Master Thesis

ESCO/EPC in a Municipal Setting

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A thesis in fulfilment of the requirements for the degree of
'Master of Engineering in Sustainable Cities'

9th of June 2017

Abstract/purpose – The purpose of this master thesis is to investigate the current experiences from a finished EPC/ESCO project in order to establish knowledge on today's condition of EPC/ESCO projects.
The motivation is to inform and inspire for future EPC projects in Denmark, combined with the need to be critical of the implementation of the model since it is acknowledged that further investigation and research is needed.

Design/methodology/approach – A deductive research methodology was applied based on an explorative approach on literature and research, case study on Greve Municipality's EPC projects and semi-structured interviews with the involved.

Findings – From the case of Greve Municipality, can it be stated that the ambitious start have led to a constructive experience in terms of efficiency and outcome. The reason why Greve did not choose to do another EPC projects is because of a priority on other political issues than energy efficiency. ESCO in general is on its way to change into the ESCO 2 model, where long-term projects essential, which meets with the requirements from other municipalities and recommendations from Siemens and supplemented studies. This thesis concludes, with the use of *public innovation theory* and supported by additional research, that policies can foster an increased amount, awareness and development of ESCO projects in Denmark.

Keywords – ESCO, Greve Municipality, EPC, Models for renovation, Siemens

Paper type – Master thesis

Reading guide – The introduction will lead the reader into the field of ESCO and EPC combined with state of art and political expectations in order to frame the research design of this thesis. Theory and methodology will follow to establish the empirical assessment. Two analyses will then examine the EPC projects of Greve municipality and analyse the experiences, potentials and challenges.
Lastly will a discussion summon the results from the case of Greve, with different perspectives from research, answer the hypotheses and present the barriers, drivers and future perspectives for ESCO.

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Thanks to my supervisor Jesper Ole Jensen for your patience and help on this thesis, Greve Municipality for data regarding the EPC projects, former Mayor of Greve municipality - Hans Barlach and Sales CEO from Siemens - Lars Nielsen.

9th of June 2017

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Glossary of terms and acronyms

Baseline	The agreed savings. E.g. 20% savings in energy from a ESCO project, which will be used to pay for the project. Therefore, should this not be under the agreed percentage. (See ESCO)
Bundling	A combination/package in marketing; ESCO combines service, screening, monitoring etc. as one single solution/offer. This requires an amount of several buildings.
CTS	Central Tilstands-Styring (Central State Control) a control unit system for monitoring ventilation, heat, energy use etc.
EE	Energy Efficiency
EPC	Energy Performance Contracting (see section EPC)
ESCO	Energy Service Company (Named 'energitjenesteselskab' in Danish by EU). ESCO is the general term, and will be used in general because of its discourse usage. **ESCOs:** (plural) Energy Service Companies **ESCO model**: The model ESCO companies uses (See EPC) **ESCO project**: A EPC project that uses the ESCO model
FM	Facilities Management
OPP	Offentlig Privat Partnerskab (English: Public Private Partnership)
PPP	Public-Private Partnership (see section OPP)

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1. Introduction

EPC (Energy Performance Contracting) projects that have been done by an ESCO (Energy-Service-Company) have been shown from research studies to be some of the best models for renovations in municipalities striving to achieve high and fast energy savings. Policies, governance and investments from EU and the Danish Government have been established to push for more projects to be done, although still more are needed and knowledge from finished EPC projects is desirable (Lindseth, 2015; Pietras, et al., 2013; Bertoldi, Boza-Kiss, Panev, & Labanca, 2014; Dyhr-Mikkelsen, et al., 2010; Jensen, Nielsen, & Nielsen, ESCO-samarbejder vinder frem i Danmark, 2016).
I think this is a paradox. In this master thesis, a critical approach will investigate the process for the municipalities in Denmark to do ESCO projects and investigate how those involved experienced it, in order to examine the challenges for ESCO.
This study will be based on a case study where interviews with the key individuals, conversations with the users, literature and a conference frame the outcome.

Denmark has a goal and a tradition of reducing co2 emissions and being part of the frontrunners when it comes to energy efficiency and savings. Politics push the industries and laws force action, combined with the recognised ambition from the private sectors. The ambitious Paris climate agreement also underlines the importance of investing in energy efficiency.

> *Investments in energy efficiency have proven to be one of the most cost-effective ways to support the transition to a low- carbon economy. Not only does it help the EU in turning its climate ambition into climate action, it also brings a number of significant benefits for European citizens and companies in terms of environment, health, security of supply, lower energy bills, more jobs and sustainable growth.*
> *(European Commission, 2017, p. 1)*

The construction and building industries do grant these goals. In these industries, there lies great potential of reducing the carbon footprint.
Buildings stand for over 100 years and are only renovated a few times. Renovation, refurbishment and retrofitting of buildings play a big part in the sustainable conversion, because 40% of Denmark's energy usage comes from buildings (Dansk Byggeri, 2017).

Refurbishment counts for 50 % of the revenue in the construction industry and employs more than 100.000 people (RENOVER Prisen, 2017).
New constructions are not the sustainable challenge. This is due to ambitious energy requirements and the fact that the new construction represents only 0,7% total building stock in Denmark (Dansk Byggeri, 2017). It is also acknowledged that renovating a building does less harm to the environment than demolition and rebuilding (Bygherreforeningen, Viegand Maagøe, InnoBYG, 2013).
Even though a renovation requires higher investments than building new, the energy savings and benefits are remarkable enough for the construction clients and building owners to take into consideration (Energistyrelsen, 2016).

But refurbishment is not exclusively for the environment's good. One could argue, that preserving buildings also plays a role for our history, identity, culture and productivity. Focus on new innovations, implementation of new technologies and educating the users of energy-systems in the buildings can not only enlighten people to use it more effectively, it can also enhance the users' health and performance. For example, research has shown the indoor climate in public schools decreases pupil's performance by 5-6%, if the CO2 level is higher than 2.000 ppm (DR, 2017). Where a normally ventilated room consists of a CO2 level of 600 ppm, research from the Danish Technical University (DTU) has shown, that the indoor climate plays a major role in terms of children's learning ability (DR, 2017) (Siemens, 2009). Associate Professor Pawel Wargocki has stated that pupils' learning ability increases 10-20%, sick leave decreases and chances of asthma and allergy are reduced, if the indoor climate in the classroom is improved with new ventilation systems, which can also pay for themselves by their energy effectiveness (Siemens, 2009).

Consequently, initiatives that support and applaud renovations instead of new buildings have been established. An example is RENOVER Prisen (the Renovation Award), a yearly award for the best renovation of a building in Denmark (hosted by Realdania and Grundejernes Investeringsfond). Certifications like DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) have shown potentials and new standards of how buildings can ensure high quality and proper refurbishment, which are also of private interest for the building owners to promote and secure the buildings for future standards (Nordregio News, 2014).

Global and local political agendas, research acknowledgement and support from a variety of actions and actors have shown the importance of refurbishment. There are many initiatives that strive for change, such as SustainSolutions and Gate21. However, this master thesis will solely focus on the ESCO model since it includes service, guarantees energy savings and pays for itself.

ESCO (Energy Service Company) is the acronym for companies that are practising the EPC (Energy Performance Contracting) model. EPC is one model out of many that focuses on energy -conservation, -supply, -infrastructure, -outsourcing, -generation, -risk management, -financing, -savings and -retrofitting. What makes EPC different from the others, is that it is a package solution that includes:

- Screening to achieve the highest savings compared to the cost
- Guarantee of the savings
- Payback through the savings
- Service and monitoring
- Education of the users
- Keeping the promised savings afterwards.

EPC is also called the 'Guarantee Savings model' because of the risk the company takes to achieve energy efficiency.
For the sake of clarity, this thesis will entitle EPC as ESCO throughout the rest of the text because of the discourse and popularity the name ESCO has gained.

A growing number of companies are now delivering energy savings products around the world and ESCOs are heading towards the leading position in terms of renovation (FORA, 2010).
The ESCO model is different from traditional ways of making sustainable buildings because it focuses on the soft sides and not only the hard ones. For example, the entrepreneur or construction companies look at how buildings are built (e.g. windows or insulation) and the ESCO companies looks at how buildings are used (e.g. improved ventilation, lightning, heating, etc.). Furthermore, the ESCO company will have more resources to do screening and find the best solution for each building and to educate the users afterwards, to ensure the costs are kept low. Educating and involving the users is a crucial issue to ensure a sustainable consumption behaviour, since enlightening the everyday users and understanding the new

technology (that can monitor our energy use) changes our habits and develops routines in favour of the lower energy usage in a building (Gram-Hanssen, 2008).
Because of the guarantee and responsibility, the ESCO company will try its best to reach the savings and even improve them. If the company reaches a higher savings, the saved money will be shared between the client and the ESCO and if not the company must pay. The payback of the whole ESCO project comes from the savings. Ergo, the ESCO company is obliged to do its best, and that makes it attractive for the buyer, because of the appropriate allocation of risks (e.g. for a municipality with low resources).

One could argue that ESCO projects have the capability to outmatch earlier ensured EE (Energy Efficiencies). For example, when the screening of a building is combined with the intention to lower the energy consumption and make the retrofitting afterwards, the ESCO company has the responsibility to act. Such action is not always a matter of course.
There is a need to connect the screening with the action to achieve energy savings. The Danish energy labelling scheme (Energimærkeordningen), which seeks to find possible energy savings, has been accused of being a waste of money (approximately 100 million EUR), since the money could have been used on the actual retrofitting instead of the labelling (Wittrup & Bredsdorff, 2017). This is supported by the 'Strategy for Energy renovations of buildings' made by the Danish government in 2014. In this government strategy, the main arguments for using the ESCO model are: the guarantee of savings, advantageous financing options and a positive experience for most people who have been in contact with it (Regeringen, 2014).

The challenges for the ESCO model are many. They include outsourcing the working labour, living up to the savings, keeping good communication and trust between the partners, changes happening in the process and the possibility of financial benefits.

Danish political expectations for ESCO refurbishment

The EU commission has an ambition to promote the ESCO projects in the context of efforts to realize socio-economically profitable energy savings (Dyhr-Mikkelsen, et al., 2010). The EU Energy Efficiency and Energy Services Directive imposes upon EU Members to create energy services and ESCOs. Thus, the EU commission defines ESCOs as:

> *'energy service company' (ESCO): 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 so doing. 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; energy performance contracting; (The European Parliament and the councel of the European Union, 2006, p. 5).*

Thus, Denmark is required to create incentives for energy services and to limit the challenges for this market. ESCOs can, according to EU's Green Paper from 2006, stimulate and contribute significantly to the implementation of cost-effective energy savings and make sure technologies which are more energy efficient than the current standard, gain greater market share (European Commision, 2006; Dyhr-Mikkelsen, et al., 2010).

Denmark was enthusiastic when ESCO first became a part of the refurbishment agenda, but had to transfer experiences and professions from Sweden because of their early adaption of ESCO (Appendix 1 - Hans Barlach)(Appendix 2 - Lars Nielsen). An effort to call attention to ESCO was created, including subsidies, study trips for stakeholders and a network called ESCOmmunerne, (contraction of ESCO and the Danish word for Municipalities) (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). An ESCO-Travel Team was even created to ensure guidance on ESCO to municipalities and regions. These accomplishments were integrated in the information activities of the OPS Travel Team (NRGI, 2009). Due to lack of resources and finances, ESCO-Travel Team was closed in 2010 (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). Today, the ESCOmmunerne network (administrated by Middelfart municipality) is still active and a network for the ESCO companies has also been created to exchange knowledge within the field (created by Danish Industry).

And Lars Christian Lilleholt, Minister of Energy, supply and climate, praises the idea and concept of ESCO at Hvidovre Hospital as a thriving initiative that can be the main solution to get renovations, new technology and health benefits in hospitals (Markussen, 2016).

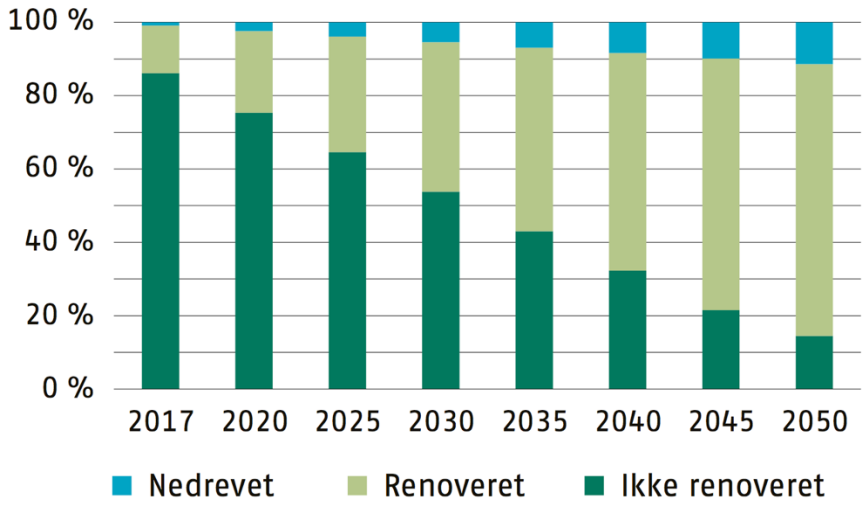
ESCO (Energy Savings Company) has approved of the climate goals to be achieved in the construction and building sectors through refurbishment. The total heat consumption in Denmark must be reduced by 40% from today until 2050 to reach the goals from the Paris agreement (Dansk Byggeri, 2017) and ESCO can play an important role as sellers of energy-services (instead of energy-suppliers) when this forms a bridge between producers of energy efficient technology and energy consumers (Det Økologiske Råd, 2005).
For the past years, the Danish politicians have had a long term focus on being fossil free by 2050. In 2012 the 'Energy Agreement' was made by the government to ensure a 12% reduction of the gross energy consumption from 2006 to 2020 (Regeringen, 2012). Among others, energy refurbishment of existing buildings are, along with the energy companies' saving efforts, two of the primary national instruments in the Energy agreement, that must push the energy efficiency (EE) forward in Denmark (Regeringen, 2012). The agreement invested 30 million Danish kroners (approximately 4 million EUR) from 2012 to 2015 in support of the transition to green energy, with a focus on sustainable production and technologies that can engage in refurbishment of the existing building mass in DK, and the ESCO model is the main solution to do so (Regeringen, 2012).

The energy agreement called for a strategy to enhance analyses and investigation to encourage initiatives that could target a cost-effective effort to enhance the refurbishment of the existing building mass, and here the ESCO models and projects mentioned were recommended (Regeringen, 2012).
The same government from 2012 made a milestone proceeding paper 'Vores Energi' (Our Energy) in 2013. Here, renovation of buildings was articulated as a serious topic and the intention of supporting that was proposed in the law of finance with 500 million Danish kroners (approximately 67 million EUR) in 2013 and 2014 (Regeringen, 2013). ESCO was also mentioned as a model that must be analysed as a potential solution to do more renovations (Regeringen, 2013).

There is a lack of information from finished ESCO Projects. 30 municipalities out of Denmark's 98 municipalities used the ESCO model in 2014 (Energistyrelsen, 2014). And since these ESCO projects have long payback periods, Denmark's National plan of action for energy efficiency (NEEAP) stipulates the need for evaluation, information and investigation in this area (Energistyrelsen, 2014).

It is predicted that the Danish building mass will have a decreasing need for renovations, because of the improved lifetime that the buildings will have gained from their renovation (Dansk Byggeri, 2017).

Figure 1 Projection of the need for renovation of the building mass



Left to right: Demolished, Renovated, Not renovated. (Dansk Byggeri, 2017, p. 14)

If this projection should be realized, and if renovated buildings should create a more energy efficient country of Denmark in the future, it will require action now. Early action requires investment and small municipalities do not have the capacity to do so alone. However, early investigation of the ESCO model in developing countries has shown that the ESCO model is a possibility for making renovations even though the financing is absent (Myung-Kyoon, 2002). The explanation is that ESCO has the possibility of making a payback plan, where the savings pay for the whole project. In this way, the ESCO model makes it possible to take action.

OPP a collaboration between the public and the private sector

The amount of ESCO projects are increasing, and thus could be a possible way of investing in more OPP projects (Danish, Offentligt Privat Partnerskab; English, PPP Public-Private Partnership). In Denmark, the organisation structure OPP was created to outsource construction projects to the private sectors, encouraging long-term investments, and turning over the responsibility to run and maintain the buildings from the public client to the private in order to create effectiveness, quality and efficiency (Bygningsstyrrelsen , 2015; Pietras, et al., 2013) At the same time the partnership gives the opportunity to exchange knowledge between the public and private sector to achieve the best solutions and optimal maintenance (Konkurrence- og Forbrugerstyrelsen, 2013). Still despite positive usage, successful projects and more quality in constructions, the amount of OPP projects are not satisfying when compared to the expectations (Pietras, et al., 2013; Rambøll, 2009).

OPP in Denmark, is described in the executive order of buildings conducted in public-private partnerships, as "*applie[d] to the construction and extension of buildings and facilities linked therefor […], when the construction is built for use by the state, financed with more than 50% loans or subsidies from the state, or built for institutions, receiving operating subsidies from the state, when the subsidies amounts to at least 50%"* (Translated by author)(Retsinformation, 2005, p. 1).

The main challenges for OPP (and also ESCO for that matter) are the transaction costs and the construction-ceiling (Anlægsloft) (Pietras, et al., 2013). A consequence of this is that projects with long-term payment periods leave the municipalities with a maintenance backlog, because of the lack of possibilities to get climate screens into the projects, including roofs, facades, etc. (Nardelli, Jensen, & Nielsen, 2015; Pietras, et al., 2013).

The ESCO Model

The ESCO model originates from the U.S. during the energy crisis in the late 1970's, where new methods were needed to reduce the rise of energy prices (Bullock & Caraghiaur, 2001). Later, when the energy prices dropped again, the model was used internationally to retrofit in countries where the finances for such projects are crucial (Myung-Kyoon, 2002). Today, the ESCO model has developed into promoting energy efficiency around the world, especially in those countries experiencing increased competition and privatization. In particular, the electric utility business experienced liberalization, among others, e.g. heat and construction sectors (Vine, 2005). ESCO also plays an important role in promoting energy efficiency and giving the initiative to start retrofitting projects immediately for the sake of the climate, even if the finances are short (Vine, 2005).

ESCO in Denmark had a kick-start in approximately 2007 for municipalities and 2011 for private households, but today the market has decreased (Pietras, et al., 2013). The first ESCO project began in 2005 as a PSO project and ended as an ESCO (Dyhr-Mikkelsen, et al., 2010). From this, the Danish Confederation of Industries a network was founded in 2007 for all ESCO Companies, consisting of 40 members (not all active as ESCOs) (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014; Dyhr-Mikkelsen, et al., 2010). The European Commission states, there was major growth from 2007-2010 in the ESCO market in Denmark, despite the financial crisis, distributed among 15-20 companies and estimated to be worth 140-150 million EUR in total investment value (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). Today, the number of ESCO companies has changed from utility/supply companies to a few big companies, due to a "*decline of the general construction sector and the consequent lack of orders* [in] *the construction, engineering and manufacturing companies seek new business opportunities* (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014, p. 55). The few companies who have gotten the ESCO markets share are Danfoss Solutions, YIT Buildings Business, Schneider Electric, Kemp & Lauritzen and Siemens (Appendix 1 - Hans Barlach) (Appendix 2 - Lars Nielsen).

An ESCO project typically consist of 60 buildings per project, a payback time of more than 10 years and is divided into 4 phases, but this varies from project to project (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). The allocation of responsibility in the agreement between the ESCO company and the client (e.g. a municipality) is different from project to project. Leonhart (2012) points out four contract types:

- ESCO acts as an adviser and is paid based on the savings achieved (incentive-based advice).
- ESCO takes over the operation of the system besides guaranteeing the savings based on the measures suggested by them.
- ESCO is responsible for the implementation phase in addition to the parts (advice and operation).
- ESCO provides full service, owns, finances, implements energy efficiency improvements and operates the system afterwards (Leonhart, 2012).

This illustrates the variation and differences in different countries.

In most cases, the ESCO model does have these 4 phases. Some projects combine phase 2 and 3, e.g. if a municipality only wishes to give a green light after the screening in phase 1 to start implementation. Therefore, will such project only consist of 3 phases. Normally will the model consist of:

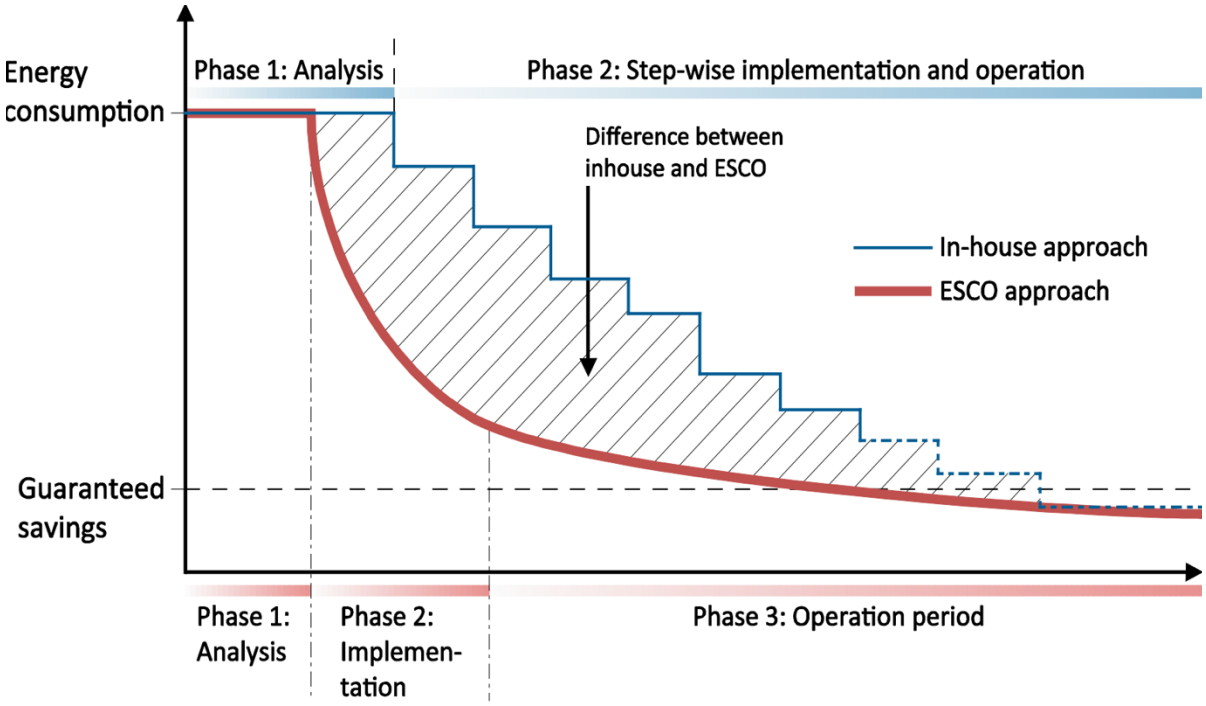
- Phase 1 – Screening (preliminary analysis and establishment of baseline)
- Phase 2 – Implementation (construction)
- Phase 3 – Education (enlightenment of users)
- Phase 4 – Operation (incl. monitoring and maintenance)

(Bertoldi, Boza-Kiss, Panev, & Labanca, 2014; Dyhr-Mikkelsen, et al., 2010).

The ESCO model compared to an in-house model

To understand how an ESCO project works, the following presentation will be based on how it is different from a traditional in-house project in, for example, a municipality.

Figure 2 ESCO vs In-house model



From Sustainability through Retrofitting (buildings) presentation (Jensen J. , 2016, p. 19).

Typically, the in-house has two phases (blue colour). Phase 1: Analysis and Phase 2: Step-wise implementation and operation. But for an ESCO (red colour), which has their expertise in analysing buildings and calculating potentials for the project, Phase 1 will be shorter in relation to the in-house, and after being given permission to start phase 2 (by the municipality), implementation will happen much faster, due to know-how and the fact that the ESCO are obligated by the guarantee (Pietras, et al., 2013). The result is that the energy consumption is decreasing faster in an ESCO project than in an in-house (Pietras, et al., 2013). In comparison, the difference between the in-house and ESCO (diagonal stripes) shows the energy consumption that the ESCO saves and the in-house loses.

Because of this expertise and effectiveness from a great company that specializes in these projects, a higher percentage of energy savings can be achieved in less time (Pietras, et al., 2013). Table 1 *Information about implementing energy renewals compared to in-house and others* illustrates the perspective of comparison:

Table 1 Information about implementing energy renewals compared to in-house and others

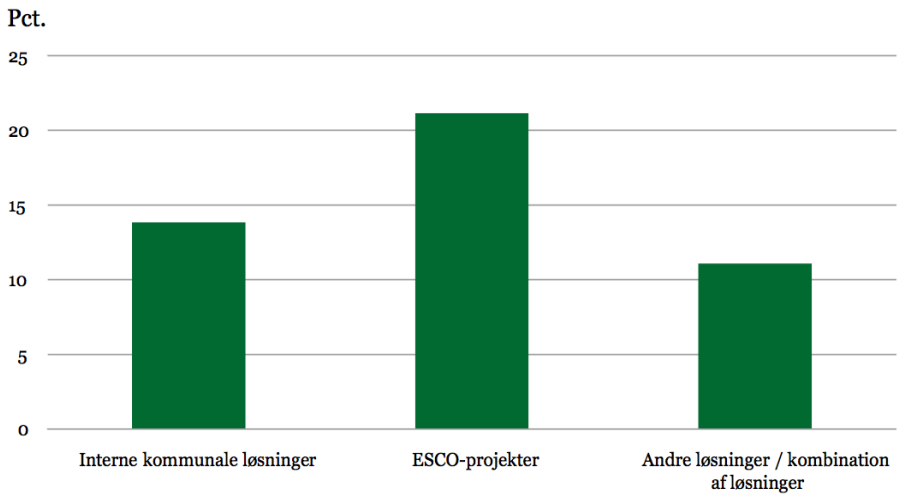
	In-house solutions	ESCO Projects	Other combinations
Years for implementation	6,3	2,2	5,0
€ / m2 invested last 5 years (DKK)	14,2 (107)	45,31 (337)	28.9 (215)
Energy savings	13,8	21,1	11,1

(Udbudsrådet, 2012) (Jensen J. , 2016, p. 22)

It should be noticed that the '€ / m2 invested' is that high in ESCO projects because the many improvements the ESCO company can find/offer (e.g. not only focusing on the low hanging fruits as light sources, but also on bigger investments as insulation, windows etc.) and the use of the financial payback from savings (Udbudsrådet, 2012).

The guarantee of savings is one of the main drivers for using ESCO. The savings that an ESCO company can provide is higher and faster compared to an in-house project (see Figure 2 ESCO vs In-house model). And in the end of the project, the savings are about 5% higher in an ESCO project (Pietras, et al., 2013). In Figure 3 *How much energy savings on average has the renovations caused?* the energy savings percentage from 13 municipalities, who have made both in-house and ESCO projects, are visualized.

Figure 3 How much energy savings on average has the renovations caused?



Left to right: Internal municipal solutions, ESCO-projects, Other solutions / combinations of solutions (Udbudsrådet, 2012, p. 24)

If the energy savings are higher than the estimated value, the profit will be shared between the client and the ESCO, and after the contract period, the client will gain the full profit from the savings. To account that the responsibility of finance may lie either with the client or the ESCO, the benefits from this model are that both the municipality/client/owner of the building and the ESCO can gain the advantages of profit from the start (Dyhr-Mikkelsen, et al., 2010). In most cases, the ESCO will be the one to pay if the savings do not reach estimated percentage and that encourages the ESCO to accomplish the best results (Dyhr-Mikkelsen, et al., 2010).
Interestingly, the contracts signed by ESCOs and municipalities in Denmark include the option for the municipality to quit at certain stages. This provision has been able to give the municipal decision-makers more confidence, especially when municipalities rarely know the ESCO supplier beforehand (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). It was furthermore concluded, that ESCO was the preferred model by 13 municipalities that have used normal refurbishment models and ESCO projects (Udbudsrådet, 2012).

To sum up, the differences between an in-house and an ESCO model, combined with the drivers, the reasons for choosing ESCO are many and it should be noted that it is different from project to project and municipality to municipality. Note that the comparison is not absolute. The general tendencies can be listed as such:

Figure 4 In-house strategy vs. ESCO

	In-house	**ESCO**
Financing	• Step-wise renovation due to budget limitations • Long-term financing uncertain	• Guarantee for energy savings is politically attractive • Energy savings from 'day one'
Transaction costs	• Low transaction costs	• Transaction costs in partnership, require minimum building volume to make ESCO profitable
Capacity building	• Keeps competences in-house, more hands-on influence on solutions	• Learning and innovation from ESCO partnership (also depends on ESCO approach)
Fixation and flexibility	• Flexible in relation to uncertainty on future building portfolio • Coordination between energy retrofitting and building maintenance easier	• ESCO reduces the risk of reductions in future investments in energy savings due to possible changes in political priorities

(Jensen J. , 2016, p. 23)

It can be argued that ESCO is a model with many advantages and has been stated to outmatch in-house refurbishments. The challenges are many and difficult to overcome, combined with the need for knowledge from finished projects. Possibly, the most important challenge could be to make the municipalities engage in more EPC projects with ESCOs or at least find out why this is not happening.

EPC

As described in the introduction, Energy Performance Contracting (EPC) is a model that an ESCO company uses to make an ESCO project.

EPC projects are, as the ESCO projects, defined by the European Union as;

> *'energy performance contracting': a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement;*
>
> (The European Parliament and the councel of the European Union, 2006, p. 5).

In addition, the Transparense Project (consists approximate of 20 countries) has worked towards transparency and trustworthiness in EPC projects. The European Code of Conduct for EPC was developed by the Transparense Project in order to define the basic values and principles that are fundamental for success to implementation of EPC projects in Europe, as a way of trying to standardize and rise confidence in the EPC model.

EPC projects are known to be financed by the company that provides the project, but this is not the case in the Nordic countries where they are almost exclusively financed by the client (e.g. municipality) (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014).

While ESCOs could offer the financing of a project, it is more economical if the municipality takes a public bank loan from the *KommuneKredit* (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). Municipalities in the Nordic countries are "*generally not indebted and do not experience liquidity problems, thus are able to engage in long term contracts, even if these involve taking loans*" (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014, p. 59). A private company will, by contrast, always get loans at a higher interest rate than a municipality loan (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). This is because of the state guarantee behind municipal loans, and the public bank KommuneKredit (Municipal Credit) can lend to municipalities at a very low interest rate (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). (More details on Kommunekredit can be found here (Kommunekredit, 2013).

ESCO in the Danish municipalities

From 2011 to 2013 the number of municipalities, that were already involved or had plans to start an EPC project, increased from 15 to over 30 municipalities (Energistyrelsen, 2014; Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013). In Denmark exists 98 municipalities today.

The economic potential of the ESCO market in Denmark is around 1-7 billion EUR, assuming that most of the state and municipal buildings, as well as social and private housing were renovated using an ESCO and taking into account all costs within an ESCO project (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). But even though the ESCO market is growing in Denmark for private clients, industry and professional portfolio owners, governmental and regional buildings, the demand from municipalities is decreasing (Jensen, Nielsen, & Nielsen, ESCO-samarbejder vinder frem i Danmark, 2016).

There is a great diversity between the ESCO compared projects, in ambition level, investments, energy savings, and time period, among other things that depend on the size and the resources in the given municipality.

The primary tendency so far has involved renovations of schools, which makes sense, since schools by far are the biggest share in the Danish building mass owned by the public (Jensen, Nielsen, & Nielsen, ESCO-samarbejder vinder frem i Danmark, 2016; Udbudsrådet, 2012).

As mentioned, the ESCOmmuner network of municipalities with ESCO projects was created to share knowledge from the projects and gain more quality. Early experiences and research have shown that ESCO is more suitable for projects lasting more than 7 years of payback and consisting of more than one building (Udbudsrådet, 2012). Bundling can also reduce the transaction cost, because it includes service for a combination of buildings and therefore ought an ESCO project to be at least 1.5-2 million EUR (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013).

Thus, ESCO has the best outcome by up-scaling the project.

Here are two examples of some of the biggest ESCO projects in municipalities:

Table 2 Municipal ESCO projects in DK

	Investment	Energy Reduction	Payback time	Note
Høje-Taastrup	10 million EUR	14 %	20 years	ESCO: Schneider Electric
Halsnæs	12 million EUR	30 %	15 years	Biggest ESCO project in 2009. ESCO: YIT

(Mortensen, Sådan plukker Høje-Taastrup de højthængende Esco-frugter, 2010, p. 1)

Both of the projects have had long payback times and have been a big investment with a high percentage of savings. Table 3 *Noteworthy ESCO projects in DK* shows some other remarkable ESCO projects from Siemens (where the client is not a municipality). The intention is to give the reader an overview of ESCO projects in municipalities and other ESCO projects in Denmark in order to compare them. It should be noticed in Table 3, that by increasing investment and payback time, the savings are higher.

Table 3 Noteworthy ESCO projects in DK

	Investment	Energy reduction	Payback time	Note
Southern University	3,5 million EUR	7 %	7 years	The project was seen as a frontrunner in 2012.
Roskilde University	10 million EUR	22,5 %	14,5 years	Biggest ESCO project in Denmark by 2015
Hospital of Hvidovre	22 million EUR	15 %	10 years	Denmark's biggest ESCO project by 2017.

(Windfeld, 2012; Winfeld, 2015; Jensen K. E., 2017; Jensen, Nielsen, & Nielsen, ESCO-samarbejder vinder frem i Danmark, 2016).

The ESCO model has great potentials for public institutions. E.g. Hvidovre Hospital in the table 3, where the resources are scarce and are prioritised to the patients and rising medicine prises, ESCO is a way to get the hospital renovated without having to include the projects in the budget (Markussen, 2016) (Røschmann J. , 2016) (Appendix 3 - Notes from Conference, Lars Nielsen).

Barriers for ESCO & State of the art

ESCO in Denmark is clearly unique and exemplary compared to other countries in EU, because of the societal and political support and economic position of the municipalities (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014).

The ESCO model also does have some challenges. Some of the in-depth sources have been chosen to give a perspective of the most crucial barriers:

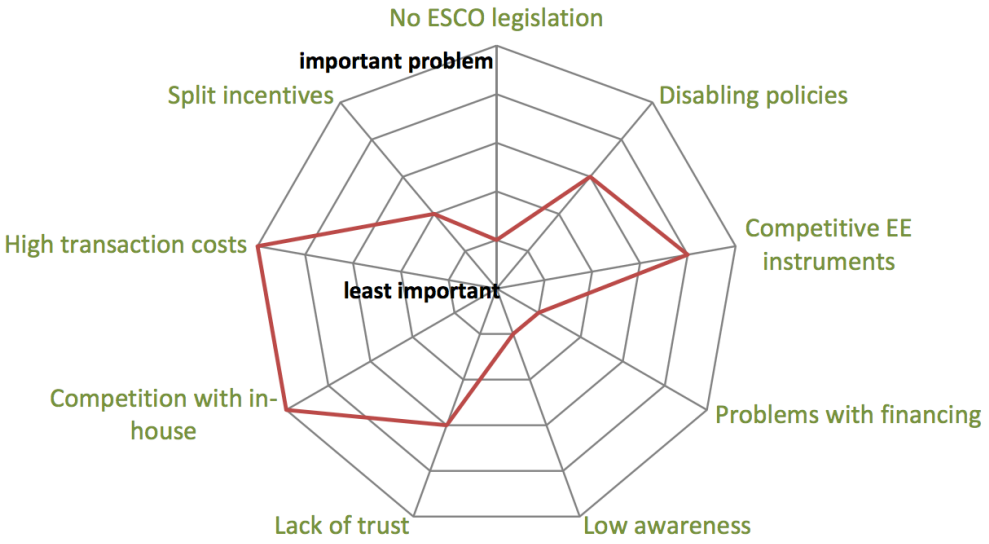
- The Transaction costs and Construction Ceiling (Danish: Anlægsloftet)
- Lack of trust in the concept and scepticism. ESCO seen as a competitor.
- Risk is seen as too high, often based on the fact that many ESCO suppliers are unknown companies.
- Municipalities prefer to keep the profit (that an ESCO gains) for themselves.

(Bertoldi, Boza-Kiss, Panev, & Labanca, 2014; Dyhr-Mikkelsen, et al., 2010; Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013)

To criticize the barrier mentioned last: The Competition and Consumer Agency points out that in-house optimization can harm the market competition and that the buildings will therefore not achieve the expected/optimal energy savings (Pietras, et al., 2013).

The European Commission (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014) has created a figure that visualises the barriers for the ESCO market in Denmark.

Figure 5 Barriers to ESCO projects in Denmark



(Bertoldi, Boza-Kiss, Panev, & Labanca, 2014, p. 60)

The high transaction costs make the ESCO projects even more expensive, and this gives an additional argument for in-house projects. Municipalities argue that when projects are carried out by in-house competences, the knowledge remains internal and can profit future projects (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013). On the other hand, the municipalities that are engaged in ESCO projects experience larger total savings and quicker realization, and therefore higher profitability (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014; Leonhart, 2012).

All in all, research calls for long term experiences on the ESCO market in Denmark, as they are needed (Pietras, et al., 2013; Energistyrelsen, 2014). In relation to the great political expectations from the municipalities, the Danish government and the EU Commission have acknowledged a lack of experiences, evaluations, assessments and knowledge about opportunities and barriers from municipalities with finished ESCO projects.

Research question

What are the experiences from an ESCO project in DK and how can this knowledge help to improve future retrofitting projects in municipalities?

Investments in renovation are unquestionably a method of future proofing against rising and changing energy prices and future sustainable adaptation. ESCO has been articulated as the best available solution/model at the time from 2010 to 2014. Therefore, my interest and purpose of this master thesis is to examine a finished ESCO project and find out if, how and why the ESCO model succeeded and what can be done better: a case-study of Greve Municipality's three EPC (ESCO) projects.
In accomplishing this, four working questions will provide critical guidance for the approach of this study:

- What understandings has the municipality achieved in relation to internal organization (core competencies, contract management, outsourcing) in relation to users and in relation to the purely energy-engineering etc.?
- How was the process of the ESCO project?
- How did the involved clients and users interpret the process?
- What have the barriers been for the municipality to create more ESCO projects?

Hypotheses

Since the sources point out that more experiences and knowledge from finished projects are needed, this master thesis investigates and discusses whether ESCO has lived up to the expected promises from the model. From the research question, several hypotheses have been made on the case study of Greve municipality.

ESCO have faced challenges due to:

- Intern politics in the municipalities
- Fear of outsourcing
- Another/better model has been found (or gotten another name)
- ESCO is not the state of art anymore
- ESCO has shown to be a bad investment
- The municipality saw the potential in finances and want to do it themselves

And if ESCO does not face challenges, a clarification of why ESCO has lost the attention could be that:

- ESCO is so integrated in the municipalities that it has lost its publicity
- The municipalities have chosen to adapt the model as their standard.

These hypotheses will be answered and discussed in the section "Is ESCO/EPC the right model for municipalities?".

2. Theoretical framework: Public Innovation Theory

Innovation is important for a public sector to remain healthy and keep up with the public needs in terms of growth and improvement. Mulgan & Ablury (2003) have, from research in case studies, proposed the challenges, reasons and advantages of fostering innovation in the public sector.

Innovation in the public sector is considered as either *incremental*, *radical* or *systemic* (Mulgan & Albury, 2003, p. 3). And while it is necessary to concede overlapping and grey zones between them, each of them does have barriers due to how the organizations handle the innovation.

- Incremental innovations can be interpreted to be a 'natural' path of innovation since it requires the absence of risks and competitors.
- Radical innovation is not possible without competition and risks to ensure higher quality from the private sector.
- Systematic innovation is forced or necessary. It develops among organizations to align and embed culture, systems, management methods and processes.

(Mulgan & Albury, 2003)

Radical innovations anticipate that organisations (in this case municipalities) who adopt new innovations, achieve improvement in performance in relation to other organisations in the sector (Mulgan & Albury, 2003). This happens while those who have not adopted the innovation continue to do as they were used to, and at the same time, have significantly dissimilar ways of solving the task (Mulgan & Albury, 2003).

Incremental innovations are the accepted path, as a smooth transition for the innovation to be implemented with the help of government. Incremental innovation does not necessarily require political or legislative adjustments, since higher successful innovations require a systematic change (Mulgan & Albury, 2003). This would more likely be a systematic innovation.

The barriers to innovation in public sectors may include a culture of risk aversion and a focus on short-term delivery pressures, due to bureaucratic conservatism, which can also hinder organizational development and progress internally, in general (Mulgan & Albury, 2003). According to Mulgan and Albury, the lack of competition and incentives are expected in a workforce that is unresponsive to, and unwilling to change. (Mulgan & Albury, 2003). For the private sector, these barriers have to be removed in order to maintain or increase profitability, give incentive to cut costs, improve market share and to create new products and

services (Mulgan & Albury, 2003). But for the public sector, the focus is more likely to be on the 'softer' effects such as the quality of services and trust between service providers and users (Mulgan & Albury, 2003).

Mulgan & Albury (2003) propose these changes for the local public sector (in this case a municipality) in order to achieve public innovation:

- The government should take the role as responsible for generating the environment or conditions for innovation to take place in the public sector, including encouraging the lateral diffusion of successful innovations.
- Radically reduce the number of inflicted targets, planning and monitoring requirements.
- Align funding streams with improvement in performance and outcomes to incentivise and create a more visible return on investment in innovation, which encourages the formation of fewer and larger providers of public services.

(Mulgan & Albury, 2003)

The theory seems to have a paradox, since it is unsure whether a few big or many small companies guarantee the best competition and conditions for the innovation.

This theory postulates an understanding of how innovations (e.g. ESCO/EPC) can face challenges and difficulties when implemented in the public sector, how these challenges can be met or avoided and how innovation plays an important role for a society to secure growth and quality.

3. Methodology and research design

The central elements of empirical research in this study have been gained through the explorative approach and critical realism (Juul & Pedersen, 2012). Qualitative research in this study includes a case study, semi-structured interviews and literature search. Deductive research methodology was applied based on the case of Greve municipality's ESCO projects, and then weighed against the hypothesis and theory of public innovation.

Case study

The purpose of using case study as a method is to generalize from the research of Greve and reflect on this as a phenomenon. The case study suggests the presence of reasons why the case is representative. One can argue, that Greve might not be representative as a 'municipality', but on the other hand representative in the category of 'Municipalities with finished ESCO projects,' as Greve municipality was one of the first municipalities to finish two EPC projects (due to their being first-movers and having short project periods). This case can be argued to be an exemplary case, since Greve chose to invest in three projects and then did not invest in ESCO projects afterwards.

The explorative approach is used to gain as much information as possible in order to establish the 'history' of what happened and how it was experienced, because this can provide a less subjective and narrowed view on the case and provide a many-sided story (Flyvbjerg, 2010). The findings will later be discussed to generalize upon the future strategies for ESCO projects. With the precaution of abstraction in this thesis, Flyvbjerg (2010) argues that it has been a misunderstanding in science that the generated data and information upon a subject cannot be used to generalize whole fields of research areas (Flyvbjerg, 2010) This study is nevertheless careful of making generalizations, but will point towards relevant connections that can inspire and ask questions, even though this case looks different from the whole picture.

This case study is engaged by the documents and summaries from Greve municipality during the organisation of ESCO projects (Appendix 3). It should be noted that the understanding of Greve municipality as an institution will be based on these documents.

Semi structured interviews

To acquire insights in the case study, 14 semi structured interviews have been conducted based on interview guides (Appendix 5). This is preferred, so the informants are able to express other key issues than those asked, as this may enable information I did not prepare and additional data I was not aware of (Bryman, 2008). The semi structured interview creates an interview that is more like a conversation and flexible, even though the topic is given and there are already questions prepared. In this method, it is possible to digress from the interview guide if relevant questions emerge on the way (Steinar & Brinkmann, 2009).

The interview data in this thesis consists of: 9 telephone interviews and conversations with relevant staff from some of the schools involved with the EPC I and EPC II in Greve, 3 interviews with participants from the EE conference (Appendix 4) and two interviews with the former Major at Greve municipality (Appendix 1 - Hans Barlach) and Sales CEO from Siemens (Appendix 2 - Lars Nielsen). The interview guides were created with inspiration from SBi's interview guide regarding ESCO in Danish municipalities (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013).

8 scheduled interviews were cancelled, with the consequence that telephone interviews had to be done in order to achieve enough empirical data for the analysis. Unfortunately, these interviews did not give the same in-depth data as the two face-to-face interviews (Appendix 1+2), and the persons interviewed had been less involved in the projects. The telephone interviews (Appendix 6) were semi structured based on the interview guide.

Research limitations/implications

Numerous rejected interviews played a role in the outcome of this thesis. Different reasons can have had an effect on why this happened, such as the fact that if a student is calling for an interview, the response will often be refused. The lack of interviews affects the conclusion and therefore, the following text will come with reasons and reflect on why this has happened.

From the start, literature research painted a clear picture that a specific contact is a key person regarding the ESCO projects in Greve municipality and would be an access to obtaining important information. This identity of the person was given from the data material from Greve municipality (Appendix 3) my phone conversations with various people in the

municipality and Greve's Technology & Environment Centre and lastly pointed out by Hans Barlach. The person was contacted and agreed to take part in an interview, and by the day the interview should have happened the person had taken off for vacation. Later, after he returned, phone calls and notes left by his colleagues, did not get any response from him. This could be due to a lot of reasons, and the change in politics after Hans Barlach, or if the person knew that Greve municipality had no interest in being an ESCO-municipality as a branding strategy is only conjecture in explaining why he vanished as a contact (see analytical framework of Greve).

Another key person that disappeared and never called back is employed at Siemens. From a call on the 10th of March, it was clear that he was willing to take part in an interview, and would even try to get the Sales CEO from Siemens (Lars Nielsen) to join the interview too, but after a cancelled meeting, several re-calls and emails, it was clear that this person did not intend to participate. Luckily, the former Major at Greve municipality (Hans Barlach) did help to get in contact with Lars Nielsen.

An interview with the employee from REEEZ (REEEZ, 2016) who has been in charge of the prospecting of EPC I in Greve, was also cancelled due to the person's termination from employment.

EPC II had no buildings with specific employees involved in the projects (except for the schools that were a part of EPC I) and EPC III is not done yet, thus the majority of the focus is on interviews with the involved in EPC I.

The phone interviews and reasons for the lack of interest in engaging in interviews are listed as followed:

- Tune school's headmaster had no knowledge of the process and also referred to the key person from Greve's Technology & Environment Centre.
- Tjørnelyskolen is in a closing process this year and therefore had no interest in taking part and additionally no employees were involved in EPC I, since everything was managed by the municipality.
- Strandskolen did not have any involvement in the process before the last phase of the EPC I, but the operational staff took some courses and education from the Technological Institute, which the operator mentioned had no real practical use, since their windows and doors were still leaking air.
- Mosedes Skole had an interview set up, but contact was cut due to the person's personal complication. Some data were thus achieved from telephone conversations.

- Krogsgårdskolen: Agreed interview with the technical service person at the school, but at the time of arrival at the school, the meeting was cancelled and he had no interest in participating, due to unknown reasons.

Learning can be attained from these refusals. Employees at schools seem to experience high working pressure and consequently a lack of time. Time constraints often cause research to be uncertain in the exploration and can have the effect that information is lost.

Qualitative literature search and comparison

In the literature used, the qualitative literature search method is used to find pragmatic information and material to cover the societal development in the ESCO market. Articles, books, papers, reports etc. are primarily achieved digitally, and therefore one should be cautious about the data and facts that are stated to be real or common knowledge (Juul & Pedersen, 2012). One must be aware of the interests of the municipalities, general institutions and private companies to gain publicity and promote their image, as well as the desire in press releases where politicians hope to gain voters (Juul & Pedersen, 2012).

4. Analytical framework of the case: Greve

Greve Municipality is a region in the capital and consists of 60,31 km², 50.000 inhabitants, 13 public schools, two private schools, 3 special schools, 1 production school, 1 high school and 6 cultural institutions (Greve Municipality, 2017).
Greve Municipality has several areas regarding sustainable initiatives, with the goal of reducing more than 20 % of their co2 emissions from 2011 to 2020. In order to achieve this, Greve municipality has signed these agreements:

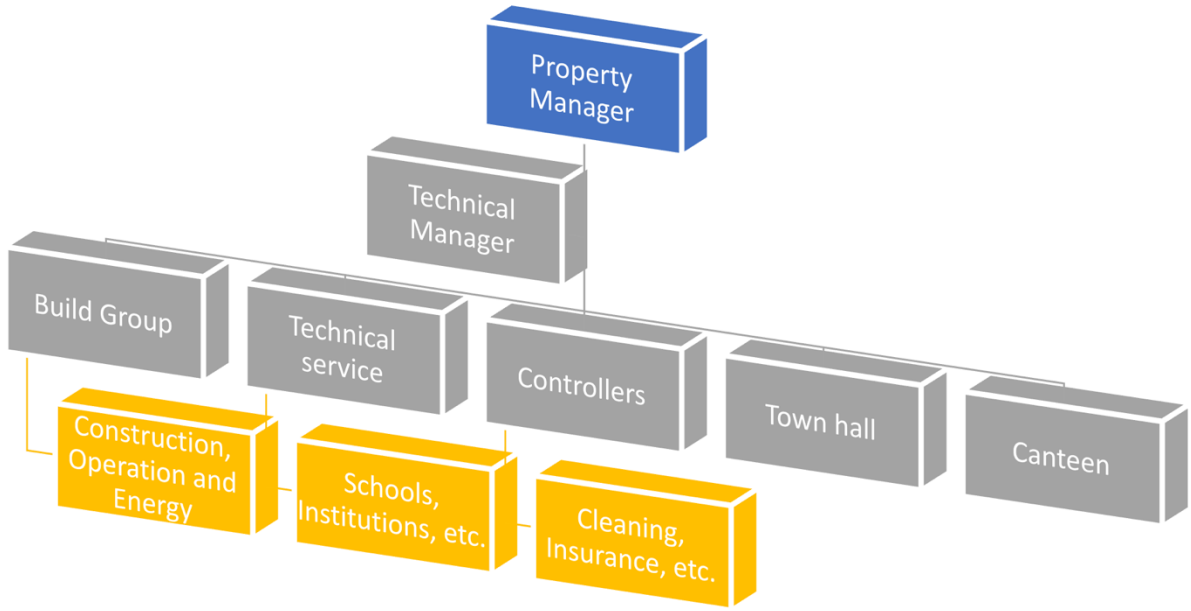
- The Mayor's Pact for Climate
- Gate 21
- Climate Municipality Agreement
- Curve Breaker Agreement (Greve Kommune, 2017)

With these agreements combined, Greve Municipality has taken the responsibility to voluntarily reduce their co2 emissions by more than the goal that EU and Denmark have imposed on municipalities to do.

Renovations in Greve

Normally, in a municipality, the maintenance and renovations are carried out by the Facilities Management (FM). FM is a management discipline to control all features that are first noticed when not working. FM focuses on all the factors that affect the daily work in a building, factors that support, optimize and are integrated into the economic and strategic conditions of the institution or company (DFMN, 2017).
In Greve municipality, the associated institution of FM in Greve is the Centre for Technology & Environment (Danish: Teknik & Miljø).
Renovations, optimization and maintenance are controlled through different organs in the organisations structure (see Figure 6 FM Organisation diagram of Greve). This falls under the Estate Centre/Property Manager (blue/grey) and Centre for Technology & Environment (grey/yellow). The colour identifies the responsibility.

Figure 6 FM Organisation diagram of Greve



FM: Blue/Grey. Centre for Technology & Environment: Grey/Yellow. (Ejendomscenteret Center for Teknik & Miljø, 2017, p. 1)

The Estate Centre is a municipality owned institution under Technology & Environment. From the interview with Hans Barlach and a phone conversation with an employee from the Centre for Technology & Environment it was clear that earlier almost all facilities were processed through the Estate Centre and have been traditionally operated with no main structural improvements or innovation in how to address renovation in a sustainable manner, until the Climate and Energy Policy Committee (who were in charge of the EPC projects) was established (Appendix 1 - Hans Barlach).

The ESCO projects in Greve municipality

Greve Municipality has had two finished ESCO projects and one is ongoing. These three ESCO projects are called EPC I, EPC II and EPC III. 'EPC I' can appear as 'EPC' (without the 'I'), since this was the first and only project at that time.

It was decided to include a limited number of buildings in EPC I due to the risk in engaging in an ESCO project (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). However, it could also be due to political issues at the time (Appendix 1 - Hans Barlach).

The ESCO model was chosen in the first place because of the guarantee, the specific knowledge of the energy area and because Greve is part of The Mayor's Pact for Climate (Middelfart Municipality, 2013).
Hans Barlach, the former mayor of Greve, came from a leading position in an electric company and therefore he knew about climate, energy use, efficiency and savings. He began as mayor in 2006, and there he saw the potential in ESCO. Although knowledge was still needed, Hans Barlach knew that something had to be done with the buildings in Greve, so he pushed for action (Appendix 1 - Hans Barlach).
One of the reasons that Greve stands out from other municipalities with ESCO projects is that Greve and Siemens agreed to share the profit from the savings if it is higher than predicted (Appendix 3: 43, 44). This is called the 'Shared-Savings Model'. As mentioned, is this not the normal practise for other municipalities (Jensen, Nielsen, & Nielsen, ESCO-samarbejder vinder frem i Danmark, 2016). where, if the ESCO received the total profit, it might encourage the ESCO to do better work to achieve higher possible savings.
Siemens was/is the chosen ESCO partner in the three projects:

- In 2009, Greve Municipality entered the first EPC agreement, which helped to reduce energy and water consumption for their schools.
- In 2012, the EPC II agreement was signed, this time concerning the day-care centres, sports facilities and the cultural house portal, which achieved energy and water savings (Greve Kommune, 2017) (Appendix 3).
- In 2013, EPC II was agreed (present-day) (Appendix 3: 26 - City Council)

Siemens has described the partnership as a win-win, since renovations and energy savings can be achieved despite scarce budgets in the municipality (Siemens, 2017). Lars Nielsen points out that "*There are three winners: The region will meet its goals and costs, the engineers will get new technology for the maintenance problems, that they could never get before, and Siemens is undertaking a project and making money on it*" (Translated by author. Appendix 2 - Lars Nielsen). And Hans Barlach articulated for the municipality, or at least in his opinion, that these sustainability projects made the city proud (Appendix 1 - Hans Barlach) (Barlach, 2011). From one of the summaries of Greve it has been stated that "*Once the EPC II and EPC III projects have been completed, it is expected that the environmental goals in Greve Municipality's climate policy 2010-2020 will be achieved for the municipal buildings*" (Translated by author - Appendix 3: 33). This shows a big trust in the projects despite the absence of knowledge from finished projects.

It was the first time that Siemens won an ESCO project in Denmark. Because of this experiences and professionals were imported from Sweden, since Sweden had had more EPC projects at that time and therefore gained more knowledge within the field (Appendix 1 - Hans Barlach; Appendix 2 - Lars Nielsen). Siemens' screening in EPC I was essentially made with help from Sweden, but since then Siemens has gotten a big market share (Appendix 1 - Hans Barlach).
The three projects have been presented in a video from Siemens in 2015 where Lars Nielsen, among others, tells the story of energy efficiency with ESCO projects in Greve municipality (link to the video can be found in the digital version of this thesis). With all three projects, when EPC III is finished, the heat consumption will be reduced by 23% and electricity consumption reduced by 27%, including savings from new solar cells. Thus, the climate is saved from 1,800 tonnes of CO2 every year (Siemens, 2017). This tells the story that both Siemens and Greve municipality had a great focus on the technology and promotion of the projects.

According to the tables in EPC I, II and III should give an overview of the three projects and make the reader able to compare and understand their scale. Compensations and courses of extra usages that have changed the baseline will be inspected later.

It should be noticed that EPC I will include more details, since it was the first project to establish the standard for project EPC II and EPC III.

EPC I

The succeeding section will analyse EPC I from appendix 1-3 to find out how the project occurred.

Table 4 ESCO/EPC I project

EPC I	**Buildings** 110.000 m^2 Buildings from 10 Schools (started as 11)	**Modifications/Notes** Ventilation system, CTS System, Lightning control in all the classrooms, new heating systems, Water-saving toilets and sink-tabs in all restrooms, insulation in the building climate-frame and small adjustments.
	Total Investment Start: 2 million EUR Ending construction license: 2.2 million EUR (excl. counselling and control by Munksgaard + Andersen a/s: 2.1 million EUR) Payback by savings: 7 years*	**Total Savings** Start: 18.5 % p.a. (water: 14,5 %) Done: 21.9% p.a. = 700 tons Co2 Which is approximately 0.25 million EUR p.a.
	Changes/Notes: - Hundige school was taken out of the ESCO project in phase 2 since it was closed. That gave a rise in total savings from 18,5 to 18,7 %. - Tune School in phase 3: Due to Subcontracting budget estimated 1.7 million EUR from Siemens it was possible to include further projects, such as ventilation systems for Tune School. - Regulation of the baseline was done in 2012 due to implementation of smartboards, windows, roof and a new gas kettle in Strandskolen. - *Payback years were changed. The correct number was not found.	

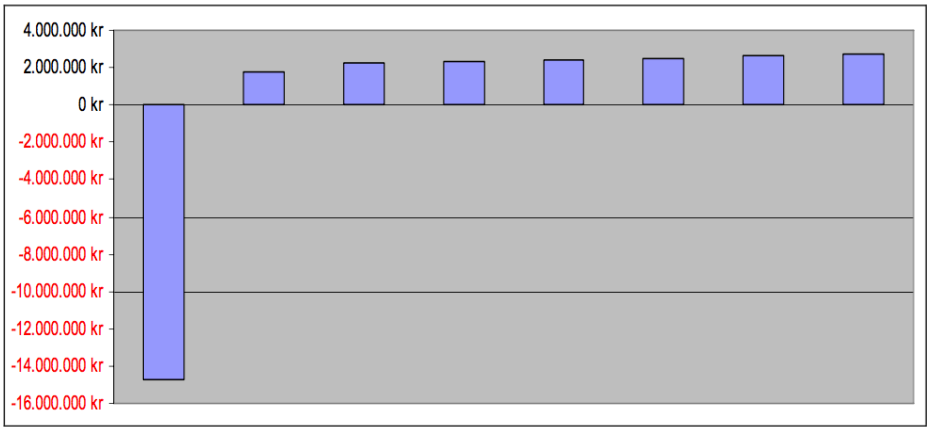
Data is exclusively acquired from Appendix 3.

Phase 1 in EPC I occurred from 5th of October to 2nd November 2009. In the first phase Greve was very careful as ESCO was a new thing. Then, when the screening was made by several competing companies (in order to give the best offer and win the ESCO contract) an additional screening was made by a consultant company (Appendix 1 - Hans Barlach;

Appendix 3). This was done to make sure that the companies would come in with a realistic offer (Appendix 1 - Hans Barlach). One representative school was chosen, and from this school the ESCOs could make their estimated deals on all the total 11 schools, since it would be unfair to expect the ESCOs to screen all the buildings (Appendix 1 - Hans Barlach; Appendix 3). From the offers, Siemens alone was chosen because they were the cheapest and gave the highest savings (Appendix 1 - Hans Barlach).

From the start of the project the plan was to work with the 7-year possible payback time from the savings with a 5% interest rate by Siemens (Siemens, 2009). However, the 'Kommunekredit' gave a lower rate as it is a public loan (and almost the only way for a municipality to make loans) and this credit method was used instead (Appendix 1 - Hans Barlach). The project ended up spending 0.2 million EUR extra because of complications (see Table 4 ESCO/EPC I project). The payback of the project, in Danish Kroner (DKK, 2009) was visualised for the board of Greve from Siemens as follows:

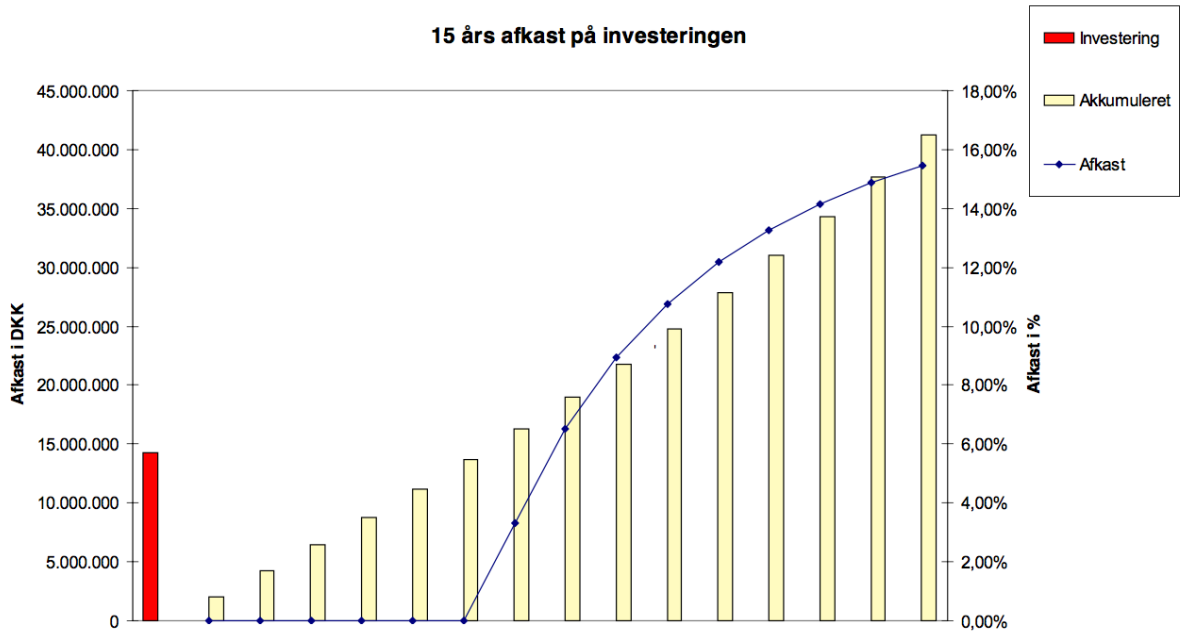
Figure 7 EPC I Investment and 7-years payback



EPC I Investment and payback (Siemens, 2009, p. 3).

The estimated lifetime of the retrofitting was between 15 to 20 years, and therefore the return on investment will be around 16% (Appendix 3). From this, it has been estimated and visualised by Siemens, that the 15 years return on investment will result in a profitable business for Greve municipality.

Figure 8 EPC I Future return of investment

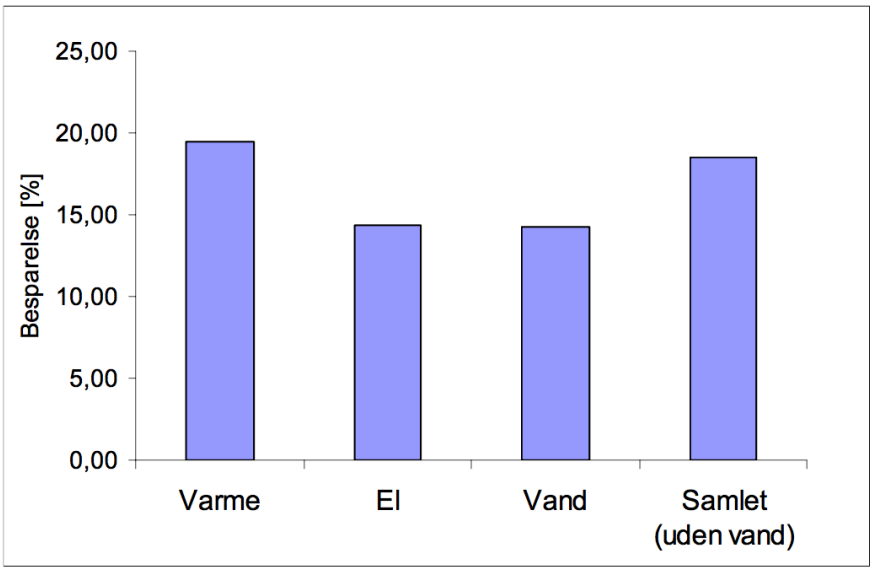


15 years return on the investment (Siemens, 2009, p. 4).

This figure shows that after 15 years Greve municipality will start to earn money from the investment, since all the additional expenses to Siemens are earned through the savings and have paid for the whole project.

The estimated results from EPC I phase 1 showed that the saved percentage differs from 15% to 20% differing from heat, electricity and water.

Figure 9 EPC I Possible energy savings



From left to right: Savings (%), Heat, Electricity, Water, Overall (without water).

(Siemens, 2009, p. 2)(Appendix 3)

Monitoring and education in phase 2 and 3 happened from 1st of June to 29th of February. As shown in Table 4 ESCO/EPC I project, the estimated savings was at first 18.5 % and ended as 21.9%. The deviation from the estimated energy saving was caused by an error in the contract documents about the number of square meters in the schools and because a school was closed down later in the project (Appendix 3). Furthermore, some schools needed new ventilation, recommended by Siemens, and this extended the payback years and increased the savings percentage. Unfortunately, was it not possible to find the final payback years for EPC I.

The schools had a big difference in how many hours the ventilation systems were in use (from 15 minutes to 24 hours a day). Because of that, Siemens' recommendation was to follow the Labour Inspectorate's requirements for an average CO2 concentration of 1000 ppm as a minimum standard (Appendix 3).

(Siemens, 2009).

When the project was finished, and Siemens gave the first realistic feedback on the savings, the baseline was approximately 2.688 EUR over the agreement (Appendix 3: 12). This was due to a flood in one of the school's sports halls that caused Siemens' equipment to be destroyed (ibid.). This could have become a complicating factor in the collaboration, thus the overall process has been trustworthy and respectful between Greve and Siemens (Appendix 2 - Lars Nielsen).

Lastly, Greve municipality was given a reduction quota from DONG Energy of 115.583 EUR, because of the renovation and EE initiative. The quota was recommended to create a job position for a leading role in the Technology & Environment Centre (Appendix 3). No mention in the summaries gave the information that the money was used for this.

EPC II

This section analyses EPC II for the purpose of creating an overview of the activities. EPC I was more of a testing project, to see if the ESCO model actually works, and consequently the following projects have less data material and summaries created.

Table 5 EPC II Project

<table>
<tr><td rowspan="3">EPC II</td><td>Buildings

32 buildings: 100.000 m^2

divided into

• 10 Day-cares
• Greve Sports Centre Karlslunde Halls, Tune Halls and “Portalen” (The Portal)</td><td>Modifications/Notes

Ventilation system, CTS System and Lightning luminaries in all the classrooms.</td></tr>
<tr><td>Total Investment

Start: 6.7 million EUR

Ending construction license:

Payback by savings: 15 Years</td><td>Total Savings

21,9 % And a co2 reduction of 526 tons. (approximately 0.4 million EUR p.a.)</td></tr>
<tr><td colspan="2">Changes/Notes:

- Delivery of EPC II was extended 8 weeks (from 28th of February to the 30th April 2013) due to lack of carrying capacity for solar panels in 3 buildings: Greve Sports Centre, Karlslunde Halls, Tune Halls</td></tr>
</table>

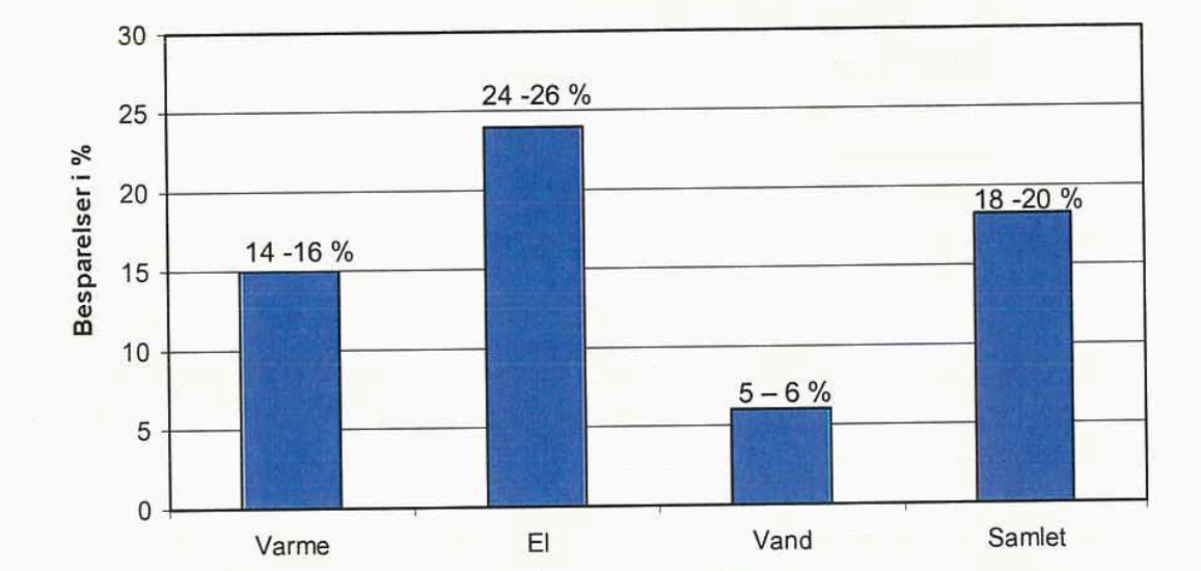
Data is exclusively acquired from Appendix 3.

EPC II only consisted of three phases instead of four. Also, Phase 1 and 2 were merged together, due to pressure of time, and lasted from 13th of December 2011 to 29th of May 2012 (Appendix 3). In principle, it can be stated that this project only consisted of two phases: A screening-phase and a monitoring-phase.

Three buildings were not strong enough in their construction to carry the increased weight when mounting the solar cells (Appendix 3). This required reinforcements and led to an eight weeks extension of the deadline. The EPC II project was finished 30th of April 2013. (Appendix 3: 14-16).

The savings and payback for the sports centre and three halls could not be found. Thus the 10 day-cares had the exact same payback model as in EPC I, with a payback of 10 years from the savings and the savings were separated as follows:

Figure 10 Potential of savings from 10 Day-cares



From left to right: Savings (%), Heat, Electricity, Water, Overall. (Appendix 3: 25).

This is the visualisation from the 10 day-cares, shown with percentages. It is clear that the savings differ a lot from EPC I.

If EPC II and EPC III could be argued to be an accepted continuation of EPC I, the limited data can be interpreted as Greve municipality's confidence in the process or lack of concern about the degree of details (Appendix 1 – Hans Barlach). On one hand this could be trust in Siemens work, and on the other it could be caused by the political change/priorities at the time. The circumstances could possibly be connected to the reason that Phase 1 and 2 were merged and fast forwarded.

EPC III

The data in 'Table 6 EPC III Project' have undergone several changes and are still in the monitoring process today (2017), consequently the following numbers will probably be outdated or changed, as these are from the agreement and meeting summaries of the contract from 2013 and 2014.

Table 6 EPC III Project

<table>
<tr><td>EPC III</td><td>Buildings

160.000 m2:
11 Schools and 25 Buildings: grouped by Greve Municipality)

Buildings from 11 schools, Knowledge centre, city hall, 10th grade school, Jobcentre and mobility administration.

Three retirement homes and four care centres.

A day school, Combined family houses, youth housing and two dentists.

A museum, sport facility house, a fort, a library and three citizens houses.</td><td>Modifications/Notes
Ventilation system, CTS System, Lightning luminaries in all the classrooms, Solar panels, New windows and doors, boiler plant, mini-power station, Insulation and hot water tanks.</td></tr>
<tr><td></td><td>Total Investment
Start: 6.7 Million EUR
Payback by savings: 15 Year
Today: 30 Years</td><td>Total Savings
Start: 0.5 million EUR p.a.
Today: 0.3 million EUR p.a.</td></tr>
<tr><td></td><td colspan="2">Changes/Notes:
1. EPC III have been changed several times due to change in politics and priorities. Total Savings is one indicator of that.
2. A consultant was also bought for 25.000 EUR.</td></tr>
</table>

Data is exclusively acquired from Appendix 3.

A preliminary examination was done by REEEZ from December 2012 to May 2013 in order to obtain the best possible benefit from its EPC III agreement (Appendix 3). REEEZ mapped the profitable energy-saving and renewable energy initiatives with help from COWI (since COWI has made four look-a-like reports) (REEEZ, 2016). Greve municipality was consistent

that Siemens should not get anything for free, and according to the law, these initiatives were made to ensure that there was correct and fair competition (Appendix 1 – Hans Barlach). However, Siemens was objectively the cheapest, with the highest savings.
As mentioned, the summaries and documents from Greve have stopped since mid 2012, and therefore it has been a challenge to establish the details about EPC III. But since EPC III was based on the same conditions as EPC I and II, and by the fact that it is still ongoing, Table 6 EPC III Project can give a picture of the actions that lie within the projects. The agreement of EPC III was made entirely on the same circumstances as the previous two (Appendix 3).

Due to the internal political change and reprioritisation, EPC III has been prolonged one and a half years (Appendix 2 – Lars Nielsen). This is because, since Hans Barlach stopped being mayor, the priorities have changed from efficiency and savings to ventilation in the schools (Appendix 2 – Lars Nielsen; Appendix 1 – Hans Barlach). This made the payback years extend from 15 years to 30 years, because if a building without ventilation should have it implemented, the energy usage will rise and that would have to be found as another savings somewhere else (Appendix 2 – Lars Nielsen).

Partial conclusion

Greve municipality was ambitious when EPC I started, that gave them an advantageous and positive experience because they choose to *bundle* the buildings with service and screening, and gave possibility to raise the investments and payback periods for every project. EPC II was forwarded, and it can be discussed for what reason, but a trust in Siemens profession and a change in political priority seams evident. EPC III was changed and delayed due to the priority from energy efficiency to social political agendas.

5. Potentials and challenges from Greve Municipality's ESCO-projects

From the two finished EPC projects and the ongoing EPC III, similarities between the theory, other reports and the empirical data have shown some possibilities and barriers apparent for the development of ESCO collaborations and future EPC projects.

The interrelated practise between the collaborators

In practise, the partnerships between the ESCO and the client (municipalities) have been shown to create some misinterpretations (as described in the introduction).
This is a normal tendency for an innovation from its first integration in the public sector, because it takes time for the workforce to comprehend and unlearn their habitual, traditional methods. These degrees of misunderstandings have been described as a barrier for the expansion of ESCO projects in municipalities and can have an effect on the total reputation (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013).
From Jensen et al. 2013, it was assumed that the relationship between a municipality and the ESCO could result in disagreements or difficulties in the process of renegotiating the baseline, exceeding the budget (as EPC I), deadline extension (as EPC II) or in general negotiation situations (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013). However, this was not the case in the Greve municipality. The relationships were decent and respectful, as neither one had the intention of cheating the other (Appendix 2 – Lars Nielsen).

The misunderstanding of ESCO projects has been shown to be a barrier for municipalities to start the projects at first, and not the collaboration. But for Greve, variations in the political setting have created uncertainty about the EPC III and resulted in prioritizing focus points other than the efficiency.

Political change and reasons for data disruption

In the search for data on the three EPC projects, some missing summaries after 2014 have been observed. It has also been observed, that EPC I and II have gotten more exposure to the public than EPC III. Therefore, an explanation of the cause will be presented.

If the innovation of EPC projects should be a systematic innovation, it does need general and fluent support in order to be sustained (Mulgan & Albury, 2003). In the case of Greve, ESCO has been shown not to be a systematic innovation, but more a radical innovation, due to the political priorities.

Hans Barlach argues that it was entirely political matters that prevented Greve from making more ESCO projects (Appendix 1 – Hans Barlach). It is not climate and green agendas that drive the politics in Greve, but more softer policies towards work the employees do inside the building. Lars Nielsen noted this issue, by stating that the politicians do not have urgent priorities for renovations, because if nothing is done, the building still stands for the next years with the same budget for minor maintenance (Appendix 2 - Lars Nielsen).

When Hans Barlach retired, the City Council agreed on the 28th of April 2014 that Climate and Energy Policy Committee was to be shut down immediately and all matters were to be taken over by the Centre for Technology & Environment (Greve municipality, 2015). Thus, EPC III was already signed, and therefore this project could not be stopped (Appendix 1 – Hans Barlach). This explains why the time extension and the change from energy efficiency and savings on light and heating to ventilation occurred in EPC III, and why the payback went from 15 years to 30 years.

Lars Nielsen supports this reasoning, and underlines that this has not affected the collaboration between Greve municipality and Siemens (Appendix 2 - Lars Nielsen).

Lars Nielsen elaborates that there have been no complications, because when a client and an ESCO works so closely together, they do have mutual respect for the progress to be as smooth as possible (Appendix 2 - Lars Nielsen). This is a natural process for the ESCO collaboration to extent the deadlines, according to Lars Nielsen.

This clarifies the complications behind the lack of data and written materials about the EPC projects and why summaries and meeting documents suddenly disappeared after the year 2014 (and also why the documents start from 2008). Consequently, the data material after 2014 will essentially be from the interviews.

Experiences from the users

After Siemens installed and monitored CTS and other measuring systems to keep track of the consumptions of energy in EPC I and EPC II, technical employees at the schools and institutions have been in contact with Siemens to ensure the required energy savings are kept at the agreed percentage. Siemens then meets with the municipality every third month to discuss the baseline, which is also important to do, since this reminds the users to save energy (Appendix 2 - Lars Nielsen). Changes in the baseline are a natural process and Siemens and Greve have had a mutually good relationship when negotiating the baseline, according to Lars Nielsen (Appendix 2 - Lars Nielsen). But in practise, from various experiences of the technical employees in the buildings, a slightly different picture has emerged of the collaboration between them and Siemens and has shown some scepticism. This can help the research to understand the possible challenges and criteria of success for future projects.

The majority of the schools contacted experience a lack of action when it comes to the new systems. Some janitors see Siemens as their 'new boss' that watches over them, since increased adjustment of heating, for example, leads to a call from an employee at Siemens with the intention of decreasing the heat consumption (Appendix 6). It creates a feeling of being paralyzed in their work, because the technical employees and janitors were used to being in charge of themselves and also being the ones who got everything under control, combined with the flexibility to be the all-around person who knew every corner of the school/institution (Appendix 6). This concern is supported by Mulgan & Albury (2003) when an innovation is implemented: a group of workforce will feel the lack of action combined with the frustration of the new system being over controlling (Mulgan & Albury, 2003).
If certain changes in the energy consumption happen due to the accountable factors, a renegotiation of the baseline would be done between the ESCO and Greve municipality (Appendix 2 - Lars Nielsen) e.g. a school building an extra building or an increase of pupils at the school. But if a decrease happens, due to more energy efficient electronics or by natural consciousness of reducing energy from the users, the surpassed savings will be acquired by Siemens (Appendix 2 - Lars Nielsen)(Appendix 1 - Hans Barlach)(Appendix 3). This gives another incentive for the ESCO to urge the janitors to decrease the energy consumption.

One of the steadfast barriers ESCO have, is the user's resistance to the model. The technical employees and janitors dissociated from ESCO at first because they had the idea that their

jobs were taken from them and from views and experiences they have heard from other professionals in their field at e.g. other schools (Appendix 6). After EPC I and EPC II were done, a more positive attitude were given from some of the employees. They were happy about the CTS technology, although they still felt as Siemens was watching over them.
In comparison with other ESCO projects, the general tendency is that janitors think ESCO is a bad idea in the start and think it's a good idea in the end.
When the user's is informed they can see that there is an efficiency potential. This is also supported by Lars Nielsen, since he has experienced the same process from day-cares (Appendix 2 - Lars Nielsen). This is mainly due to the building industry invites innovation, as CTS systems, and a whole new niche for intelligent and sustainable products and services (Hansen & Nielsen, 2015).

Employees at Krogsgårdsskolen, Mosedeskolen, Tjørnelystskolen and Strandskolen mentioned that their new CTS systems are fairly easy to use, and they have been on educational courses on how these systems work, but in practise have they gotten the feeling that no adjustments can be done with the systems, except turning them down (Appendix 6). The janitor at Krogsgårdsskolen mentioned that this would possible be a problem for the ventilation in summer times, because he is encouraged to open windows instead of turning the air-condition up, which can lead to the pupils being restless due to noise and the wish to come outside (Appendix 6).

Some employees have given the impression that they were not included before and during the monitoring (as in phase 1 to 3). From a conversation with the technical support and the school leader from the Tune school it was pointed out that they had no influence nor gained educational effect from the ESCO project. When asked about an introduction to the new system afterwards, the technical support said that he had taken one minor course that he did not get any new knowledge from (Appendix 6). It can be discussed whether Tune school was not aware of the ongoing ESCO projects, or if those involved have previous competences that would make the education from Siemens unnecessary, thus the tone was that they did not experience it in a positive way. The same can be said about Mosede Skole, since the janitor gave the impression that no one was included in the progress, and the renovation (ESCO project) was made entirely top-down. And even though Tjørnelyskolen is in a closing process and had no interest in taking part in an interview, it was revealed that no employees were

involved in EPC I, since everything was managed by the municipality. Strandskolen did not have any influence before the last phase of the EPC I, but the operational staff had some courses and education from the Technological Institute, which the operator mentioned had no real practical use, since their windows and doors were still leaking air. He was not impressed by the EPC I or EPC III, because it was targeting the wrong elements (such as lightning and ventilation) instead of the climate frame of the building (Appendix 6). It should be mentioned, that Siemens made screenings of the building and estimated that it was a better investment to renovate the roof and make solar panels instead of the windows (Appendix 3). The employee might not have the professional insights to judge the modifications, although this utterance should be considered as a valid feedback if Strandskolen should be a part of a future refurbishment project.

These results from the technical employees and janitors in the case of Greve municipality fits with the research from additional municipalities. Research have uncovered, from several interviews, the unwillingness in the technical departments to conclude energy partnerships (Pietras, et al., 2013). It is perceived that they can do it better themselves, and at the profit that the ESCO provider earn is lost money (Pietras, et al., 2013). This is supported by Lars Nielsen, he argues that these technical employed people are indirectly scared of ESCOs (Appendix 2 - Lars Nielsen). It is completely understandable, course they can fear for their job and the exposure of their own energy savings which can indicate that they have not done a good job if they have achieved a remarkable minor saving (or argued that no savings were possible) than the ESCO can provide. This creates a reasonable resistance to ESCO. Lars Nielsen continues with, if a politician is offered the ESCO model, and this person is advised be the technical employees, will the given feedback to the politician be that ESCO is a bad idea (because of the general resistance) (Appendix 2 - Lars Nielsen). It can be uncomfortable for some people, and therefore will the response be 'No, ESCO is too expensive, we do not want to share energy savings with anyone' because of the feelings that are in play (Appendix 2 - Lars Nielsen). Thus, a research study points out, that 50 % of in-house projects were cancelled, even though the ESCO model were offered and rejected (Mortensen, Ny undersøgelse: Danske kommuner siger nej til Esco, 2011).

Another challenge from the user's perspective in the day-cares from EPC II, is that there are many who do not understand what happened. Employees see that Siemens only has been in the technical room and question why the renovations do not include changing windows, painting rooms or maybe moving a wall. This is typical for short payback times, because then the investment would not include the higher hanging fruits (Appendix 2 - Lars Nielsen).

Lastly, Lars Nielsen pointed out, if a technical employee does not want to turn down the heat or electricity use, or if significant change in the baseline is present, Siemens is not forced to pay for that change, which will only change the baseline. He explains that "*An ESCO collaboration is like a marriage. Nobody is trying to cheat each other. That's why we (Siemens) are doing a lot of customer satisfaction*" (translated by author Appendix 2 - Lars Nielsen).

ESCO/EPC as a public Innovation incentive

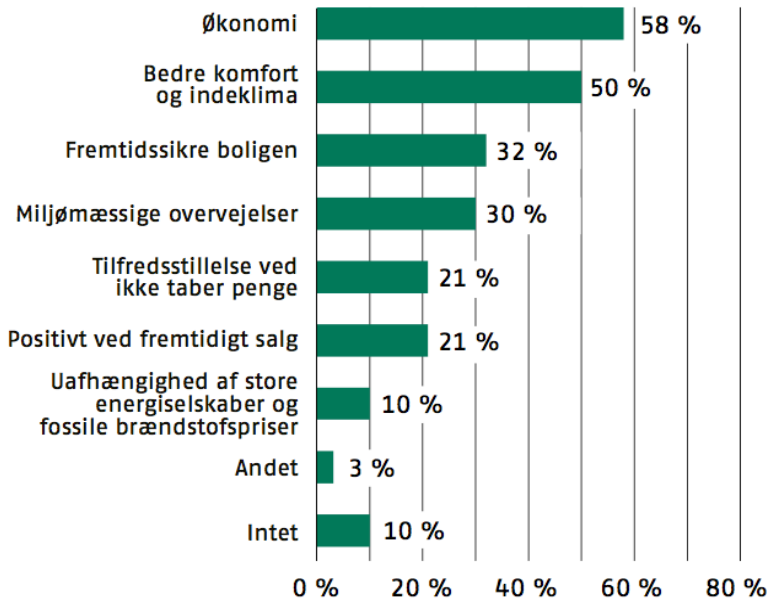
From the proceeding analysis of ESCO in Greve municipality, evaluated by the interviews, data material from Greve and literature research, the ESCO/EPC model can be indicated to be a radical innovation. As Mulgan & Albury define it, a radical innovation is a "*Change […that…] often originates on the margins of society and from the experience of other countries*" (Mulgan & Albury, 2003, p. 14).
The economic perspective from Greve municipality, as they prioritize the best financial solutions over innovation, corresponds with the public innovation theory that states one of the main drivers for innovation in the public sector is access to funding for experiments (Mulgan & Albury, 2003). This is not saying that Greve municipality does not have resources for these kind of projects, but a question of prioritizing.
Another perspective on why ESCO could be a radical innovation in the case of Greve, is that they (combined with other municipalities at that time) chose to test out the model with the EPC I and hired consultants, because "*the more necessary scale and scope for effective trialling and implementation*" the more the innovation is a radical innovation (Mulgan & Albury, 2003, p. 26). This is supported by the fact that knowledge is demanded from finished projects.

The absence of competitive pressures is a barrier for the radical innovation (Mulgan & Albury, 2003). Only a few companies are left from the start of EPC in Denmark and Siemens

tends to have the best market share (best, cheapest and highest saving solutions, e.g. for Greve's EPC projects and Hvidovre hospital). Hans Barlach argues that the risk has been too big for the smaller ESCO and has made them afraid of this market because they are not good enough, hence they cannot reach as high savings as Siemens can (Appendix 1 – Hans Barlach). These smaller companies have arguably left the ESCO market due to one experience in which they did not live up to the prospected savings, since they have to pay the missing savings because of the guarantee in the model (Appendix 1 – Hans Barlach).

Public innovation is motivated more by recognition and pride rather than by financial reward (Mulgan & Albury, 2003). Hans Barlach shares this statement, as he was proud of starting the EPC projects, because even though economic profit through savings is a part of ESCO, the primary driver for ESCO should be the acknowledgement of sustainability agendas and the act for change (Appendix 1 – Hans Barlach) (Barlach, 2011).
The building industry in general, however, does not support EE by recognition (Dansk Byggeri, 2017).

Figure 11 Condition that motivates use of energy efficiencies, 2016



From top to bottom: Economy, Better comfort and indoor climate, Future-proof housing, Environmental considerations, Satisfaction by not losing money, Positive for future sales, Independence of major energy companies and fossil fuel prices, Other, Nothing. Translated by author. (Dansk Byggeri, 2017, p. 23)

Municipalities are dissimilar in size and by priorities. A vibrant motivation for investments in ESCO is to emphasize the financial benefits of the savings and (over time) profit, for a municipality like Greve. However, other municipalities could use the arguments of sustainability as a motivation and economy as rational argument, combined with the guarantee. From this, it can be said that every single municipality has different main concerns and the ESCO model should then be flexible instead of being standardized (which is otherwise sought after). This statement is backed up by the EU commission, hence this problem is overcome by a greater flexibility in the contracts, since this is one of the major barriers in the context of public sector ESCO projects (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014).

Partial conclusion

The collaborations between Greve and Siemens have nothing to do with the changes in EPC III and reason why no additional EPC project is made. Greve prioritises growth through in-house solutions because they want to keep the profit to themselves instead of a higher efficiency and savings. Sustainability seems not to be prioritised in the case of renovations, but Greve have shown to engage in other agreements for a green agenda.
The users were not included as much as they wanted to. They did not gain the educational expected knowledge and felt incapability by the fact that they had to follow the instructions from Siemens, which can be an interpretation of getting used to their new role.

6. Discussion: Future perspectives on ESCO

During this thesis, several motivations, challenges and barriers for ESCO in municipalities, have been established. Here, will a summon of these topics be taken up in a general discussion combined with the hypotheses about a future perspective of and stimuli to foster ESCO as innovation.

Overcoming the Municipal's complexities

From the case of Greve municipality and statements from various studies has similar complexities been observed. Here, will how these complexities can be dealt with be discussed with the use of the case analysis of Greve, interviews and literature concerning other municipalities.

One of the solutions to promote ESCO for Danish municipalities have been to standardise the model. From the case study it is however clear, that this have not been the request from Greve municipality, because they have experienced flexibility and had a trustworthy cooperation with Siemens (Appendix 3, Chapter 5). This can also be perceived in how Lars Nielsen expresses the collaboration (Appendix 2). Some references support this tendency, since flexibility in the model and in the contract, are preferred. It is also visible when the orientations of a standardisation are not desired, which could be a course of the municipalities different starting points, their ambition levels and intentions with the ESCO cooperation (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013).

One of this report's hypotheses is that "The municipality saw the potentials in finances and want to do it themselves". This can be interpreted to be correct in the case in Greve. Followed by Hans Barlach, is the real reason due to the shift in politics from a climate priority to an economic interest (Appendix 1 – Hans Barlach). Additional municipalities who stay out of the ESCO business claim to do so because of the better economy they can achieve alone (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). In particular, large municipalities that have the budget and human resources sees ESCO as an expensive investment compared to their own (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013). However, the majority of studies argue that municipalities always end up paying less for a project if done with the help of an ESCO (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). Lars Nielsen mentioned, that those municipalities that have tried other

models or tried ESCO by themselves, have met the circumstance that these projects turned out to be more expensive than expected (Appendix 2 - Lars Nielsen). Here are two examples; Odense municipality, where Deloitte as consultant tried another model than ESCO, and Århus municipality, who tried to do an ESCO project by themselves and this turned out to be a bad investment (Appendix 2 - Lars Nielsen) (Nielsen, 2014). However, no references during this thesis managed to find information about these examples. The European Commission claim in the ESCO Market Report (2014) that:

> *As of 2013, municipalities seem to be divided on what the best solution could be for them. There are still many municipalities who insist on carrying out energy renovation with in-house resources, because they believe they can achieve energy savings at a lower cost and with better success without external intervention (an approach common before). On the other hand, by now there are many municipalities who favour ESCOs in order to accelerate project implementation*
> *(Bertoldi, Boza-Kiss, Panev, & Labanca, 2014, p. 55).*

According to this quote, these tendencies from the municipalities to do renovation projects by themselves with the argument of saving money, can be argued to absence the greater perception of ESCO. This is encountered by the fact that even though ESCO projects require a larger investment, the outcome results in a higher saving percentage and faster implementation. This argument is supported by the Competition and Consumer Agency, who point out that there is a certain risk that internal optimization does not achieve the expected results of energy savings or that no competition is created on the tasks (Pietras, et al., 2013). This can be seen in the case of Greve, since Siemens managed to win the three EPC projects because they could achieve the highest savings. Even though a municipality is not interested in the highest possible savings (which would be an anti-sustainable decision in this circumstance) and focus on the local workforce instead, it can still be argued that it is an ineffective strategy and goes against the intention of OPP.

The transaction costs are one of the reasons why ESCO projects requires a higher investment than an in-house. However, Greve municipality has not from this research shown any complications with the transaction costs, or at least was this not one of the barriers to start the projects. This can be reasoned in how the projects were *bundled* with several buildings. Transaction costs are raised by the need for data collection and the lack of previously done

benchmarking and documentation of earlier interventions, and this can be costly for projects with small payback periods (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). In Norway, have the consequences of too high transaction costs and laws already started to show; the transaction costs have almost eliminated the ESCO marked, because the Norwegian structure hinder ESCOs in making profit (Liv Lindseth, Appendix 4).
By investing in long-term contracts, with reduced transaction costs, will trust between the ESCO and client be enhanced (Backlund & Eidenskog, 2012). And if considered the other way around, will short-termism inhibit radical innovation (Mulgan & Albury, 2003). This strengthen the argument for municipalities to create EPC projects with more than 10 payback years and with an investment of over 1.4 million EUR in order to create the best profitable and trustfully projects.

Considering the economic issue, that in-house projects are cheaper than ESCO, should the use of subsidies be used with a higher extent. E.g. Greve municipality who got a reduction quota from DONG Energy. Some municipalities do not know about these subsidies, although research show that 20% of asked municipalities mention, that subsidies are a motivation to make EE projects (Dansk Byggeri, 2017) (Jensen, Jensen, & Larsen, Modeller for energibesparelser i kommunale bygninger, 2013).
Another point is, that municipalities have almost no possibility to take loans. With renovations that seek to improve EE can it however become possible since municipalities in general have a maintenance backlog and indoor climate problems (Appendix 2 - Lars Nielsen; Appendix 1 – Hans Barlach). Using the ESCO model is an easy way to release money from 'KommuneKredit', plus new loan methods (who can get around the construction sealing - anlægsloft) have started to show, according to Lars Nielsen (Appendix 2 - Lars Nielsen).

Learnings from the private sectors perspective

From the conference on Financing Energy Efficiency in Denmark, Sweden and Finland organised as part of the Sustainable Energy Investment Forums contract, have perspectives challenged the public and private marked for ESCO (Appendix 4).

One of the core hindering for ESCO in the private sector was the lack of interests from investors and banks (Appendix 4). According to public innovation theory (Mulgan & Albury,

2003) one could argue, that if ESCO succeeds to be a sexy topic for politicians and that the EE and green agenda shows to be a solid proof innovation in the public sector, the investors will get a good documentation to see ESCO as a good long-term investment, including the credibility, and the private sector will gain from this trust in the model. This could lead to the implementation of EPC as a less challenged innovation model. Frédéric Brodach from Investors' Confidence Projects (IPC) and Carsten Glenting from COWI have stated that this have already started to happen. This is because, databases alike IPC and DEEP (from COWI) opens the door to investors, with certifications and standardisations that proves the delivering guarantee in objective data (before the investment takes place), which gives a transparent representation of EE and ESCO projects (Appendix 4). Mats Olausson from Green Bonds in SEB Sweden argues that ESCO should start the so-called ketchup effect* from investors and he encourages politicians to take action for it to happen.

*Ketchup effect in finances; slamming on the ketchup bottle until uncontrollable amount of ketchup runs put – This means that investments push a certain market and runs out of control, which creates a great competition and awareness. E.g. how Tesla gained success.

A critical perspective on the ESCO model was furthermore presented during a conversation in the conference. A CEO from a utility company revealed that "*the money has to come from somewhere, easy as that.*" (conversation during the conference Appendix 4). This proclamation by the CEO is based on the fact that ESCO projects pays themselves by the savings. The 'free lunch' that ESCO presents does not happen, because a utility company have their budgets and have to ensure a certain income. So, if one building has a saving of 20 %, then these 20% will be distributed to the other buildings in the grid. And if all the buildings in a city reduces their consumption by 20 %, the price will be the same to pay, since the utility company would still need to have the same income. The CEO's argument is a relevant perspective, and can be an interesting research to do. But since this is not a part of this thesis, is it hereby recommended for future research; how can ESCO projects affect the overall utility business and how would the energy prices develop?

Is ESCO/EPC the right model for municipalities?

In this section will the remaining hypotheses be answered one by one (light blue text).

The municipalities resentment of using the ESCO model due to "Intern politics in the municipalities" can be argued to be true in the case of Greve, and results showed no indications of "ESCO have shown to be a bad investment". As mentioned, political structure during and after the retirement of Hans Barlach changed the priority from energy efficient renovations to ventilations in the EPC III project. Followed by Hans Barlach, this resentment was already happening during his period (Appendix 1 – Hans Barlach). Lars Nielsen emphasises, that the political structure in a municipality is complicated when addressing an ESCO model; First the major or a person who is responsible of renovation in the municipality thinks that it is a great idea on a political level; "*it is in principal a free lunch, does not cost anything, decreased the costs for maintenance, and typically also educated some staff*" (Appendix 2 – Lars Nielsen). He continues, that if a politician or major is then asked about the ESCO model, the person would, if the model is understood correct, have a positive opinion about it. But when the decision has to be visible for the citizens or the decision have to be on either a social political topic or renovation, the choice will not be an ESCO project (Appendix 2 - Lars Nielsen). This statement matches the conversations at the Appendix 4 Regional conference on Financing Energy Efficiency in Nordic countries Copenhagen; That the ESCO model is not 'sexy' enough to compete with other social agendas for a municipality. Intern policies can vary and it could be more valued for an environmentally focussed municipality, but for additional municipalities must the ESCO model be promoted with the excess benefits.

"Fear of outsourcing "

The reason for deselecting ESCO because of the fear of outsourcing can be argued to be one of the main barriers for ESCO. From the case study, no indications of outsourcing were observed as an issue, and had no effect on the decision to choose the ESCO model. However, research from additional municipalities have shown that outsourcing is a serious issue when choosing between ESCO and in-house (Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013; Pietras, et al., 2013). On one hand, in-house can be argued to be a competitor with the advantage of not outsourcing the labour and focusing on the core competences in the municipality (which can increase the

intern cash flow) (Dyhr-Mikkelsen, et al., 2010). And on the other hand, research have pointed at the lack of EE, savings, technological advancement and slowly implementations when creating in-house (Bertoldi, Boza-Kiss, Panev, & Labanca, 2014). Outsourcing can arguably be a threat to the local economy in a municipality and create a distance to the politicians if they chose an ESCO instead of local workforce. It could hereby be considered for future development of ESCO, to include and make it visible that local workforce can play an important role in a EPC/ESCO project.

"Another/better model have been found (or gotten another name)"

The answer to this hypothesis is 'no'; From the case study and research is ESCO the one and only model in focus in terms of renovation. From the analysis of Greve, the EE conference and the interviews have the given picture been, that the challenges for the ESCO model is a question of 'why the municipalities reject the ESCO model as an innovation' and no other/better model is hereby evident. As Mulgan and Albury situates it; Business and organisations need to innovate – or die (Mulgan & Albury, 2003). In the public sectors, it is unlikely that organisations will collapse due to lack of innovation. Thus, if ESCO should increase its implementation in Denmark investment in long-term must conquer the culture of risk aversion which impedes or blocks the ESCO model as innovation.

"ESCO is not the state of art anymore"

The lack of media coverage has no reason in a new state of art or interest in ESCO. The explanation could be, that news or publicity about ESCO projects have the tendencies to stay within the local newspapers or as articles in offices of politicians, and therefore never reaches the nation-wide coverage (Appendix 1 – Hans Barlach). This highlights the potential to make ESCO a 'sexy' topic for politicians and citizens in a way that it is the method to reach other social political issues. An example is Hvidovre hospital, where the Minister of energy, supply and climate, Lars Christian Lilleholt, promotes the ESCO model with the possibility to increase equipment, make ventilation and indoor climate (see introduction).

Examples from various municipalities have increased the ambition with more integrated solutions where installation technique and physical improvements includes (Jensen, Nielsen, & Hansen, ESCO i danske kommuner, 2013). This was also the case of Greve, but since they did not continue with an EPC IIII, it can be discussed whether Greve is not a representative

case. From research and the interview with Lars Nielsen, this raise in ambition have changed the model to what is called ESCO 2. ESCO traditionally had a possibility to include short-term payback periods, but since ESCO have to be sold on new qualities than sustainability, require ESCO 2 long-term payback periods (up to 20 years) (Appendix 2 - Lars Nielsen).

"The municipalities have chosen to adapt the model as their standard."

To follow up on previous section, ESCO is not on its way out of the Danish marked. The municipalities who have tried ESCO, have changed their requirements and view on the model. In response, ESCOs have started to learn and adapt to form ESCO 2.

Mentioned in Chapter 4, these short payback times have also created problems for the users, since they have a hard time to understand the optimisations in the building if Siemens are only in the control room. Long-term payments include the 'higher fruits', as new doors and windows-solutions, that are visible for the users. The parents who comes to get their child in the day-care, would for example, see the difference with new windows and are told that they are paid by the savings, and so becomes ESCO a political incentive that can gain voters (Appendix 2 - Lars Nielsen). This only supports the creation of ESCO 2.
This does also kill the last hypothesis "ESCO so integrated in the municipalities that it has lost its publicity", since research and reports have shown, as mentioned, that even if a municipality integrate the ESCO model, the internal knowledge and lack of expertise will make the project cost more than an ESCO.

EPC/ESCO pros and cons

From the experiences of Greve municipality and from the gained knowledge from research within this thesis, several pros and cons have appeared in the case of EPC projects and collaborations with ESCOs. In order to create a clean and transparent understanding of these pros and cons, will the following two tables, Table 7 and Table 8, show the incentives and barriers established in this thesis. To differ between the case of Greve and other municipalities, these tables shows a summary of the findings. Data is exclusively from the case study of Greve, the interviews and (Udbudsrådet, 2012; Regeringen, 2014; Konkurrence- og Forbrugerstyrelsen, 2013; Bygningsstyrelsen, 2012; Lindseth, 2015; Jensen, Nielsen, & Hansen, Greening Public Buildings: ESCO-Contracting in Danish Municipalities, 2013).

Table 7 Incentives for Greve and in general

Incentives in General	Incentives from Greve
Higher savings and efficiency	(same incentive) - Reach Climate Goals
Shared profit – better output	Shared profit – more efficiency
Synergies of knowledge	Synergies of collaboration - OPP
Safety, since ESCO takes the risk	Safety, that ESCO gives the guarantee
Finance: pay by savings	Get renovations done without changing budgets + get around the "anlægsloft"
New efficient technology	Better ventilation + indoor climate
Successful past projects	Trust in successful past projects
Capacity and Speed	(Not an incentive)

Table 8 Barriers for Greve and in general

Barriers in general	Barriers for Greve
Conservatism for innovation	Money over efficiency and savings
In-house costs less	(same barrier)
Economy over sustainability: Focus on the city's small businesses instead of a big corporation as Siemens.	Economy over sustainability: Todays City council prioritises cheapest solution and intern growth.
Lack of knowledge (from municipalities)	Why share profit when we can do it?
Afraid of outsourcing to an ESCO	(same barrier)
ESCO is not 'sexy' as buzzword	Local politics: prioritise 'softer' issues
No Danish standard for ESCO	(not a barrier)
Users: change is scary	Users: No inclusion, impotence and lack of education
Lack of trust	Uncertain: since consultation on the screening of EPC I and III had to be bought.
Transaction Costs	(not a barrier, because of bundling)

These two tables are left alone by purpose, because they sum up results from the analysis and discussion. The following section will discuss the potentials and upcoming development from the perception of the incentives and barriers presented.

Future Perspectives

Peter Bach from the Danish Energy Agency argues, that municipalities have to overcome the non-rational behaviour and ESCOs have to make it easier to reduce the risk (Appendix 4). This relates to the findings from the case of Greve; some municipalities argue in a way that is mistakenly interpreted due to politicians who hear the story from technical employees who is afraid of their job and reasons the ESCO model as a bad investment (see chapter 4). Lars Nielsen puts emphasises on this by saying "Siemens' biggest competitor is not Schneider electric or Kempl & Lauritzen, but the intern in the municipalities" (Translated by author, Appendix 2 - Lars Nielsen). This follows the statements from Sandra Lennander from Swedish Energy Agency and Päivi Laitila from Motiva in Finland, hence the financing and economics is not the barriers for ESCO but municipalities are the barriers themselves (Appendix 4).

ESCO is needed, and various arguments from the conference on Financing Energy Efficiency points at, that it is time to convince municipalities (and building owners in general) to do more for the EPC projects in Europe, even though "*Public policy has been the main driver for EE improvements*" (Peter Bach, Danish Energy Agency. Appendix 4) more is needed.

Lars Nielsen matches this statement, as he points at the enlightenment for politicians in municipalities and in the ministries (Appendix 2 - Lars Nielsen): "*we can see that there is an increased interest in the social politics and not the energy political agenda. Therefore, we try to sell ESCO on the softer values […] There is nothing left or right wing political wrong with the model, because every party in the parliament likes it. The problem is that there is no burning platform underneath them!"* (Translated by author. Appendix 2 – Lars Nielsen). By this quote, Lars Nielsen expresses that the politicians have nothing to lose when they hear about ESCO and would likely focus on other social political topics rather than energy efficiency. Hans Barlach shares this view, but underlines that municipalities have to see the good stories and understand the trick behind ESCO "*Municipalities cannot see the trick and if they focus on the softer political issues, therefore is enlightenment and pressure from the parliament needed in order to change the attitude from the municipalities*" (Translated by author, Appendix 1 – Hans Barlach).

From the theory of public innovation and the statements from the empirical data is it clear that the government must take action and responsibility to create the acquired condition and put focus on the visible return from the investment to encourage wide-spread usage of ESCO. Thus, one could argue, according to Lars Nielsen who points at ESCO 2 and according to public innovation theory (Mulgan & Albury, 2003), that change is already happening and push from the EU commission, market and diverse acknowledgements from labouring countries will result on an increase in in the EPC/ESCO market.

Partial conclusion

Resentment from municipalities, economic compliances plus the municipalities misinterpretations frames the challenges for the ESCO model. Enlightenment and pressure on politicians can create more focus and publicity on the advantages and benefits from finished projects which will help the future for ESCO 2 with long-term project period to increase the EPC projects in Danish municipalities. ESCO is the state of art even though publicity is lacking. And if ESCO 2 should increase, the model will need to be sold on the 'sexy' benefits instead of only EE.

7. Conclusion

No generalisation can be made from this study. However, from the case study of Greve municipality, data achieved, indications and results from the analyses and discussion, the research question; "What are the experiences from an ESCO project in DK and how can this knowledge help to improve future retrofitting projects in municipalities?" will be answered.

The ESCO/EPC model is experienced as disruptive in general and therefore it is often suppressed by some municipalities. But for Greve is it clear, that this is not the case. Greve have tried the model, found success in the projects (combined with trust and guarantee in the collaboration with Siemens). Since Hans Barlach retired (who can be interpreted as the first runner for innovation to reach the sustainability targets of Greve) no new contracts was made. This was mainly due to conservatism and incomprehensible approach to the model, substantially because of the political priorities lies on the 'softer' and financial agenda rather than innovation, efficiency and the environment. It should be noticed, that this result can be affected by Hans Barlach retirement, the change in Climate and Energy Policy Committee and the lack of data material from the rejected interviews. Since Greve have no plans of making an EPC IIII, does this finding meet with other report's assumptions on why municipalities do not modernise renovation models and keep their traditionally practises. Outsourcing can be seen as the main barrier for a municipality, since this thesis did not find any answer to this challenge. However, janitors and technical employees who experienced a pressure from Siemens, suggests an inclusion in phase 1, in order to get them to understand the positive consequences and quality the ESCO projects provides. For this matter, ESCOs should have an application on how the model strengthen the users everyday (e.g. better ventilation, windows and indoor climate).

EPC/ESCO projects is not on its way out of the Danish marked and the lack of publicity is due to emphasis on the successful projects and the shift towards a few big companies who offer the ESCO model.
From the analysis and discussion about future perspectives on ESCO, further studies should consider, that the ESCO model does not meet economic barriers if subsidies, public loans (KommuneKredit), long-term payback periods and *bundling* is applied. This is caused by a higher profit that can be achieved by an increased saving after the period ends.

Incentives for the municipalities to create ESCO projects consists of; getting around the construction ceiling, reaching the climate goals, improve the 'softer' agendas as ventilation and fast implementation/energy-savings. The last two mentioned is also the new sales approach that ESCO 2 will be sold upon.

ESCO can be argued to be a *radical innovation* by the *theory of public innovation*. To foster a radical innovation, supported by stakeholders from the conference on Financing Energy Efficiency and interviews with Lars Nielsen and Hans Barlach, should political push, enlightenment and raise of awareness be more widespread included the good results the ESCO model can offer. Furthermore, it can be stated that this development is now present, due to the focus on ESCO 2.

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Appendices

Appendix 1 - Hans Barlach Interview with Hans Barlach

Audio file can be achieved here

Notes (in Danish) can be achieved here

Appendix 2 - Lars Nielsen Interview with Lars Nielsen

Audio file can be achieved here

Notes (in Danish) can be achieved here

Appendix 3 Reports and Summaries from Greve Municipality

Access to all documents gained from Greve Municipality can be achieved here

City Council

1. Anlægsregnskab - Energiprojekt skoler (Esco)-bilag
2. Anlægsregnskab - Energiprojekt skoler (Esco)
3. Disponering af anlægsmidler til udførelse af genopretningsarbejder ved EPC II-bilag
4. Disponering af anlægsmidler til udførelse af genopretningsarbejder ved EPC II
5. EPC II - Frigivelse af anlægsbevilling til Fase 3- Udførelse af arbejderne 2011
6. EPC II - Frigivelse af anlægsbevilling til Fase 3- Udførelse af arbejderne-bilag
7. EPC II tidsfristforlængelse 2011
8. EPC III - Skoler (ekstra), plejecentre, administrationsbygninger, m.v. 2012
9. EPC III - Skoler (ekstra), plejecentre, administrationsbygninger, m.v.-bilag
10. EPC III - Skoler (ekstra), plejecentre, administrationsbygninger, m.v.-bilag2
11. EPC III udbud og screening 2012
12. EPC Projektet - resultat af fase 1 samt indstilling vedr. projektet-bilag
13. EPC Projektet - resultat af fase 1 samt indstilling vedr. Projektet
14. EPC skoler statusopgørelse pr 29-02-2012-bilag1
15. EPC skoler statusopgørelse pr 29-02-2012
16. EPC skoler statusopgørelse pr 29-02-2012bilag2
17. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote)-bilag1
18. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote)-bilag2
19. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote)
20. EPC-projekt på daginstitutioner og udvalgte kultur- og fritidsinstitutioner - ny tidsplan
21. EPC-Projektet, budgetmæssige rettelser i konsekvens af den indgåede aftale
22. Indgåelse af aftale med Siemens a/s om EPC aftalen, herunder frigivelse af anlægsbudget-bilag
23. Indgåelse af aftale med Siemens a/s om EPC aftalen, herunder frigivelse af anlægsbudget
24. Projekt EPC
25. Projektforslag EPC på daginstitutioner-bilag
26. Projektforslag EPC på daginstitutioner
27. Status på EPC projektet

Economics and Planning Committee

28. Addresseliste med ejendomme til EPC III
29. Anlægsregnskab - Energiprojekt skoler (Esco)
30. Disponering af anlægsmidler til udførelse af genopretningsarbejder ved EPC II
31. EPC II - Frigivelse af anlægsbevilling til Fase 3- Udførelse af arbejderne
32. EPC II tidsfristforlængelse
33. EPC III - Skoler (ekstra), plejecentre, administrationsbygninger, mv
34. EPC III udbud og screening
35. EPC Projektet - resultat af fase 1 samt indstilling vedr. projektet - Bilag fra siemens
36. EPC Projektet - resultat af fase 1 samt indstilling vedr. Projektet
37. EPC skoler statusopgørelse pr 29-02-2012
38. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote) Bilag
39. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote) Notat
40. EPC tilskudsmulighed - Indberetning af C02-kvote (reduktionskvote)
41. EPC-projekt på daginstitutioner og udvalgte kultur- og fritidsinstitutioner - ny tidsplan
42. EPC-Projektet, budgetmæssige rettelser i konsekvens af den indgåede aftale
43. Indgåelse af aftale med Siemens a/s om EPC aftalen, herunder frigivelse af anlægsbudget Bilag
44. Indgåelse af aftale med Siemens a/s om EPC aftalen, herunder frigivelse af anlægsbudget
45. Notat til dagsordenspunkt
46. Notat
47. Projekt EPC
48. Projektforslag EPC på daginstitutioner – Bilag
49. Projektforslag EPC på daginstitutioner
50. Status på EPC projektet

Appendix 4 Regional conference on Financing Energy Efficiency in Nordic countries Copenhagen

- 19th May 2017

Conference proceedings, presentations and notes can be found here

Appendix 5 Interview Guides

The interview guide can be downloaded here

Appendix 6 List of telephone interviews

Greve Municipality - Teknik & Miljø (Technician and Environment)

EPC I

- Tjørnelyskolen
- Strandskolen
- Mosedes Skole
- Tune Skole
- Krogsgårdskolen

EPC II

- Tune Hallerne (same employee at Tune Skole)

EPC III

- Tjørnelyskolen
- Krogsgårdskolen
- Tune Skole
- Mosedeskolen
- Strandskolen
- Strandcentret
- Greve Borgerhus