PRELIMINARY STUDY OF BARRIERS OF GREEN BUSINESS MODELS IN THE MARITIME TRAFFIC SECTOR

Environmental Management & Sustainability Science, Aalborg University 2012
Niels Holm Ørnstrup

Picture: Amen & Evergren 2012 & Saeedy n.d.

Title:	Preliminary study of barriers of green business models in the maritime transport sector
Theme:	Business and Environmental Management
Project period:	8th of June 2012 – 6th of September 2012
Field of Study:	Environmental Management & Sustainability Science, 4th semester – Final thesis
Number of pages:	43
Number of copies:	3
Supervisor:	Henrik Riisgaard
Project participants:	1

Niels Holm Ørnstrup

Abstract

The financial recession has created hard times for some business. Financial aid packages have been made to stimulate the markets and governments. The oil price is increasing and the transport sector is consuming large amounts of oil on a global scale. The majority of large businesses and corporations need to show engagement towards the environment. This engagement is expected from both customers and societal norms. Lots of resources are spent on communicating visions and good case stories to the surroundings about this subject. This pin points that, the environment is not only a company position, but also a commercial factor. These factors indicate that we are in a time where innovative thinking combined with action is needed. The Danish small ferries has through history been built in steel and been fuel consuming. To decrease the consumption, lightweight ferries made of composite can be a solution. The problem is to make the investments of the ferries and the thesis will look into different business models and how they can help to make it possible for ferry owners to change elder ferries with newer less energy consuming ones. As the running costs has been increasing there might be a potential in purchasing composite ferries even though they are more expensive to purchase than regular steel vessels. But the composite has lower running costs. The thesis estimate the total cost of ownership on a steel vessel and the ECO island ferry paid with different green business models. The three green business models are the energy saving tax, public private partnership and the ESCO business model. Odder municipality's options of obtain loans on behalf of the private companies in return of energy reduction guarantee is discussed and conclude that the municipality will be capable of obtaining loans for energy saving purposes. The introduction of green business models in the maritime transport sector can potentially help municipalities to install lightweight ferries with low fuel consumption. The low fuel consumption result in less GHG emissions from the ferry service, meaning the green business models improve both the environment and the municipality's economy.

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1. Background

Since the 1980's, when the Brundtland report was published, the environment has been a growing subject on the political agenda. The European Union included environmental regulations in their policy in 1987 and their regulatory actions are funded on the main beliefs of protective and precautious engagements together with the polluter-pays principle (Danish Presidency of the Council of the European Union 2012).

In Denmark, environmental policies have been implemented in all sectors with the aim of minimizing GHG emissions and environmental impacts. This is done to reach both European and national targets and thereby contribute to mitigate global warming issues. Denmark has made a long term target of independency of fossil fuels in 2050 (Regeringen 2011). Although Denmark, globally, is amongst the leading countries with optimistic targets the transport sector, has been lacking active environmental actions (Regeringen 2011). When comparing the energy consumption in the different sectors in Denmark, the transport sector is the one increasing the consumption by far the most (Ea Energianalyse et al 2008). Figure 1 illustrates this consumption development divided into sectors.

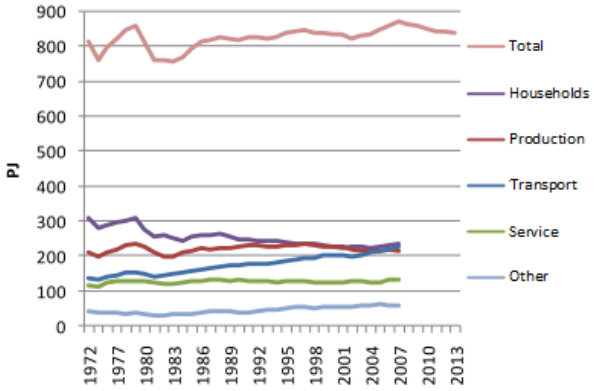


Figure 1 shows the gross energy consumption in Denmark (Ea Energianalyse et al 2008)

The Danish transport sector is based on mainly oil and stands for approximately 60% of the Danish oil consumption. The consumption from the transport sector is constantly increasing (Trafikselskaberne n.d.) and this is contributing to the development illustrated in figure 1. The Danish public transport association, called Trafikselskaberne, believes project and test with alternative energy sources ought to be tried in Denmark. This will potentially reduce not only the public transport, but also the transport sector if the alternatives are capable of being implemented in the general picture (Trafikselskaberne n.d.).

Today it is common to include the environment aspects in nearly every part of the daily life. In the supermarkets, the Danes are forced to choose between ordinary products or products which are produced environmentally and/or organically correct. In other words, it is a choice of purchasing products with or without eco-labels. Our dairy products are labeled with eco-labels, automobiles are labeled with environmental performance specifications (Transportministeriet 2012) and

even the Danish houses are being environmentally evaluated on its energy consumption and climate envelope when transfer of ownership happens (Energimærkning.dk n.d.).

All these initiatives have been introduced over the last decades and the Danish society's attitude towards the environment can be seen in i.e. the private households' investment in photovoltaic solar panels. From 2007 till 2011 the installed photovoltaic solar panels in Denmark increased from 500 kW to 11.000 kW, which is an increase on 2.100%. The installed capacity of heat pump is also greatly increased with 221,4% in those five years (Installatørernes Organisation 2012). These numbers illustrates the common Danes positive attitude towards investing in green energy.

Although this can be taken as the general Danish populations' attitude towards green development there are differences between the private household investments and the industrial investments. Institutional barriers might be the object which prevents implementation of greener business models which could lead to more sustainable developments.

On the other hand, due to expensive investments and not as efficient consumption development, transport is the Achilles heel of green performances. One of the aspects of changing the potentials could be through new purchasing models or transfer existing business models between sectors so innovation and investments are possible on green transport. Transport projects such as small island ferries consume significantly different amounts of fuel depending on what material the hull is constructed of.

1.1. A nation by the sea

Denmark is a small country on approximately 43.000 square kilometers consisting of one peninsula (Jutland) and more than 440 islands (Danmarks Statistik n.d.). In comparison to the country's size it has an incredible long coastal line of more than 7,300 km (Danmarks Statistik 2011), which is the same distance as from Denmark to the Caribbean. The sea has throughout history had great influence on the Scandinavian country and transportation between the inhabited islands has been needed for as long people have been living on them. Historical wise, there is a rich tradition for using the sea for both fishery and trade. In the early 1900th century the Danish (at that time Norway was included in Denmark) fleet is the fifth largest European fleet. Presently Maersk Line stands for approximately 15 % of the global market share of container shipping worldwide and this continuous use of naval transport ought to engage research on sustainable transport (Anagor 2012). The history, tradition and location by the sea make marine transport of great importance for Denmark. Already in 1995 the Danish Maritime Authority recommended that small island ferries ought to improve the environmental condition (Søfartsstyrelsen 1995).

1.2. Marine transport in rural Denmark and urbanization

About 78 of the Danish islands are inhabited (Gyldendal 2009) and the people living here commute to the main land and main islands with ferry and bridges. There are approximately 40 ferry routes which are located in only Danish waters and each route is covered by at least one vessel per route. This transport service is essential for people living in these areas and without it the inhabitant could be forced to move. The Danish government supports the municipalities which include islands and this governmental island support can be used for renewing the transport connections.

Urbanization is an ongoing development in Denmark and the outskirts of Denmark are becoming less populated and especially the youth are moving to the cities to get educations and not returning back to the islands (Realdaniaby n.d.). According to Eurostat (2012), Denmark is one of Europe's least urbanized countries with just 22 % living in urban regions. The areas are classified as urban, intermediate and rural and the analysis is done on population and density. In comparison 41% of the European population lived in urban regions, see table 1 (Eurostat 2012).

Table 1 Population by urban-rural typology, 2011 (Eurostat 2012)

Percentage of total population			
	Urban	Intermediate	Rural
EU (27 member countries)	41	35	23
Denmark	22	36	42

While the majority of the Danish population on one hand is living in the rural regions, Denmark is amongst the European countries which is experiencing the largest urbanizations in percentage, see table 2 (Eurostat 2012).

Table 2 Population change (2010-2011) by urban-rural typology (Eurostat 2012)

Population change per 1000 inhabitants by urban-intermediate-rural typology			
	Urban	Intermediate	Rural
EU (27 member countries)	5,2	2,2	-0,8
Denmark	15,0	4,8	-0,8

The depopulation in western Jutland around Ringkøbing, Skive and Lemvig is estimated to be 15% in 2030. The trend furthermore shows that the economical income and educational level in the urban regions are higher than in the rural regions and the cities are predicted as the location for economic growth (Realdaniaby n.d.).

Despite of the urbanizing trend, the transport services in the rural areas are still needed for the rural population, especially as the Danish politi-

cians illustrate their concern for the development in the rural regions and would like these regions to be on the level as the rest of the Danish society (Folketinget 2012 & Folketinget 2010).

With the described urbanization tendencies in mind it is possible to assume that the small island ferries, located in rural regions, will transport less people in the future – though without taking seasonal and holiday influences into the equation. This result in less income from ferry tickets and each ferry-journey will thereby become more expensive to run for the responsible municipality, if the oil consumption, salaries and running cost stays on the same level.

The urbanization is a relevant topic to touch upon as decision makers ought to decide whether regions (rural, intermediate or urban) should be kept alive even with economic deficits or if economy is ought to defeat the diversity of rural, intermediate and urban cultures, jobs and ways of living. As mentioned before, the politicians agree upon Denmark developed as a unit, so the decision is clear. Sustainable developments might be the solution in the rural regions to keep the population from moving to the cities (Folketinget 2012 & Folketinget 2010).

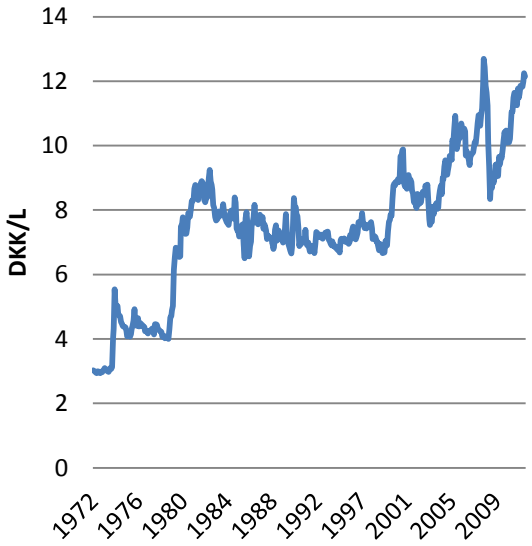
1.3. Lightweight ferries

A large part of the ferries are built before environmental pollution and efficiency came on the agenda. Therefore vessels and ferries have a long history of being constructed in steel. Vessels made of composite are much lighter and does therefore reduce the fuel consumption to make the boat move. Legislation on the area addresses steel constructions significantly more than composite constructions.

Lightweight carbon composite constructions have been used to supply super yachts, extreme water sports and the navy with high speed boats (i.e. through Danish Yachts). Some of the solutions which make the high speed possible could be used to improve the energy efficiency. Instead of using the benefits on speed it could be used on saving fuel, which will reduce the environmental impact and running costs on fuel. The fuel prices are increasing and little implies that the prices will be reduced, so to keep low running costs, fuel savings appears to be a low hanging fruit.

Since the late 1990s oil prices have increased and presently reached some of the highest levels in history. The Energy and Oil forum (2012) has delivered the data for the table below, illustrating the changes in diesel prices in Denmark since 1972. The base product of marine diesel is the same as regular diesel and even with a small difference in taxation the diesel products will follow each other (Appendix 4).

Table 3 shows the development of diesel prices from 1972 - 2012 in DKK/L (Energi- og Olieforum 2012)



The majority of transportation is done by the use of oil products, and especially the maritime sector is a key user. When purchasing vessels, an outline of the total lifetime costs could help to purchase the economically right one in the long term. An assessment done in collaboration with LASS (Lightweight constructions at sea) has calculated the financial costs of three vessels with the same design and main characteristics, though with different hull materials.

Table 4 The main characteristics of the assessed vessels are the same (Burman et al n.d.)

Length overall	128 m
Passengers	1000
Operational range	300 nm
Speed	42 kn
Cargo Capacity	352 cars / 220 trailers

The vessel used in the assessed example is a high speed ferry and the construction materials are respectively (1) a steel hull with an aluminum superstructure, (2) a complete aluminum construction and (3) a composite vessel with a sandwich construction with a core of foam material and reinforced carbon fibers as the outer layers (Burman et al n.d.).

When comparing the life cycle costs of steel, aluminum and composite vessels (with the same service abilities) starting with production of respective steel, aluminum and composite, the steel vessel is the cheapest material for construction. The aluminum vessel has nearly the same production price as the steel construction and the composite vessel is the most expensive due to the higher material prices. However, the majority of a life cycle costs are linked to the operation and maintenance of the vessel. Figure 2 illustrates the life cycle costs for the three vessels where the breakeven points are marked and the two first years of costs are the production. The steel vessels is clearly the most expensive and even with the composite's higher production costs only takes two years for this type of vessel to breakeven. The aluminum vessel and composite breakeven after 10 years operation and from there on the composite is the most cost efficient material (Burman et al .n.d.).

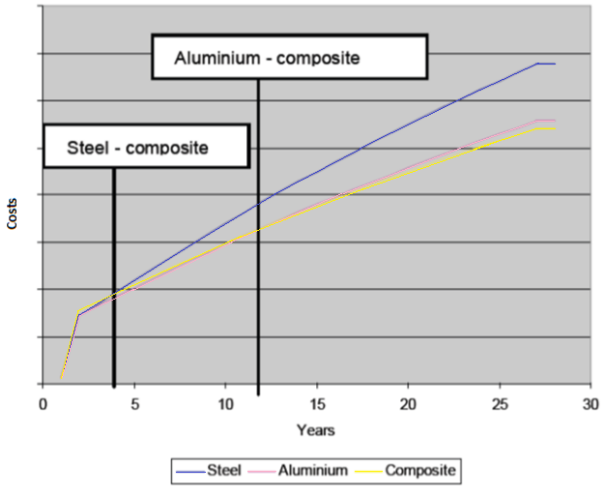


Figure 1 Illustrates the lifecycle costs of a steel-, aluminum- and composite vessel as well as the breakeven points (Burman et al n.d.)

The advantage of composite material is the light weight, which results in less fuel consumption and lower maintenance costs of the hull construction. The end of life costs does not significantly affect the total life cycle costs (Burman et al n.d.).

Niels Hjørnet (2011), a naval architect and consultant, argue that after approximately 15 - 20 years the maintenance costs of steel constructions increases rapidly due to factors like corrosion. This is illustrated by figure 3, where composite constructions not are expected to increase its maintenance costs.

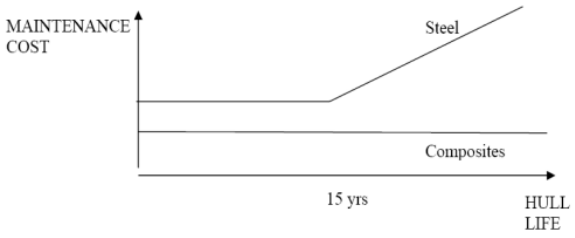


Figure 3 - Maintenance cost over time for a ship built of plastic composite and steel (Hjørnet 2011)

The two figures (2 and 3) show the same tendencies though with different enhancements, but the general understanding is steel vessels is more expensive to operate and maintain than composite vessels.

The Danish Maritime Authority has an objective to help decreasing emissions from naval transport. They pin point one of the targets as, reducing emissions through research in both new and know technologies (Søfartsstyrelsen 2007). The composite material has been used by the military and sports vessels and experiences and ideas from these lead users ought to be inspiration for regular vessels such as ferries.

1.4. Municipal environmental- and climate strategies

The majority of the Danish municipalities have entered agreements on the level of GHG they emit and how much it ought to be reduced. There are different agreements such as the "Curve-bender agreement" (kurveknækker aftale), climate municipality and sustainability city. The agreements have slightly different targets, but all in all similar objectives, which are to reduce fossil consumption and reduce GHG, especially CO_2.

Similar tendencies are developed on company levels, i.e. Corporate Social Reasonability. Sustainability strategies are made for short and long term objectives, so specific goals can be reach.

The Danish municipalities are assigned certain restrictions when acquiring product and services. The national association of municipalities has entered an agreement on energy saving measures where the municipalities are obliged to implement energy efficient behavior, energy efficient buildings and energy efficient acquisitions (KL n.d.). The municipalities have the option of obtaining loans for energy saving investments. Until now the municipalities have mostly focused the investments in insulation to decrease heat losses and general energy optimizations within electricity saving measures (Region Midtjylland 2012).

1.4.1. Climate Municipalities

The Danish Society for Nature Conservation has developed a concept call *Climate Municipality*. This is done to put a demand on the municipalities to reduce their CO2 emissions and by being a climate municipality, they are obliged to reduce the CO2 emissions by at least 2% annually. By being part of climate municipalities the mitigation and reduction work is a structured and organized way of reducing CO2 emissions and accomplishes the individual municipalities' reduction targets. Due to great endorsement, the Danish Society for Nature Conservation can use their experience from one municipality to help other municipalities. Currently 74% of the municipalities in Denmark has joined the movement and has therefore set goals and targets to reduce their impact on nature (Danmarks Naturfredningsforening 2012a).

Climate change is a global issue, but actions should take place at the local level. Thus, civil society, private sector and government have to cooperate in order to achieve significant results in climate change prevention. While participating and encouraging each other, nations and regions can get economic benefits and save the environment.

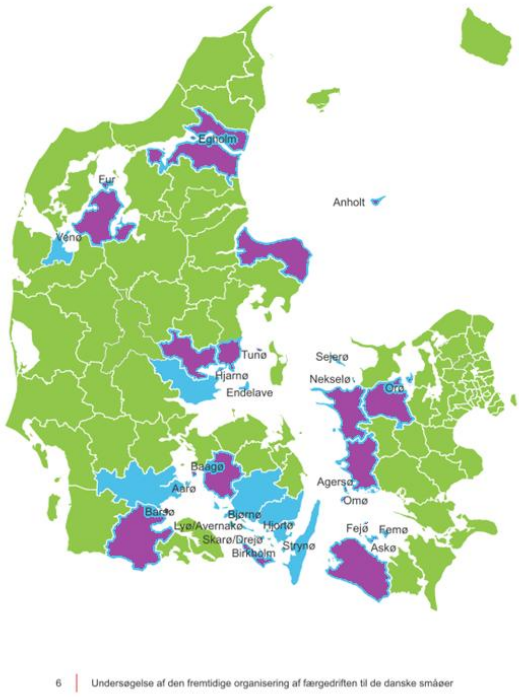


Figure 4 displays the convergence of climate municipalities and municipalities with small island receiving governmental support (Indenrigs- og sundhedsministeriet et al 2011 & Danmarks Naturfredningsforening 2012a).

The map illustrates the municipalities which receives governmental support for small islands (with blue) and the purple color illustrates the municipalities with both receives the governmen-

tal island support (hence contain small islands) and is part of the Danish Society for Nature Conservation (Indenrigs- og sundhedsministeriet et al 2011 & Danmarks Naturfredningsforening 2012a).

1.5. Purpose of the project

To reach the environmental targets, especially municipal buildings are getting retrofitted to consume less energy. For municipalities with ship operations there is potential for reduction of CO_2 emissions through investments in lightweight ferries instead of traditional steel constructions.

The thesis will attempt to investigate business models for the purpose of financing small island ferries, suited for the Danish municipalities as owners. A case with the Tun island ferry, owned by Odder municipality, and the Øko Ø-færge project (Eco island ferry) is drawn upon to exemplify. The Eco island ferry is not constructed, but is a calculated example of how a lightweight ferry would be designed and performs. The institutional barriers of financing such a construction is analyzed, so sustainable development are more likely to happen in the rural regions of Denmark.

One can argue that when the operation of the small island ferries, in general, generates deficit instead of income it is not a good business. But to keep the possibility of development in these regions the political decision is taken to keep the ferry routes despite of the depopulation. With this perspective in mind, the issue is simplified and it is a question of keeping the running cost as low as possible to generate as little a deficit – hopefully a profit.

As the focus is on the municipal ownership the thesis will look into the municipalities' opportunities of financial loans for investments. The ESCO business model which is used for improving environmental conditions and impacts from buildings will be used for inspiration and ideas towards developing a business model suited for the municipal marine traffic services.

1.5.1. Research question

Which institutional barriers hinter the transport sector in implementing green business models originated from other industry sectors?

The transport sector is a large perspective and to make it possible to cover within the limitations on the thesis, the focus will be held on the municipal maritime level. Sub question like the one stated below will be used to answer the research question.

- *How can a green business model be used for investment in a new Eco island ferry?*

1.5.2. Limitation

The limitations on the thesis allow inclusion of only a few models so further investigation could

be done on other green business models. Due to lack of data in this maritime area, both economic and consumption data, the thesis has taken use of the available data. Even though a data collection has been conducted through a market analysis the response rate is so low, the data would be invalid to use as average data.

The institutional reasons for excluding the transport sector as an applicant for financial support from the energy saving tax has not been possible to find and a thorough research into this could potentially open for possibilities within this area.

2. Research methodology

The point of departure for the research of the municipalities' ferry operation started with a critical reflection on the bad economy in the municipal ferry business. The thesis is conducted primarily through literature review, telephone interviews and email correspondence with experts has been made to clarify i.e. interpretations of legislations. Telephone interview is a qualitative method which primarily is completed with a specialist in a specific area of expertise (Yin 1994). The interview has been made with a semi structured approach, so the correspondent would be capable of contributing with potentially new angles and topics of the issue.

A marked analysis, collecting data on the Danish ferry's energy consumption, maintenance costs and the owners' environmental engagement has been made, but the response from the municipalities and Danish ferry operations has been minimal. Hence the results given by the few answers will not be enough to base assumptions and tendencies on.

The benefit of a quantitative marked analysis would be to give a picture of the current costs of small ferries as well as what the owner- and operators' focus is on when keeping ferry business running. Despite this to give an overview of to what degree the owners have considerations of changing ferries to less fuel consuming models.

The literature study is used for the green business models among other things. The green business models are essential in this thesis as the environmental impacts usually reflect the economical focus. An example is, when installing a product (in this case a ferry) with lower fuel consumption, it results in less emissions and a decrease in the finances spend on fuel. This report take use of existing green business models to inspire investments in small island ferries. A literature study has been conducted to identify different green business models and the green business models picked out is in general from non-marine environments. The green business models are chosen on to include both environmental aspects, which could be minimizing the environmental impacts, and minimizing the life time costs for the customer. The green business models are, if necessary, being transformed.

The life time costs are essential as the purchase price of a ferry usually isn't the most expensive financial cost. Thus, this thesis focuses on green business models and a study with broader economic and technical environmental matters could be produced to give exact results on the full picture of the total costs.

The green business models are assessed by focusing on the total costs of ownership for the municipalities. This makes the municipalities being enlightened not to purchase the cheapest purchase price, but to include the operational and maintenance costs in the total costs for the municipality.

2.1. Total cost of ownership

A shift has been taking place when it comes to viewing products in Denmark and it is no long enough to look at just the energy consumed at the production, but also the life time expenses are important when purchasing energy consuming products (Remmen & Thrane 2007). The life time expenses can also be called total cost of ownership (TCO) and are used by the Danish municipalities, regions and independent institutions when purchasing IT products. Shortly described it makes the suppliers state the products acquisition price and the expected costs, i.e. electricity consumption, throughout the products life time. It is the TCO which determine the public authorities' choice of supplier (NyhedsInformation 2012).

When municipalities are obliged to use this model for buying IT products it is hard to not ask the question – why is it only IT products? TCO could be implemented in or inspire the Danish ferry sector to secure both green and economic awareness. As the foundation of investments is the full life cycle more awareness could be made in thinking a broader perspective when investing in new ferries.

2.2. Tunøfærgen

Odder municipality joined in 2012 the Climate Municipality agreement and before this green accounts for the municipal activities in 2010 and 2011 has been made. The municipality's transport activities account for 18% of the municipality's total emission and are the second largest emission category after *buildings*. The municipality has started 81 refurbishment projects, focusing mainly on ventilation and lights, which will save 387.800 kWh annually (Danmarks Naturfredningsforening 2012b), so the startup of this category is covered. The transport's total emission is 939 tons of CO2 and more than 43% of the transport emissions are caused by the ferry-connection to Tunø (Odder Kommune 2012a). Figure 5 displays the subcategories of the transport emissions.

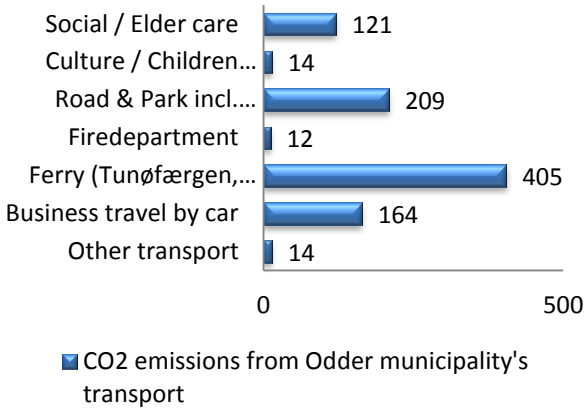


Figure 5 Illustrates the CO2 emissions from the transport Odder Municipality was responsible for in 2011 (Odder Kommune 2012a)

The Tun island ferry, Tunøfærgen, which connects Tunø to the mainland, is a steel construction built in 1993 (MarineTraffic 2012). Hence its 19 years, the environment was not a subject which influenced the maritime sector at the time of construction. MARKIS, a maritime network in Swe-

den, Norway and Denmark funded by the European Union, has together with different partners started the project *Øko Ø-færge* (Eco island ferry) which is a fictive substitute for Tun island ferry (MARKIS n.d.). The Eco island ferry project has the goal of documenting that small ferries made of carbon composite are more environmentally friendly than steel constructions. The ferry must have the same services as the existing Tun island ferry, such as capacity of passengers and cars (Amen & Evergren 2012).

A comparable analysis of a steel ferry (the Tun island ferry) and a composite ferry has been made by SP Technical Research Institute of Sweden. The current ferry on the route is a steel construction which has a lightweight on 250 tones and the displacement weight is 340 tones. The fictive carbon composite vessel, the Eco island ferry) has a lightweight on 77,2 tones and the displacement weight to 124,6 tones. This is a weight reduction on more than 60 % when the ships are fully bulked, all due to change of construction material. Because the Eco island ferry is lighter than the existing Tunø ferry, it will not need the same engine power to drive the ferry at running speed and it will not use as much fuel, thus smaller fuel consumption.

Weight specifications for the reference object, the Tun island ferry, and the Øko-Ø-færge

Weight item	*Tun island ferry [kg]*	*Øko-Ø-færge [kg]*
Lightweight*	250 000	77 168
Ballast	33 900	0
Fuel	18 800	10 100
Stores	1 000	1 000
Passengers	15 000	15 000
Crew	225	225
Luggage	2 000	2 000
Cars	16 000	160 00
Deck cargo	3 075	3 075
Displacement**	**340 000**	**124 568**

* The lightweight is a nautical term for the displacement of a ship (normally given in tonnes but here given in kg) without cargo, fuel, lubricating oil, ballast water, consumable stores as well as passengers, crew and their effects.
** Displacement is a nautical term for the total weight of a ship.

Figure 6 displaying the weight details of the Tun island ferry and the Eco island ferry (Amen & Evergren 2012)

Figure 6 illustrate the details of the two ferries and it is possible to see that the service capabilities are the same. The capacity of passengers, crew, luggage, cars and deck cargo is the exact same on the two ferries (Amen & Evergren 2012).

The Tun island ferry's fuel consumption has not been possible to get and the municipality's previous financial accounts do not have a specific post for this. The municipality's budget for 2012 specify that they expect to use 782.800 DKK on fuel for the Tun island ferry which is 13,6% of the total budget spent on the ferry operation in 2012. This amount has withdrawn the usual tax, as the municipality does not have to pay tax for this. In comparison, the employees' salary equals to more than 50% of the total operation costs (Appendix 5).

The Eco island ferry's fuel consumption has been estimated to be 48,22 L/departure. It is an estimate calculated from the details delivered by one of the actors in the Eco island ferry project (Appendix 1) and the current ferry service time (Tunøfærgen 2012). An approximation of the departures for 2012 shows 1.450 departures

which result in a total fuel consumption on 69.919L/year. With the current price (the price is valid for the 4th of September 2012) on marine diesel being 6,8866kr/L (without tax) the annual fuel cost would be 481.504 DKK (OK 2012). This gives a reduction of fuel on 43.751L marine diesel and a decrease in the fuel costs on nearly 40%.

There is great uncertainty attached to these estimated fuel consumption as it is calculated on the Eco island ferry's engines consumption details when the speed is 10 knots (the service speed) and the time the ferry is in harbour is not included in the estimate even though the ferry is running. The acceleration process of the vessel is neither implemented in the estimate.

A price has not been published if a realization of the Eco island ferry was to happen. Glancing at the LASS' analysis on steel, aluminum and composite vessels the planning, design and production cost of a composite vessel is 6% more expensive than a steel vessel (Burman n.d.).

2.3. Municipal financial options

The municipalities have some options of financing a new ferry and the governmental island support was previously ear marked to support the ferry route, operation and investments in it (Indenrigs- og Sundhedsministeriet 2009). Moreover the municipalities are able to get issued loans which leads to energy saving matters (Økonomi- og Indenrigsministeriet 2011). The next paragraphs will introduce the municipalities' loan options and the governmental island support and some of the issues following in the footsteps when the support is not locked to a single target area, but the right of disposal is all in the municipality's hand.

2.3.1. Municipal loan options

This thesis relates to environmental matters and attempts to put forward green business models which in return will decrease environmental impacts. Some of the green business models such as ESCO originate from the building sector and this is apparent in the municipal loan options. In the Declaration of Municipal Loan Obtaining and Granting of Guaranty**,** § 2 relates to energy saving measures, but only includes energy saving measures such as retrofitting in the building stock and power production facilities. It does not include energy consuming products such as transport units or computers (Økonomi- og Indenrigsministeriet 2012), even though improving ferries' abilities to consume less fuel is an energy saving action.

Fortunately, certain municipalities have the opportunity to obtain loans which covers the "*cost or legal support of replacement, new construction or retrofitting of ferries and ferry facilities which is connected to the ferry routes*" (Økonomi- og Indenrigsministeriet 2011§2). Hence, the municipal loan option is not a barrier for investment in a

ferry leading to improving the environmental condition and performance of the ferry route connection a long with potentially decreasing fuel consumption.

2.3.2. Governmental island support

Municipalities with inhabited small islands have for decades received a governmental island support as these municipalities might have special needs to make sure the islands takes part in the societal development. Declaration LBK nr 561 of 19/06/2009 concerning equalization and general subsidies to municipalities, defines the municipalities with small islands as: Kalundborg, Holbæk, Slagelse, Lolland, Assens, Fåborg-Midtfyn, Ærø, Langeland, Svendborg, Haderslev, Aabenraa, Esbjerg, Horsens, Hedensted, Struer, Norddjurs, Odder, Skive and Aalborg municipality (Indenrigs- og Sundhedsministeriet 2009). Figure 7 illustrate at the left map, the municipalities which receive the governmental island support.

Figure 7 The map illustrates the municipalities which receives governmental support for small islands (with blue) (Indenrigs- og sundhedsministeriet et al 2011)

The support has among others been granted towards the ferry operation before the municipalities were restructured in 2007. At that time the support was primarily dedicated towards the operation and maintenance of the ferry as well as savings for new investments. After the restructuring the responsibility of operating the ferry service has fully been the municipalities. The municipalities have different expenditure needs and the island support is distributed by the government through a distribution model so the magnitude of the grant corresponds with previous years; ferry support, educational youth support and economical troubled municipalities due to specific island expenses. Thus, the support size from previous years is the underlying basis for the grant size given, but the islands population, length of the ferry route and the islands size also concurrent

factor (Indenrigs- og sundhedsministeriet et al 2011).

In 2007 the governmental islands grant was 71,1 million DKK and this is the regulation year which the governmental island support annually is calculated from. The grant is regulated with the expected price- and salary development for the municipal sector (Indenrigs- og Sundhedsministeriet 2009) and in 2011 the total governmental island support for small islands increased to DKK 86,3 million, which had to be divided between the municipalities, mentioned above. Table 5 illustrates the granted support to Faaborg-Midtfyn municipality in 2011 (Faaborg-Midtfyn Kommune 2011).

Criteria for grant	DDK
1. grant corresponds with previous years ferry support	2.394.000
2. grant corresponds with previous years special subsidy	943.517
3. grant corresponds with population	
4. grant corresponds with population, ferry route distance and island size	
Criteria 3 and 4 relates to previous years investment support	1.414.000
Total island grant for Faaborg-Midtfyn municipality in 2011	4.751.517

Table 5 Detailed illustration of Faaborg-Midtfyn municipality's governmental island grant in 2011 (Faaborg-Midtfyn Kommune 2011)

Table 5 visualize that 50% of the support is given on behalf of the old support methodology, where the ferry support was dedicated towards this area. Today the municipality can control the total amount of the support in whatever direction they feel it is needed. The government's objective with this grant is to get the municipality to implement the support gained from criteria 3 and 4 in the annual depreciation allowance on ferries. The municipality ought to either pay off debt on previously bought ferries or save up for new ferries as it after the municipal reformation is their full responsibility to save for new ferries. The Ministry of Welfare claimed this would give the municipalities incentive to think long term, but at the same time clarify that the municipalities with small islands have access to loan options for investments in new ferries (Indenrigs- og Socialministeriet 2009).

The municipalities are operating the ferry routes by different forms of companies such as joint stock companies and other routes are privately owned. In the 2011 report about organizing the ferry operation by the Ministry of the Interior and Health, it is stated that the ferry route must be operated as economical efficient as possible by the municipalities and at the same time keep an attractive living and working situation on the islands, thus the ferry routes must keep a certain level of service and departures. The report concludes that the population on the small Danish islands between 2004 and 2009 decreased with 7% and on the contrary that the amount of ferry departures, passengers and cars were slightly increasing. Out of the 2009 governmental island grant on 79,4 million DKK, the ferry support was 67,7 million DKK and it is reported by the munici-

palities that they supported the ferry routes with 97,1 million DKK the same year (Indenrigs- og sundhedsministeriet et al 2011). This indicates that the municipalities receive approximately 65 % of the total costs from the government as grants to support the running expenditures. Though, since the municipal reformation the governmental island grant is no longer designated only for the ferry routes, as it is up to the municipality to distribute the grant.

A concern is that the municipalities do not administrate the support to new investments and depreciation allowance, as the administration of the support no longer is supervised by the government and the former regional council (Indenrigs- og sundhedsministeriet et al 2011). The support is granted on behalf of the previously ferry grant, but head of political administration office, Christian Bo Christiansen, state that neither the entire nor part of the governmental island grant is designated towards the ferry routes, see appendix 2. The Union of Small Danish Islands believes the island support should be designated towards the ferry routes, as political priorities between the island- and the mainland population could become an issue with the way the current agreement is structured.

Beside the annual governmental support, between 2008 and 2010 the government put forward financial subsidies with a total value of 260 million DKK only for the ferry routes for acquisition of new ferries (Indenrigs- og sundhedsministeriet et al 2011). It has not been possible to figure out how much of these subsidies have been applied and used by the municipalities.

There is also a governmental support for municipalities on larger islands such as Læsø, Samø, Ærø and Bornholm. The grant is of similar size and nearly calculated the same way, but distributed between fewer municipalities. This is not a focus pint of the thesis.

3. Green business models

The thesis contains multiple green business models which are separately structured to first introduce the model and explain the main ideas as well as more explicitly in form of the procedures within the green business model. Secondly will the environmental and economic benefits be highlighted and illustrated. Thirdly, potential barriers which prohibit the implementation of the model will be included to enhance difficulties in improving the environmental performances of ferries. After this, recommendations are disseminated as the final section in the chapter.

FORA's report on green business models in the Nordic region (2010) defines green business models as, "*business models which support the development of products and services (systems) with environmental benefits, reduce resource use/waste and which are economic viable. These business models have a lower environmental impact than traditional business models*."

The difference between *green business models* and *traditional green businesses* is that green businesses focuses on the production (clean technology) of the product/service i.e. how much energy is used to in the production phase of the product/service. Whereas the green business models focuses on the customer's products/services and can be paid according to the performance of these (FORA et al 2010). This green business model forces the supplier to focus on the life time of the product and not just a clean production. The life cycle thinking increases the understanding of the environmental issues of a product from not just the production phase, but also to the life time of the product as well as end of life (Remmen & Thrane 2007). The following chapter will introduce the green business models.

3.1. Energy saving tax

The Danish energy companies have by law implemented an energy saving tax on electricity sold in Denmark. This tax creates a pool of money which has to be used as energy saving grants. Both civil population and industries can apply for these grants for energy saving purposes in all sectors except transport (Energistyrelsen 2009). Declaration nr 677 of June 2010 about energy saving granting, state the energy company must promote and encourage cost-effective energy savings which benefit the energy consumer and the Danish society. But the declaration excludes transport (Klima- og Energiministeriet 2010).

An approximation of the amount of money gained by the energy saving tax for electricity can be calculated by using the Danish consumption of electricity. The Danish Energy Saving Trust clarify in a phone interview (Appendix 6), that all electricity in Denmark is required to pay the energy saving tax, even so-called CO_2 free electricity from wind turbines. In 2010 Denmark had a total electricity consumption on 35.000 GWh (Danmarks Vindmølleforening 2011) and the energy saving tax is 6,40 Danish cent per KWh (øre/KWh)

which gives a total income on 2,24 billion DKK from the Danish consumers, which is designated towards energy saving measures. It is the energy companies' responsibility to offer the consumers energy saving services and it has to be in the region where the energy company is located. As mentioned before all sectors but the transport sector are capable of apply for grants from the pool of money, which might rise some questions. Figure 1 display the past decades' development in gross energy consumption in Denmark up to 2007 and the sector which increases the most is transport. In total the consumption has been more or less on the same level, whereas the energy consumption from households has decreased with close to 100 PJ over the last 30 years (Ea Energianalyse et al 2008).

Including the transport sector would give the energy companies multiple options of investing in energy savings and help the transport sector to decrease its energy consumption or at least minimize the increased rate. Several energy companies have expressed that including the transport sector would be beneficial (Ea Energianalyse et al 2008). Why the transport sector is not included as a possible sector to invest energy savings in is not revealed in the declaration hearings before the declaration was implemented does not contain topics of transport. The authorities on the area have neither responded on email nor are they able to answer why the transport sector is excluded as the only sector, through telephone interviews (Appendix 6).

In this green business model, the barrier is that the transport sector can not apply for the grants. Without the elimination of the transport sector, the energy saving taxation would be an obvious way of financing the purchases of new low fuel consumption ferries.

3.2. Public Private Partnership

Design, Build, Finance and Operate (DBFO) is a green business model focuses on long term business contracts, typically around 30-35 years. It is a form of public private partnership (PPP) which connects private capital to public project, in this case the funding of public infrastructure in the form of ferries. The DBFO partnership relies on the private provider's expertise in delivering and managing the projects, so the construction, maintenance and operation is taken care of by the supplier. This model should give the supplier incentive to minimize the total costs, thus including the running costs and heighten the quality of the product (FORA et al 2010). Figure 8 displays the usual DBFO overview, where the customer represents the municipality.

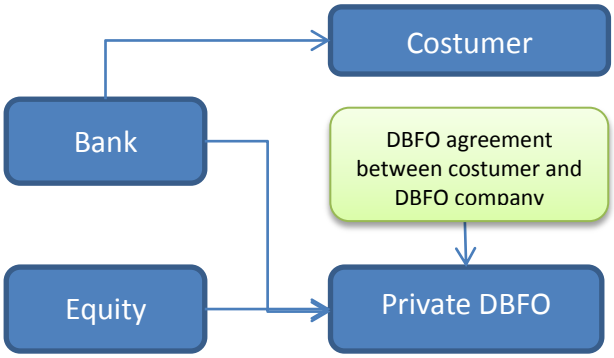


Figure 8 illustrates the usual DBFO overview, where the customer represents the municipality (FORA et al 2010).

The supplier is required to provide a guaranty of the products energy performance level, which allows the municipality to obtain a loan for the private supplier. This is illustrated in figure 8 above where bank illustrates the loan. The private supplier provides a guaranty on the service level and if the construction of the ferry is more expensive than the expected it is the supplier who will pay the extra costs. Moreover if the service and maintenance level is not satisfying the agreed standard, the monthly payment will be reduced as a consequence. With this model the municipality will not be the one carrying the operational and maintenance responsibility costs as they will be handled by the supplier, whom would have the incentive to perform as good as possible (FORA et al 2010).

Within a municipality, the budget can be tight and with the DBFO the costs for the ferry service will be steady and not exceed the expected amount. In a long term perspective this green business model will be capable of providing a proper ferry service for the local population, without the municipality having to prioritize if there is room in the budget for proper maintenance or having to loan the financial means (FORA et al 2010).

The design and construction of vessels is usually done separately from the service and maintenance of the vessel. By connecting these elements the DBFO green business model will potentially result in both environmental and economic benefits. When the benefits of building a structure which consume less fuel and has low maintenance costs, entitles the supplier of the vessel it can lead to innovation in design and technical solutions. Especially being part of the total life time of the project instead of just being part of single phases of the project encourage the supplier to perform best possible (FORA et al 2010).

3.3. Energy Service Company

ESCO refers to Energy Service Company, which performs various solutions for energy saving measures. It is yet only known used for retrofitting buildings, where the majority is municipal or public owned (Go'Energi 2011). In the Scandinavian countries the business concept is called ESCO, but in England and United States of America it is known as Environmental Performance Contracting (EPC) and ESCO is the company performing the energy saving measures and services (EPC Watch n.d.). The thesis will refer to this green

business model as the *ESCO business model* and the supplier of the service is also referred to as *ESCO*, hence the geographical focus for the thesis is in Danish waters and therefore aligns to the local Nordic interpretation.

The ESCO business model has similarities with DBFO in the aspects of the supplier (ESCO) provides a guarantee of the product's energy performance. In return of this guaranty the municipality obtains a loan on behalf of the ESCO, so the product (the ferry) is financed in a kind of agreement between the supplier and customer. The ESCO can receive the purchase price at the start of the project (depending on the signed agreement) through the loan obtained by the customer on behalf of guaranteed energy savings from the ESCO. The ESCO business model provides an alternative method for the customer to pay. The energy savings are generated through the installation of a new and low energy consuming ferry and the purchase price is then paid back through the appeared savings. The savings are illustrated in figure 9 where the running costs decreases. The municipality keeps paying the regular amount of running costs, as this is how the loan is being paid back (Rambøll n.d.).

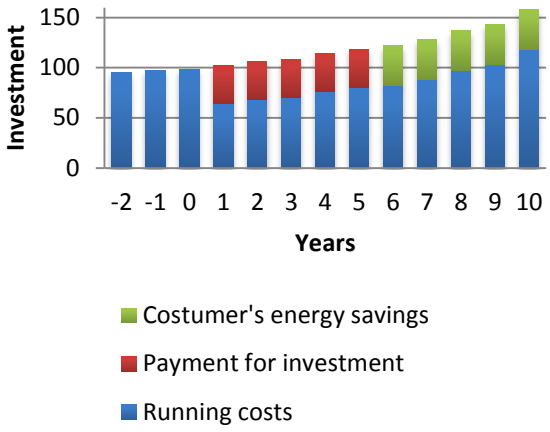


Figure 9 illustrates the payment method when using the ESCO business model (Inspiration from ESCO Gruppen n.d.).

ESCO use existing consumption data from the building which is object to the retrofitting process. The consumption data is connected to the area the ESCO is performing energy savings measures. Figure 9 illustrates running costs and the payback time in this illustration is five years, but is subject to negotiation between the ESCO and the customer. In the example referred to, the customer will in the first five years not experience the decreased energy consumption (ESCO Gruppen n.d.). After the payback period the costumer will get the full satisfaction of the decreased running costs due to the energy savings.

As the municipalities have the option of cheap loans the interest rate is not a fluctuating variable in their cases. The energy prices is an external factor which neither the ESCO nor the customer possess control over. Because of this the contract ought to contain agreements on what happens with i.e. rising fuel prices and how this affects the guaranteed energy savings. Furthermore measuring and verifications during the operational peri-

od would be preferable to include in the contract, so there is no doubt about the responsibility and costs of this issue arises (EPC Watch 2007).

The operational hours should be agreed upon by the ESCO and the customer. A documented baseline for this is important as change in operational hours could be interpreted as increase or decrease in the guaranteed savings. Thus, clarifying if the operational hours should be measured or stipulated should be agreed upon by both the ESCO and the customer (EPC Watch 2007). The ESCO business model is somewhat more complex legally wise as there are two responsible actors in comparison to the DBFO business model where just one actor is held responsible for the total project.

The relationship and actions by the different actors are illustrated in figure 10 below, where the bottom left corner displays the ESCO. They calculate and issue the guarantee to the customer whom then uses the guarantee to obtain a loan with, which the ESCO uses to finance the project. Once the vessel is completed the energy consumption on the ferry route should decrease, which results in lower economic expenses and less GHG emissions (FORA et al 2010).

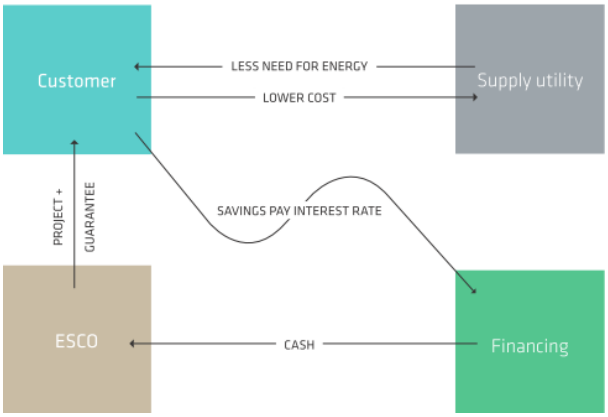


Figure 10 illustrating the ESCO green business model and the flow of actions between actors (FORA et al 2010)

In the ESCO business model there are two parameters which impact the energy consumption and intentionally savings, one being the amount of power or fuel used and the other being the operation hours. Figure 10 displays the two factors and the total energy consumption and potential savings (EPC Watch 2007). As the ESCO business model usually is performing retrofitting on buildings, it is called *post retrofit power/hours*.

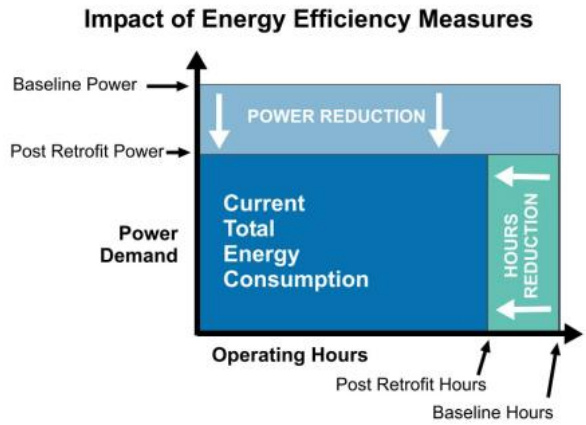


Figure 11 Illustrates the two options of reducing energy consumption (EPC Watch 2007)

Figure 11 illustrates both the baseline consumption and the post scenario where the new equipment has been implemented. The performance

(power demand in figure 11) relates to the amount of energy consumed to achieve the particular task wanted, i.e. move a vessel from one place to another. Usage (operating hours in figure11) relates to the total time the operation runs. These two factors generate together the full energy consumption and the baseline for the total consumed power/fuel and operating hours is central information when calculating the potential savings before the project, thus measuring of consumption or analyzing the levels must be done (EPC Watch 2007).

4. Eco island ferry

In the discussion the three green business models will be put into the context of the Eco island ferry and the TCO will be estimated where this is possible.

Operation of ferry routes are an economic hard business and eight of out nine municipality operated ferry routes in Limfjorden had in 2011 a total deficit on 16 million DKK (Maritime Danmark 2012). Søren Andersen (2012), the head of The Small Islands' Ferry Companies (Småøernes Færgeselskaber) state that the running costs of ferry operation has increased over the last years. Research in- or introduction of new business developments might be an option to lower the running costs. According to the diesel price development, there are no indications that the fuel costs for running the ferries are going to decrease and a benefit of installing a lightweight vessel is the possible fuel savings.

An investigation of the resent development of Danish passenger vessels and ferries shows that the fleet's total gross tonnage has decreased the last five years. Figure 12 displays the number of vessels is 108 in year 2007 and this is the same amount in 2012 (Danmarks Statistik 2012). The decrease in total gross tonnage might be a coincidence as it is visible the graph is fluctuating through the period. Never the less, a decrease in weight is experienced, which means the average weight of each vessel has been reduced.

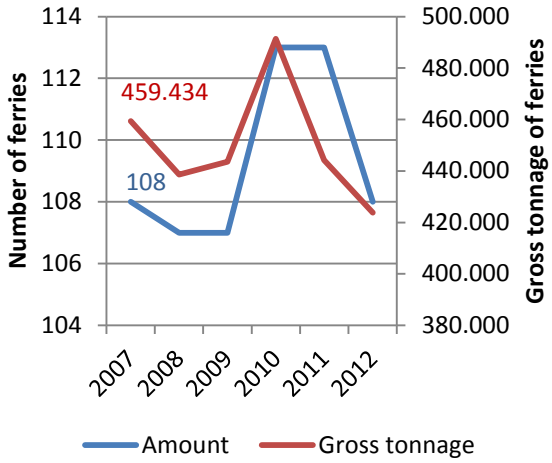


Figure 12 illustrates the number and gross tonnage of ferries in Denmark (Danmarks Statistik 2012)

4.1. Energy saving tax

The *energy saving tax* has benefits and disadvantages when merged with the Eco island ferry. For Odder municipality it will be a great economic contribution to their financial accounts if the Eco island ferry is funded solely by the energy saving tax. The energy service company funding the project would be capable of claiming the energy reduction on their accounts and the municipality would therefore not be able to use the reduced emissions in their emission accounts (Regeringen 2011). Meaning that the agreement between the municipality and the Danish Society for Nature Conservation would not benefit from this action (Danmarks Naturfredningsforening 2012).

On the other hand, it could potentially result in more saved emissions for the environment if this green business model was to be used. By using the energy saving tax to fund the Eco island ferry,

Odder municipality would still have to decrease their annual CO_2 emissions by 2 %, subsequent a total CO_2 emissions reduction on 2 % plus the reductions gained from changing the current Tun island ferry with the Eco island ferry.

An exact price of a new ferry is difficult to generate as there is different details for each route. Investigating the prices of three ferries which was price labeled in 2008 the average price is 48 million DKK (Folketinget 2008). These are all steel constructions, thus to calculate the price of a composite vessel a 6 % increase in the price will be added, resulting in a price level of 51 million DKK (Burman n.d.). In a scenario where the total financial support from the 2010 energy saving taxes was to be used on funding new composite vessels, a total number of 43 new ferries would be possible to purchase with this estimation.

It is unknown how much of the 2,24 billion DKK, gain from the energy saving tax in 2010, which was used on energy saving measurements. As the legislation presently is, the transport sector is not capable of applying for the support (Regeringen 2011). The reason for this is unclear, but nevertheless reality. Several energy companies have expressed that including the transport sector could be beneficial for both actors (Ea Energianalyse et al 2008). A compromise could be to let the transport sector apply for the annual remainder of the support pool and thereby create an opportunity and see if the municipalities actually will use this option. Furthermore in a societal perspective the energy companies could be the helping hand the transport sector needs to reverse the trends of increasing energy consumption, shown in figure 1. One of the benefits of using the energy saving tax as funding would be the municipalities would have an option to not obtain loans for new investments, but use funding which is set aside to the purpose of reducing GHG emissions.

An analysis of the future organization of the small islands' ferry operation states that operation both will need to have a firm and efficient economy as well as keeping the islands attractive to live and work at (Indenrigs- og sundhedsministeriet et al 2011). Meaning that the municipality is imposed to keep the ferries running as much as needed to keep the island location attractive and with as little economical costs as possible. Thus, a decrease in number of departures would make it unattractive for the general population. Therefore will the TCO estimated in the next paragraph not change the hours of ferry service.

The price of a composite vessel is calculated to be 51 million DKK (burman n.d.). And changing the Tun island ferry to the Eco island ferry would annually result in saving approximately 300.000 DKK on fuel costs. Figure 13 illustrate the estimated total costs of a steel vessel with the same properties as the Tun island ferry and the composite vessel, Eco island ferry, for a period of 35 year. This calculation include the annual costs of labor, harbor fee, insurance, maintenance and

the difference in fuel consumption – all prices are set to 2012 values and therefore is inflation not taken into account. There is furthermore uncertainty attached to this estimation as the maintenance costs are the same as the current Tun island ferry has in 2012 (Odder commune 2012b).

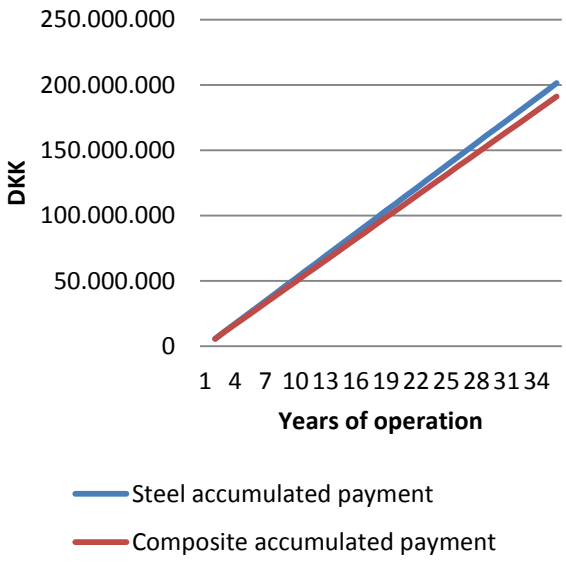


Figure 13 The cost development of the two vessels (steel and composite) (This graph has been made with data from Appendix 5, Burman n.d. & OK 2012).

The difference in of the TCO is 10,2 million DKK between the two vessels over a life time of 35 years. Because the ferry is funded by the energy saving tax, there is no purchase price included. The TCO for the composite vessel is 191,2 million DKK.

4.1.1. Barrier

The most obvious institutional barrier would be the legislation does not allow the municipalities to apply for this financial support when the target area is within the transport sector. A subject which also could be a barrier or disadvantage is the major reason for the energy service companies to grant the support to the municipality would be the use the reductions of CO_2 emission in their own green accounts. The disadvantage being, if the reduction in CO_2 emissions was not large enough for them to use in the green account, the incentive them granting the support would not be great. The annual CO_2 emission reduction received if installing the Eco island ferry instead of the Tun island ferry is estimated to be the equivalent of 43.751L marine diesel – see chapter 2.2.

4.2. Public Private Partnership

The DBFO green business model is more complex than the energy saving tax model, as it is more than an agreement on funding the production of a ferry in return of the CO_2 emission savings throughout the life time of the ferry. In this model, Odder municipality will need to trust a supplier to both deliver the Eco island ferry and run the ferry service in a long term perspective. The supplier on the other hand needs to earn that trust otherwise it will be an economic cost for themselves, as extra costs not included in the agreement between the two partners is paid by the supplier. This gives the supplier incentive to deliver the ferry on time and maintain it properly, because if they do not perform as the contract says, it can consequently result in deduction on the monthly payment from the municipality (FO-

RA et al 2010). In other words, it pays to perform well.

The municipality, in the DBFO model, does not pay for the ferry at the start of the period, but the price on the ferry will be included in the monthly payments to the supplier as the supplier will need to get its costs covered. So the supplier receives a payment which covers both the operation of the service and the Eco island ferry itself. Odder municipality still needs to obtain a loan at the startup period, but this in on behalf of the supply company, who instead delivers certain guarantees on the project, see figure 8 (FORA et 2010).

The TCO for this model has not been possible to conduct as a potential agreement between Odder municipality and a DBFO company can be very complex and is a negotiation between the two partners which settle the agreement. Odder municipality will in this model not have any costs on fuel, labor, maintenance, but just a monthly price to the DBFO company which takes care of the ferry service in conditions which could be similar to leasing agreements.

4.2.1. Barriers

The DBFO green business model has in other sectors shown great potential (FORA et al 2010). But within the ship industry it will be hard to realize without a partnership between a ship constructor and an operating company (Appendix 3). As the design and construction of the vessel is one kind of expertise, the service and maintenance is another kind of expertise, thus a partnership would be necessary to obtain the best result. If the ship constructors were to do a DBFO project on their own, it would require more from them than at traditional transactions (Appendix 3). They would have to move out of their comfort zone and cross into a new sector where not only financial resource is needed but also knowledge and know-how to keep the overview.

4.3. ESCO

The ESCO model has similarities with the DBFO, but the ESCO does not take control of the operation. With the ESCO business model, Odder municipality ought to receive a project which is transparent and has a clear financial profile throughout the entire project period. A business model designed this way makes it first of all possible for customers to invest in energy saving measures and secondly puts pressure on the ESCO company to deliver the product best possible, because they will benefit from a performance better than expected (Nordisk Folkecenter for Vedvarende Energi 2008).

Figure 14 displays the TCO when the purchase price of the ferry is included (respectively 48 million DKK for steel and 51 million for composite) together with the annual costs as well as in chapter 4.1 (labor, harbor fee, insurance and maintenance). The prices are in 2012 values and inflation has therefore not been taken into account. The ESCO model is like DBFO model a negotiable

agreement between the two partners, Odder municipality and the ESCO. This result is the closest estimation of the TCO for the ESCO green business model in this thesis. The Eco island ferry and the steel vessel has the breakeven point after 11 years and with a life time on 35 years, 7,2 million DKK will be saved on purely fuel costs.

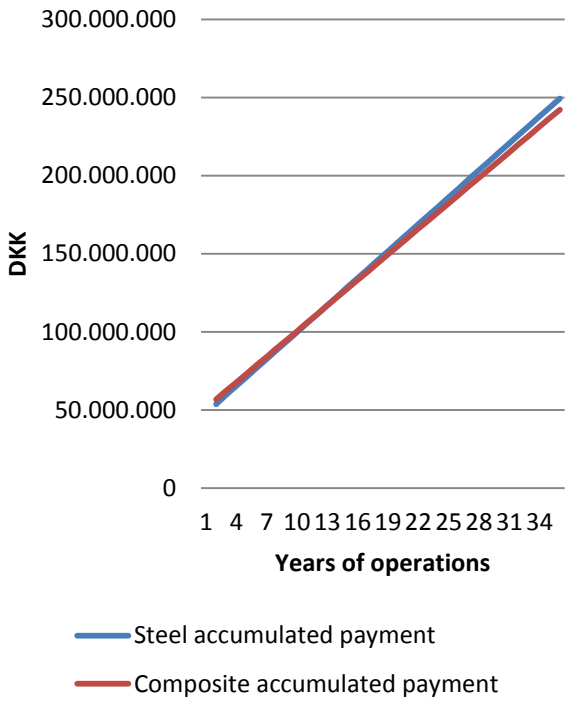


Figure 14 The breakeven point of the two vessels (steel and composite) happen at the 11th year (This graph has been made with data from Appendix 5, Burman n.d. & OK 2012).

The TCO, with a life time of 35 years, will for the composite vessel be 242,2 million DKK and for the steel vessel be 249,4 million DKK.

The ESCO model could be a possible financing model together with the municipal loan option as it gives a guarantee on the energy savings (Økonomi- og Indenrigsministeriet 2012b). The payback time of a ferry typically takes 15-25 years and this includes the depreciation allowance (Indenrigs- og sundhedsministeriet et al 2011). The profit from the Tun island connection is not included in the calculated estimations in this thesis, due to great uncertainty of the income.

4.3.1. Barriers

One could argue that the ESCO business model creates a suitable situation for the environment, the customer's economy and business for the supplier. The decrease in consumption leads to a decrease in the costs related to fuel. If fuel prices increases - the running fuel costs will still be lower, than if the new investment had not been implemented. A point though, is that the ESCO business model is about the partners sharing risks of the energy optimization of ferry route. The less use of fuel ought not to create any risk, but if there not are a satisfying number of people using the ferry there might be a financial profit risk. The payback probability has to be reasonably high for an ESCO to enter an agreement (Appendix 3).

For the Odder municipality this should not be an issue though, as they are forced to keep the connection running. As stated in the introduction, there is an issue of bad economy at the ferry operations and it is about reducing this negative profit as much as possible through the fuel consumption – and maintenance if possible. If the fuel savings is enough to actually make the municipal ferry operation go round is not known, but the estimates show that the running costs can be

reduced through an ESCO agreement. The main element deciding the potential of this model could be if the reduced fuel consumption is significant enough (Appendix 3).

5. Conclusion

The thesis has analyzed three green business models, respectively the *Energy saving tax*, Public private partnership in for of *Design Build Finance & Operate* and the *Energy Service Company*, to find the answer to the research question:

Which institutional barriers hinter the transport sector in implementing green business models originated from other industry sectors?

Furthermore has the thesis answered the sub question: *How can a green business model be used for investment in a new Eco island ferry?*

The green business models have been applied on the case of Odder municipality, where the steel constructed Tun island ferry has been challenged by a lightweight Eco island ferry made of composite. The discussion of the three models has included the concept of *total cost of ownership* as the methodological assessment tool and the barriers of implementation have been found.

The *energy saving tax* has been estimated to have the lowest total cost of ownership for Odder municipality. This is because the purchase price of a new ferry is funded by the energy saving tax and in return the energy service company will receive the right to the CO_2 emissions saved by the implementation for their green account. Odder municipality will in with this green business model receive a lightweight composite ferry and the total cost of ownership for a 35 year life time period be 191,2 million DKK.

The *Design Build Finance & Operate* is a complex model which needs more investigation to assess. The total cost of ownership has not been possible to estimate. The green business model has performed well in other sectors, but there is no long term experience with the maritime transport sector. Neither is there with the two other business models, but they do not contain long term agreements of up to 35 years.

The *Energy Service Company* model has been estimated to have the highest total cost of ownership of the two green business models which was possible to calculate. This is due to the inclusion of the purchase price on the ferry in the calculation. Odder will with the ESCO business model have an estimated total cost of ownership on 242,2 million DKK for a composite vessel with life time of 35 years. Odder municipality will with this green business model be capable of using the saved CO_2 emissions in their green account and to fulfill the climate municipality target. The annual CO_2 emission reduction received if installing the Eco island ferry is estimated to be the equivalent of 43.751L marine diesel.

Twelve out of nineteen municipalities with small islands have entered an agreement with the Danish Society for Nature Conservation about being a climate municipality. Thus the municipalities in focus in the report generally have environmental targets, but the national participation in climate municipality is higher.

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