen: aanstellen van een energie manager, aanpassen van verlichting met bewegingssensors en daglicht schakelaars. De enquête is verstuurd naar een derde van alle bedrijven op bedrijventerrein de Hurk, voor het volledige bedrijventerrein de potentiele energie besparing ligt rond de 1000 MWh.

Dit geeft aan dat er potentie is voor ESCo's voor midden en klein bedrijf. De doelgroep van deze ESCo zullen kleine bedrijven zijn die eigenaar zijn van het pand. Dit zijn bedrijven die aangeven wel energie efficiënte aanpassingen te willen doen maar niet het geld en de kennis hebben. De rol van de ESCo is dan het adviseren en regelen van de financiering. Dit zal zorgen voor een energie besparing maar ook een financieel voordeel met zich mee brengen.

Een van de vragen van de enquête was waarom de bedrijven geïnteresseerd zijn in ESCo's. De meeste beantwoordden dat de kosten vermindering en CO_2 besparing het belangrijkst waren. De AHP analyse geeft aan dat de bedrijven verwachten dat de ESCo de investering zal doen en dat er gewerkt wordt met een korte contractduur. Ze verwachten ook dat in zee gaan met een ESCo het maatschappelijk verantwoord ondernemen vergroot. Dit zijn ook de aandachtspunten om de bekendheid van ESCo's te vergroten. Aanpassingen die weinig investeringen vragen en werken met contracten van korte duur geven de bedrijven een kans te wennen aan het ESCo concept.

DISCUSSIE
Dit onderzoek werkt met een casestudy van bedrijventerrein de Hurk. De samenstelling van de respondenten komt niet overeen met de samenstelling van bedrijven in Nederland, hierdoor is de uitkomst niet op te schalen naar heel Nederland.

De enquête leverde 23 volledig ingevulde lijsten op wat een kleine steekproef is. Doordat deze ook nog opgedeeld is in 10 groepen met verschillende samenstelling de betrouwbaarheid van de kleine groepen is twijfelachtig.

De enquête geeft ook aan dat de bedrijven graag zonnepanelen willen installeren maar eerder onderzoek geeft aan dat dit niet financieel rendabel is door regels van de overheid. Ook het opgegeven energie verbruik lijkt niet te kloppen. Dit komt waarschijnlijk omdat de bedrijven niet genoeg onderzoek hebben gedaan naar zonnepanelen en geen idee hebben wat hun energie verbruik is. Dit komt ook overeen met de lage bekendheid van het energie besparingspotentieel en de voordelen een ESCo kan bieden.