Kær halvø and Sønderborg Airport

Sustainable rural districts through joint technical and social solutions

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Executive summary

During this project under the title: "*Sustainable rural districts through joint technical and social solutions*", we have chosen to optimize the heating production methods at Kær halvø. We have done this with a goal of creating a good solution, but also making the citizens realize that they can help the environment at the same time as saving money.

In order to make the best possible solutions we first had to make a detailed mapping of the current consumption – since this was a big wish from the citizens, we created an interactive map that could be distributed to all the citizens in order for them to see what their consumption situation is. We did this interactive map with quite big success since the citizens from Kær halvø where very good at answering our questionnaires, and with help from Jørgen Wilkenfeldt the percent of answers got very positive. During the mapping we also got consumption information from Sønderborg Airport in order to suggest a solution to them as well.

We then set up three different cases that we imagined would be useful for both the citizens at Kær halvø and Sønderborg airport. Through investigations of these different cases we calculated what the actual need was, what the price of the new equipment was, and finally, what the annual saving in both money and CO_2-emission would be. The rural district where very concerned about how many households would support the plan of getting district heating to Kær halvø – which is very important in order for the district heating of Sønderborg to implement heating pipes to Kær halvø. Therefore we created a computer program that will be distributed to the citizens, where they have the possibility to calculate the payback time of implementing district heating in their house. The district heating company of Sønderborg required 40 % of support in order for it to be profitable, and as we have recorded until now, we have seen a support-rate of more than 70 % from the answers we got from the questionnaires.

Lastly we have come to the conclusion that district heating should be implemented in as many households as possible at Kær Bygade and Ormstoft. Any other solutions will be ether less profitable or impossible to implement because of the district conservation plan. For Sønderborg airport we have recommended to install four heating pumps with two ground water wells. This is a solutions that can minimize their consumption with more than 50 %, and combined with solar collectors and a windmill, that will make them totally CO_2 neutral, regarding heating, which also is Project Zeros master plan for Sønderborg in 2029.

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Introduction

This project deals with suggestions to improvements and new solutions regarding the energy consumption at Kær halvø, and is a part of the ongoing joined project between Project Zero, Sønderborg municipality and the university of southern Denmark, with the title: Sustainable rural districts through joint technical and social solutions.

During this project we will go through the process of creating one or more sustainable solutions that will fit the households and companies that are located on Kær halvø. The first step of the project will be to map and clarify the current solutions and heat sources used in the rural district of Kær halvø – this information combined with the needs and wishes of the citizens in Kær halvø, will generate the possibility to come up with suggestions to improvements, and ideas to new possible solutions.

The project will also contain suggestions towards social and technical solutions that can be implemented in the future, along with illustrations, return of investments-calculations, and reflections on the suggested solutions. Finally, feedback will be gathered from the citizens of Kær halvø.

Problem formulation

Project background

This project is done in cooperation with Project Zero, Sønderborg municipality and the University of Southern Denmark. The headline is as follows: “How to create a sustainable rural district through joint technical and social solutions”. This group will focus on Kær halvø, and in short terms we will start out by clarifying the citizens current solutions, and then in the end present ideas improvements, and new solutions to be used on Kær halvø.

This is interesting, because the rural districts often is neglected when the government and municipalities works with energy-reducing solutions. Furthermore we've learned that the citizens of Kær halvø is really interested in finding new and better solutions, and they are, as well as we are, very engaged in participating in making Sønderborg CO_2-neutral as soon as possible.

Kær halvø is an area with a lot of potential, and it is located in a such way that many interesting solutions could be implemented - unfortunately Kær halvø has a district conservation plan, which blocks for the possibility to place solar panels on most of the houses, so that solution is not an option in some parts of Kær halvø.

This should be done in close cooperation with the citizens of Kær halvø - as well as in close cooperation with the municipality of Sønderborg and Project Zero.

Problem formulation

What are the current solutions for heat generation? Can we improve them?
What kind of barriers do we have now?
What kind of barriers does the local plan gives us?
Is it possible to create solutions for small clusters of households?
Can we optimize the consumption at Sønderborg Airport?
How is the return of investment on suggested solutions?

Project delimitation

The main thing working against the thoroughness of the project is the time. Therefore we can't end up with a final solution suggestion ready to install, since it would require way to much information and work. We will though end up with basic solution suggestions that gives Kær halvø an idea of how they can improve their current solutions, and also convince them that it will be advantageous both for the environment and them.

It may be possible that the most optimal solution will be a combination of the cases that we will be investigating in the report, but it may though not be possible in the given amount of time to do calculations that show the final returns on investments when combining the different solutions - it will include all those final informations for all the single cases.

Introduction to the area of Kær halvø

Kær halvø is an area located on Als, close to the city of Sønderborg and is the entire area south of the red line on the map to the left.
The area has a lot of historical memorials and war graves.
There is around 250 households and farms, military training area, a fruit orchard and an airport.

The closest populated area is Kærbygade including Ormstoft. Spread around the area are small clusters of houses and farms, non exciting ten households. The clusters are; Skovhuse, Rønhave, Hestehave and Honninghul.

Mapping

After attending the citizen's assembly we saw clearly that one of the very big wishes of the small society of Kær halvø, is to get a clear mapping of what [1] are used in their area right now regarding heat production. It is though not only important to them, since we also need to know how well the houses are insulated and how big a consumption they have right now, in order to be able to see if it is actually financially profitable and environmentally profitable to install any new energy and heat production methods!

Since the citizens and the village association where so interested in getting all of this information, we have chosen to do an interactive map that is easy to use, so we are not delivering a confusing table of data, but a map that is easy to use.

Methodology

The mapping of Kær halvø requires quite a lot of information, since there are more than 250 households. Here we had the advantage of working with the local postman, Jørgen Wilkenskjeldt - he distributed all of our questionnaires and he also reminded the citizens who had forgotten the first deadline, to hand in their questionnaires before it was too late. All of the answers have been made easily accessible by plotting into an interactive map. The questionnaire has been done as a structured questionnaire with close-ended questions that has a combination of ordinal-polytomos and continuous answer possibilities. We have find our methods to be quite successful since we have gotten 119 answers that all were valid for our further data calculations.

Questionnaires

In order to do a mapping of the houses at Kær halvø, we have used our contact person from Kær halvø, Jørgen Wilkenskjeldt, who is the chairman of the village association, and who is also the postman of the area, to distribute questionnaires to all the houses in the area. This gave us a clear advantage in data collection since he was able to be in charge of distribution, and also getting as many questionnaires back as possible.

The things that we wanted information about from the questionnaire was,

- Their heat production method
- The size of their heated housing,

[1] Digital appendices\Citizen's assembly review.docx

- how well isolated their houses are,
- And what their consumption of heat and energy is.

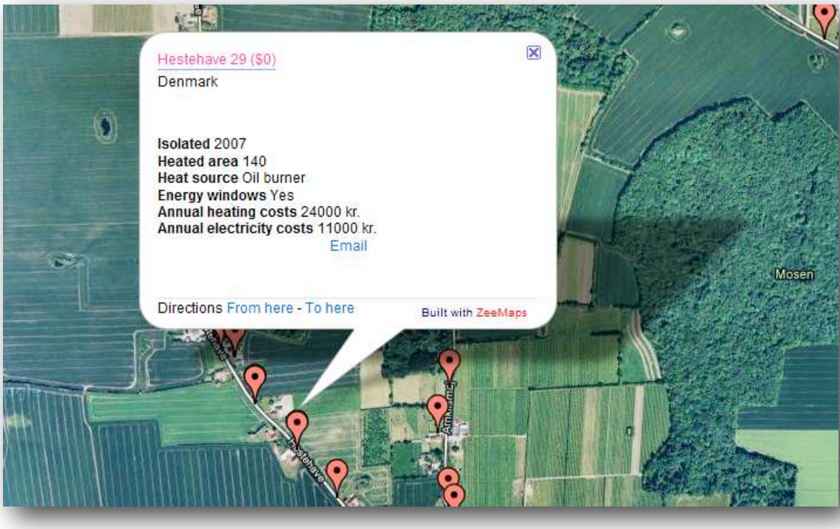
We saw at the citizen's meeting that a district heating plant had already been in their plans on environmental development. It seemed though, that in the last second, people didn't want the district heating anyways. Therefore we also want to check whether the citizens actually want the district heating or not.

In order to get as many answers as possible, we did a digital version[2] of the questionnaire, which also meant that we could get some of the answers as fast as possible. The final questionnaire, and questionnaire results can be found in the appendices.

Consumption map

In order to create an interactive map we have used *.csv converted from our result data, which have been uploaded to a server, in order to create an interactive map which the citizens at Kær halvø will be able to use if they want to.

Our map makes it possible for anyone who has access to the webpage, to click on their own address on Kær halvø, which will then display the data connected to this address. This makes it possible for the village association to see how the current situation on consumption in their area is, but it also makes it possible for us to calculate what households will have any benefit from a future solution.



The map can be seen in digital appendices as "Map.html".

[2] http://bit.ly/nhFcdc

Mapping calculations and conclusion

Since not everyone wanted to inform their expenses on heat and energy, they informed us about their early consumption in kWh. In order to have similar values for each household for further calculations, we converted these kWh into Danish Kroner with help from the average prices pr. kWh[3] according to their heating methods. This doesn't give us 100 % precise consumption numbers, but though precise enough to do financial calculations on an estimate on the return on investments.

To get an idea of how the general consumption is in Kær halvø, we have these calculated values, which has been calculated from the collected data:

Average annual consumption on heat pr. household	19.570,- kr.
Average annual consumption on electricity pr. household	12.200,- kr.

These numbers will be used as references in our further cases in order to see how good a possible solution will be at first sight.

[3] Digital references\Energistatistik_2010.pdf

Cases

In order to find out what the best solution for the different areas of Kær halvø is, we want to set up some different cases that we can analyze. What we want to achieve with these cases, is to calculate what the financial and environmental benefits we can get from each case, and from that start a convergence phase in order to choose the best possible solutions.

Case 1: district heating to Kær and the Airport

Since we saw at the citizen's assembly that many people in Kær halvø and especially the village association wanted to have district heating established, we want to check whether this is actually possible with the current support.

After a meeting with Sønderborg Airport we learned that if it's in any way possible to get district heating for the airport, they would like to be connected too. Therefore we also have to check whether this is economically responsible for the district heating company, and if it's even possible to meet the airport's quite big heating demands.

Case 2: joined vs. single heat pumps at Hestehave

Some of the smaller areas outside the bigger streets of Kær halvø have small collections of houses that we might be able to optimize in form of heat production. When looking at the small collection of houses that you see to the right, which is a part of Hestehave, it's seems obvious to establish geothermal heating in the area, which is able to provide heating for all the houses in this small area.

Therefore we want to investigate how much heat it is possible to retrieve from a small geothermal plant in this area and what the returns on environmental and financial investments are.

Case 3: geothermal plant at Sønderborg Airport

At a meeting with Torben Kristensen, Operations Manager at Sønderborg Airport it became clear that they were very interested in getting a new and cheaper heating source for the entire Airport, including both the buildings used by Cimber and also the ones used by Air Alsie. In total it includes three hangars, the departure buildings, administration buildings and the fire station. Currently they are using oil burners as heating source using approximately 131.000 liters of oil each year. These are used for heating water to 55 °C. The heated water is then distributed to radiators mounted at the wall in the administration buildings and unit heaters mounted in the sealing of hangars with a fan mounted so that it is capable of distributing the heat quickly after closing the gates. The problem though, is that the oil burners are getting very old and therefore they need to be replaced. This is a perfect opportunity for them to change their heating source to a cheaper and more environmental type. In case 1 we, as mentioned above, will investigate the possibility of getting district heating to the airport and whether it would be a feasible solution for them, both economically and environmentally.

The interesting thing would be to find out if it would be possible for the airport to be able to produce the heat themselves, on site, as they do today, but in a greener, more environmental friendly, but still efficient way. At the same time the economic aspect should be feasible as well.

Based on this, we want to investigate if it is possible for the airport to fulfill this by using a large geothermal plant on site perhaps combined with an energy producing source.

Case investigations

Three different cases has been created, in order to clarify our suggestions to a new solutions. Case 1 deals with a solution using district heating at Kær bygade and Ormstoft, but also as a solutions to Sønderborg Airport. Case 2 deals with joined vs single heat-pumps with a joint geothermal pipeline, at the household-cluster at Hestehave. Case 3 deals with a solution to Sønderborg Airport using a geothermal plant. In this chapter we will deal with the different cases, describe them, and in the end conclude in the which would be realistic and most sufficient.

Case 1: District heating to Kær and the Airport

Applying the possibility of district heating to Kær Bygade, Ormstoft and the airport is a quite big job. This means that highly isolated district heating pipes will have to be dug down all the way from their plant, to both Kær Bygade and the airport. Fortunately the investment of doing this is not in the hand of the users, but the district heating company – which is Sønderborg Fjernvarme Amba. This does though also have a drawback, since we will have to convince Sønderborg Fjernvarme that it will be a good investment for them to dig down the pipes.

We have contacted the CEO of Sønderborg Fjernvarme, Steffen Moe. He had already done the calculations on whether it was financially possible for Sønderborg Fjernvarme to dig down pipes to Kær Halvø. His calculations where based on the fact that 30 households on Kær Bygade and Ormstoft would like district heating, but since the questionnaire showed that actually 36 wanted district heating on the two streets, the wish for Sønderborg Fjernvarme to implement district heating in the area just increased.

Whether it's possible to implement district heating for the airport is though a bigger problem. The airport uses 131.000 liters of oil pr. year, which adds up to just about 5,4 TJ. The question is then, whether Sønderborg Fjernvarme are able to deliver this much energy – but also whether the heat loss will be too big, since there's quite a long way to the airport. This is though up to Steffen Moe to calculate – and he is unfortunately not able to have the calculations done before the 12th of January.

We will though of course focus on, how it will benefit the airport in case district heating is actually possible to implement. For Kær Bygade and Ormstoft we have all the information, which makes it possible to calculate the effect of implementing district heating in each household.

Financial benefit calculations for private households

The process of calculating the financial benefits for the household is quite simple. We have to go through the following steps:

1. Calculating implementation costs.
2. Calculating the present costs on heat consumption.
3. Calculating the costs of heat consumption when heated by district heating.
4. Find the annual cost reduction.
5. Dividing implementation costs with annual cost reduction in order to find pay-off time.

Because we want it to be possible for each household on Kær Bygade and Ormstoft to calculate whether it would be financially beneficial for them to get connected to district heating, we want to design a small program that makes it easy for them to check it without doing any calculations then selves. This program has to be distributed to every household in the area, because this may convince more to support the district heating implementation and thereby make it even more beneficial for Sønderborg Fjernvarme to put down pipes!

We can now show how the program[4] is designed. First the implementation costs for the household will have to be found. We do this from the implementation-facts[5] from Sønderborg Fjernvarme. From the information on implementation costs we can see, that we first need to know whether the house is more than 300m^2. If it's less, the implementation costs become kr. 70.000,- and if larger, it becomes dependent on the exact size of the house – therefore we will have to know the exact size of the house in case it's larger than 300m^2. We then need to know whether there is more than one family living in the building – this would mean that more than one counter had to be installed, and therefore give higher implementation costs. The last factor is the distance from the building

[4] See "Digital appendices\dhc program.xlsx"

[5] See appendix 6 or "Digital references\takstblad.pdf"

to the end of property – if it's more than 20 meters, an additional amount of money will also be charged.

We now know the implementations costs! Now we need some information on what heat production methods are used, and how much fuel are used for these heat producers. When we know the liters of oil, tons of straw and some on, which is used for heating, we can convert this to kroner, by looking at the mean prices of each type of fuel in 2011. Also, we can convert it into used kWh – this is done by looking at the energy capacity of each material, and calculating the efficiency of the heat producer (which is a function of age – these functions are given by Nilan).

From the amount of used kWh and the price pr. kWh at Sønderborg Fjernvarme, we can then calculate how much money the household will consume heating energy for pr. year. This means that we have the annual saving!
When dividing the found implementation costs with the annual saving, we now have the pay-off time.

If we use an example where all the basic requirements on implementation are fulfilled, we will see implementation costs of kr. 70.000. Let's say that this household has an oil burner that is 10 year old – then the effectiveness of their burner will be 80 %. With a consumption of 2000 liter of oil pr. year, this would give an annual benefit of k. 8.480. Finally, we are able to see that the pay-off time is 8 years and 3 months. When talking about investing in district heating contra a burner system in the house, the pay-off time is not so critical – when burners are installed we can only expect a lifetime of 20-25 years, where the district heating should have a lifetime which is *much* longer.

Financial benefit calculations for Sønderborg Airport

The steps of calculating the financial benefit for the airport on this solution is somewhat the same as when calculation with private households. The implementation costs are though not the same, since there are several buildings and companies at the airport. First we can calculate the total implementation costs for the airport[6]:

Component:	Component price:	# components:	Price in all:
Basic rate:	15.000 kr. + 60 kr. / m2 , pr. building.	Building1: 1700 m^2 Building2: 4500 m^2 Building3: 1600 m^2 Building4: 4800 m^2	816.000 kr.
Pipes:	Distance from building to property end * 1400 kr. / m. (for this charge is for each building)	268 m* (Pipes from property end to all buildings)	375.200 kr.
Counters:	Numbers of buildings minus one * 3500 kr.	4 buildings in all – 3 will be charged extra.	10.500 kr.
		Total price (excl. VAT):	1.201.700 kr.

*a value estimated from digital maps over the airport!

This seems like quite big implementations costs, but we can now look at what their annual costs are now, and what they will be in the future if they choose district heating:

Present solution:

Annual fuel consumption	Equivalent kWh	Estimated annual costs:
131.000 l oil	1.310.000 kWh	1.146.250 kr.*

*Based on an oil price of 8,75 kr/l

The reason we calculated the equivalent kWh, is that we can now use this to calculate the estimated annual costs for heat from Sønderborg Fjernvarme:

Future solution:

Annual expected consumption	kWh-price:	Estimated annual costs:
1.310.000 kWh	0,72 kr./kWh	943.200 kr.

We can immediately see that the annual cost reduction will be quite huge. More precisely it will be:

1.146.250 - 943.200 = 203.050 kr / year

This means that we can find the pay-off time is given by:

implementation / annual saving = 1.201.700 / 203.050 = 5,92 year

So, by implementing district heating at the airport, and only using this heat production method, they will be able to get their investment paid back in just a bit under 6 years if their

[6] See appendix 6 or “Digital references\takstblad.pdf”

heat consumption stays the same. Due to rising oil prices, it may actually also be an even lower pay-off time. What's even more surprising is that the annual saving after these six years will be 203.050 kr.

Environmental benefit calculations for Airport

Annually, the airport is now using 131.000 l. oil pro anno, which adds up to the following CO_2 emitted[7]:

$$131.000 \times 2,7 = 353,7 \text{ ton of } CO_2$$

(This theory can also be applied for normal households with oil burners, but is not possible to make for burners for wood, pells, straw e.g. since they are seen as CO_2-neutral fuel materials).

We can hold this number up against the annual emission from Sønderborg Fjernvarme, due to the effect needed by Sønderborg airport. 131.000 liter of oil is the same as 1.310.000 kWh of energy – if we hold this up against the CO_2 emission from Sønderborg fjernvarme[8] we see the following emission:

$$1.310.000 \times 0,115 = 150,7 \text{ ton of } CO_2$$

This means that the annual benefit to the for the environment for Sønderborg airport to get district heating, will be 203 tons of CO_2. So we see that more than half of the emission has been cut off!

[7] Thumb rule of CO_2 emission pr. oil consumption: 2,7 ton pr. 1.000 liters of oil.

[8] http://www.noah.dk/energi/co2tabel.html

Case 2: Joined vs. single heat pumps

The first essential number we need in order to do any calculations for a small joint geothermal plant is the size of the area where we have to install geothermal pipes. This size was seen on a digital map, where we saw that the possible installation area is 4000m^2.
From our mapping we can find the following information on the houses that we would like to implement in this solution:

Adress:	Heated area:	Heating source:	Heat consumption:	Isolated:
Hestehave 33	300 m^2	Pellet burner	15.000 kr.	2006
Hestehave 31	150 m^2	Electrical + other	16.500 kr.*	1981
Hestehave 18	200 m^2	Oil burner	25.000 kr.	2003
Hestehave 16	159 m^2	Oil burner	20.000 kr.	1970
Hestehave 14	107 m^2	Oil burner	17.000 kr.	1967

*Since another heating source than electrical heating is given in the questionnaire, and the consumption is unrealistically low, we have estimated a realistic value, given that they use a wood burning stove.

From the consumption numbers we have estimated the amount of pellets, oil e.g. they use per year (these values have been calculated by our contact person from Nilan who is an expert in geothermal heating).

Adress:	Consumption in fossil amounts:
Hestehave 33	8,8 ton pellets
Hestehave 31	11409 kWh electricity
Hestehave 18	2500 liter oil
Hestehave 16	2000 liter oil
Hestehave 14	1700 liter oil

Consumption calculations

When Nilan do calculations on cases like this, they use a special calculator program called Nilan JVP calculator 2010 04, which generates the needed values for further calculations. In corporation with our contact person from Nilan, we got to try this program. The input to the program was all the numbers that you see on the two above schemes and the output was as follows:

Adress:	Energy consumption pr. m^2	Energy consumption pr. year	Necessary heat capacity at -12 °C	Present paid price pr. kW
Hestehave 33	98 kWh/m^2/year	29400 kWh/year	16 kW	0,5 kr/kW
Hestehave 31	76 kWh/m^2/year	11400 kWh/year	6,5 kW	0,9 kr/kW
Hestehave 18	77 kWh/m^2/year	15400 kWh/year	8,5 kW	1,6 kr/kW
Hestehave 16	71 kWh/m^2/year	11289 kWh/year	6,5 kW	1,8 kr/kW
Hestehave 14	84 kWh/m^2/year	8988 kWh/year	5,5 kW	1,9 kr/kW

(see documentation on the numbers for each household in digital appendices\Nilan JVP calculations)

We now have two different options for the implementation of geothermal heating. We can either choose to have a joint heat pumping system, or to have individual pumps for each household. First, we will look at the totally joint solution, where they share a heat pump system.

Joint solution

In order to do this joint solution, we first have to put out 1700 meters of geothermal pipes on the given area. Then we will have to build a small shed to contain the heat pumps. Here we would need three pumps in order to keep up the produced heat contra the used energy in the warmer months (from the calculation of necessary heat capacity we can see that we need in total 43 kW heat pumps). Then we would need to do electrical installations in the shed, lead highly isolated district heating pipes from the shed to each house and lastly we would need both a calorie counter and a hot water container for each house. Here is a scheme estimating the costs on both buying the components and installing them:

Component	# needed	Unit price	Total price
15 kW heat pump	3	70.000 kr./unit	210.000 kr.
Geothermal pipes (incl. installation)	1683 m	40 kr./m	67.320 kr.
District heating pipes	350 m	150 kr./m	52.500 kr.
Shed	1	10.000 kr./unit	10.000 kr.
Electricity counter (incl. installation)	1	20.000 kr./unit	20.000 kr.
Hot water container	5	15.000 kr./unit	75.000 kr.
Calorie counter	5	2.500 kr./unit	12.500 kr.
Installation in houses	1	82.000 kr.*	82.000 kr.
Installation of shed and pumps.	1	20.000 kr.	20.000 kr.

Total price:	**549.320 kr.**
Price pr. Household:	**109.864 kr.**

*Installation in the house are quite high, since Hestehave 31 do not have radiators installed in the house. These will need to be installed before installation of hot water container and calorie counter (given price is though incl. radiators).

This then seems to be quite an expensive solution. Based on the calculations we choose to discard this solution because of these factors:

- Huge heat loss due to transportation length of the hot water.
- High installation costs due to that we need a shed, and that we have electricity counter separately for the shed (we will need to lead it from the electricity plant), and still have to do installations in the houses.
- A company we have to be started, that manages payments and control consumptions for each household.
- Joint costs becomes high just because of Hestehave 31, and it will not be possible to split up the costs in unequal sizes.

Single heat pump, joint geothermal plant.

Therefore we should now look at the solutions where we do not have a joint heat pump system, but where the households only share the pipelines.

This will mean that the same geothermal pipes as in previous example should be installed, plus geothermal pipes to the houses instead of the district heating pipes. We then need a separate heat pump for each house including hot water container. From this we can find some key numbers for this new solution:

Adress:	Heat pump consumption pr. year (incl. hot water)	Cost of running heat pump pr. year	Houses' saving pr. year
Hestehave 33	13.679 kWh/year	28.589 kr.	-13.589 kr.
Hestehave 31	6.212 kWh/year	12.983 kr.	3.517 kr.
Hestehave 18	8.191 kWh/year	17.119 kr.	7.881 kr.
Hestehave 16	6.194 kWh/year	12.945 kr.	7.055 kr.
Hestehave 14	5.534 kWh/year	11.566 kr.	5.434 kr.

What we can see right away in the scheme, is that Hestehave 33 shouldn't be a part of this solutions, since that would generate a loss of more than 13.500 kr. pr. year. In order to be able to calculate the return on investment, we will now have to look at what the actual investment they will have to pay for components and installations are.

Adress:	Heating pump price:	Installation of heating pump:	Meters of pipe:	Total price of pipes:	Total price:
Hestehave 31	60.000 kr.	50.000 kr.	307 m	12.280 kr.	**122.280 kr.**
Hestehave 18	62.500 kr.	8.000 kr.	387 m	15.480 kr.	**85.980 kr.**
Hestehave 16	60.000 kr.	8.000 kr.	306 m	12.240 kr.	**80.240 kr.**
Hestehave 14	59.000 kr.	8.000 kr.	257 m	10.280 kr.	**70.280 kr.**

Since we now know their present consumption and the costs of this, we can with the help from the calculated prices, see what the return on investment for each household will be when implementing this solution.

Adress:	Houses' saving pr. year	Total price:	Payback time without interest
Hestehave 31	3.517 kr.	122.280 kr.	34,77 years
Hestehave 18	7.881 kr.	85.980 kr.	10,91 years
Hestehave 16	7.055 kr.	80.240 kr.	11,37 years
Hestehave 14	5.434 kr.	70.280 kr.	14,22 years

Since the normal life-time of a heat pump is approximately 20 years, it will not be smart for Hestehave 31 to be a part of the project either. This will though not affect the payback time for each of the other households, as the costs have been calculated based on the prices of exactly the pipe length needed for each household. This leaves only the houses left that use oil burners – and if we look at the price tendency on oil, this will only make the payback time shorter.

Case 2 conclusion

As a conclusion to these solution calculations, we would say that a joint geothermal pipes with separated heat pumps would be the best solution. Hestehaven 14, 16 and 18 should do this solutions which should then be able to generate a profit during the lifetime of the heating pump of approx. 25-70.000 with the current oil prices. Higher oil prices in the future will though only give a higher return on investment![9]

Case 3: geothermal plant at Sønderborg Airport

We felt that we needed a lot of information, before we were able to investigate the possibility of a geothermal plant at the airport. We then did some research on who produces and sells large geothermal plants in Denmark. We found out that ASAP-energy in Sønderborg sells large geothermal plants from Alpha-InnoTec and are engaged in large projects concerning energy optimization. We felt that they had a lot of information and experience that we would love to learn from, and therefore we contacted Rainer Carstens, director of ASAP-energy, and told him about the project and asked him if he was interested in telling us something about large geothermal plants, opportunities, demands and establishing a source of energy.

After the meeting we were a lot of information richer regarding a large geothermal plant for the case.

First step in order to be able to say something about how the geothermal plant should look like, is to look at the airports maximum demand of heating capacity at -12 °C.
In order to do so, we need to know their total oil consumption per year and the heated area of all the buildings together.

Departments	Energy-consumption (ltr./oil)	Area (m^2)
Sønderborg Airport	21.000	1700
Cimber Hangar facilities	40.000	4500
Cimber Administration	10.000	1600
Air Alsie Hangars and adm.	55.000	4800
Total	**131.000**	**12.600**

[9] All calculations can be seen in “Digital appendices\Nilan JVP calculations\Regneark.xlsx”

This information we type into the program Nilan JVP Calculator, given by Nilan. From this program we can see that they need 535,06 kW at -12 °C.[10] Having in mind that both Rainer (ASAP) and Lars (Nilan) advised us to connect several geothermal heating pumps together instead of one single pump, when demanding a larger geothermal plant. This is done so that it is possible to minimize the production in periods where the heating demand is low, without putting too much energy into the pump, compared to the energy produced by the pump. Therefore we looked at what Alpha InnoTec had to offer concerning heating pumps in these sizes.[11]

The suggestion that we would make for the heating pump would be to use four SWP 1600 which have the following technical specifications:

Type Name	Heating Power B0 / W35 (kW)	COP B0 / W35	Price €
SWP 1600	161,6	4,4	37.562,00

Having a heating power at B0/W35 means that it produces 161,6 kW when the input temperature is zero and the water that is used for heating is 35 °C. It is possible to improve the heating power by changing different factors as higher input temp, lower output temp etc. The other way around, if the output temperature is demanded higher the heating power is of course lowered. The Cop value is given as

$$Cop = \frac{\dot{Q}_{WP}}{P_{el}}$$

$$where, \dot{Q}_{WP} = \ thermal\ output,\ P_{el}\ electric\ power\ consumption$$

The Cop value is also at 0°C in / 35°C out, and changes due to temperature changes and other factors as well. This value tells how efficient the heating pump uses the energy it receives contra the heating it produces. The SWP 1600 has a Cop value of 4,4 kW meaning that every 1 kW it receives it transforms into 4,4 kW of heating at 0°C in / 35°C out. When using four SWP 1600 they would be capable of delivering 646,5kW it would be theoretically possible to make the plant with only 3 SWP 1600 pumps but the energy source, the pipes and the heating flows in the building has to be at the optimal condition in order for it to work. At the same time they were talking about extending the airport with another building and with 3 SWP 1600 pumps it wouldn’t be a possibility.

[10] See “Digital appendices\Airport.pdf”

[11] Found in “Preis- und Typenliste 2011” obtained at the meeting with Rainer Christensen.

Having a pump with a master controller will also increase the life of the four pumps compared to three pumps. This is because the master controller is be able to make the compressors in the pumps run the same amount of time making the total living time for all four pumps longer than with three. One compressor has approximately 50.000-60.000 running hours, and a system like this should last between 25-30 years at perfect dimensions.

Different energy sources

The efficiency of the heating pumps depends on the temperature of the fluid going into the heating pump. There are 4 different possibilities that we can use for this project:

- We can use seawater as an energy source but then we need a very high flow of water to prevent the seawater from freezing. We would need a very efficient filter that prevents the pump from getting stuffed. A possible filter could be a Bernoulli filter[12] which is a self cleaning filter that has a constant pressure loss making it more energy efficient because the pump doesn't have to increase and decrease the effect constantly but can remain somewhat constant. The problem though, when using the seawater is, that the temperature can easily get below 0 °C meaning that the heating power of the heating pump wouldn't be at its optimal conditions leading to higher running costs.

- We can use geothermal heating pipes place horizontally in the soil. The most common used energy source when talking small private plants. The pipes has to be place 1,5 meter down in the soil with a distance of at least 1 meter between each string meaning that per meter of pipe it requires 1m^3 of soil. The strings may not exceed 200 meter each. For a plant of this size we would need approximately 25 km of pipe meaning 25.000m^3 of soil or an area of 25.000m^2. Giving us 125 strings of 200 meters each. The area cannot be used for anything besides a green area because the pipes need the soil to reestablish its energy after the pipes has relocated it.

- We can use geothermal probes, placed vertically down in the soil. This is a very efficient solution because the temperature in the depth that the geothermal probe reaches is stabile and relatively high. It starts at approximately 6-8 °C and raises 1 °C for every 100

[12] See "Digital appendices\Bernoulli-Filter.pdf"

meter you go downwards. This means a very efficient heating pump because it can have a high and stabile input temperature. The down side of this solution is that the implementation costs are very high because we are talking energy drilling in at least 100 meters vertically down per geothermal probe and we were advised to use approximately 80 geothermal probes at a depth of 100 meters by Rainer (ASAP). A price for drilling is found to 530 DKKR. per meter plus 5000 DKKR. for geothermal investigation of the earth making it a very expensive alternative.[13]

- We can use groundwater wells, where we are pumping the ground water from one well through the heat pumps and then leading it back through another groundwater well. It is a very efficient solution because the groundwater has a stabile and high temperature of 8°C. It is possible to use several wells as long as we can control the pressure loss. The only drawback is that permission is needed in order to make these wells, but it is possible, especially if we use alcohol in our heating pumps as coolant because if the system gets a leak it would not pollute the groundwater.

The best solutions for the airport would be to use that last option mentioned above, groundwater wells. Because it's a really efficient solution and it should be possible to get the permission to drill in order to reach the goal of CO_2 neutral Sønderborg within 2029.

Optimizations

During the meeting with Rainer he told us that if we dimensioned everything right and was able to optimize the heating distribution channels it was possible to lower their flow temperature from 55 °C to 35-40°C and still fulfill the airports demands. This means that we have to look at the flow of the water through the heating system, because an optimal flow means that we are able to make the radiators surface temperature equally distributed throughout the whole radiator. This makes it a better heater, demanding lower temperatures. Rainer also made it clear that he could guarantee that the airport could save 50% of their current consumption in DKKR. At the same time for every degree we can lower their flow temperature it is possible to save an additionally 2%. For this to be possible they need unit heaters that can manage the job of heating the hangar with a water input temperature of only 35-40°C, such a unit heater can Wolf GbmH deliver. In addition to the four heating pumps a buffer capacity is needed in order to minimize the

[13] See "Digital appendices\Geothermal-probe-price-per-meter.pdf"

work load on the 8 compressors (two in each heat pump) because it minimizes on-off periods. By looking through the catalogue from Alpha-Innotec[14] one can see that for each SWP 1600 a buffer tank of 1.500 liter is needed, but we were advised by Rainer to choose one a bit higher, meaning a 2.000 liter buffer tank per SWP 1600. Therefore we will be using four TPS 2000, which is a 2.000 liter buffer tank.

We also need to be looking at what their demand for hot water is. Is it only used for bathrooms with temperatures around a maximum of 40°C or do they need a higher temperature. We have to look into how they are producing their hot water now, and at what distance does it travel from the hot water container to the water tap. If they are badly insulated pipes with a high heat loss it is possible to lower the heat loss and thereby lower the temperature in the water container, saving energy.

Zero CO_2 emission from heating the airport

A part of project Zero's Master plan[15] is to make Sønderborg a CO_2 emission free area, with the use of green energy. Changing the airports heating source from oil burners, which emits 353,7 ton CO_2 per year, to a greener alternative, like a heating pump, fits Project Zero's master plan well. It is a possibility to make the heating pumps CO_2 neutral in use. This can be obtained by using solar collectors and a windmill. The solar collectors can be used as a buffer with a high storage temperature this can lower the use of energy from the heat pumps significant because it can use the buffer capacity from the solar collectors when the temperature in the buffer is high. This is already an opportunity implemented in the SWP 1600 so it only needs to be connected to the SWP 1600 and it is ready for use. The energy that the heat pumps need in order to function can be produced from a windmill. This solution will make Sønderborg airport a CO_2 emission neutral airport when concerning heating.

[14] Found in "Preis- und Typenliste 2011" obtained at the meeting with Rainer Christensen.

[15] See "Digital appendices\ProjectZero-VejenModNullet.pdf"

Cost estimations of geothermal plant

We are only capable to estimate a price for such a project, because the total price for a project depends on so many factors that with the knowledge and time we have aren't able to investigate.

Some standard price is though possible to obtain from Alpha InnoTecs price catalogue.

Unit	Number of units	Price per unit €	Total price DKKR
SWP 1600	4	37.562,00	1.134.372,40
TPS 2000	4	2.936,00	88.667,20

During the meeting we also discussed pricing and we were told that some rough estimation would be:

- 1.300.000 DKKR for the necessary groundwater wells and drillings.
- 25 % of the price for the heat pumps and the buffer tanks is needed for fittings and pipes.
- 25 % of the price for the heat pumps and the buffer tanks is needed for installations and pipe replacements.
- Additionally we will be adding 25 % of the price for the heat pumps and the buffer tanks for hot water container, pressure regulators and in order to be on the safe side.

This gives us a total estimate of:

3.440.320,00 DKKR

Return of investment

3,5 million DKKR sounds like a lot of money, but baring in mind that we as a minimum will be able to half their heating costs compared to their current consumption and if we can lower the flow temperature and at the same time increase the input temperature for the heat pump we can lower the consumption additionally. A payback time can be estimated from their current consumption as follows.

131.000 liters of oil x (6,1188 x 1,25)DKKR[16] per liter of oil =

1.001.953,50 DKKR

Having a saving of minimum 50% per year gives a payback capacity of at least:

500.976,75 DKKR

Making the payback time:

3.440.320,00 / 500.976,75 = **6,87 years**

Bare in mind that this is the maximum payback time because we are expecting an energy saving higher than 50%

[16] Oil price obtained at www.q8.dk, see digital appendices\oilprice.21-12-11.pdf

Conclusion

Being a part of this project has been extremely interesting for us. We have, in cooperation with the other participants in this project, fulfilled all our goals stated in the problem formulation. To mention one case in particular, we are very satisfied with the rate of success in case 1. Where we've managed to get 71%[17] of the citizens living in Kær bygade and Ormstoft to support the implementation of district heating, and the start-up process has already been initiated. This was the citizens of Kær halvø biggest wish, and top priority.

We are also really satisfied with the suggestions made in case 2 and 3, and we find it a great success that we were able to fulfill the needs of the private households as well as the biggest company in the area, Sønderborg Airport - those calculations were made in cooperation with Rainer Carstens, CEO of the ASAP-group. Which means that the airport can be CO_2-neutral regarding heating, by combining a geothermal plant with solar collectors and a windmill, if they follow our advise.

Working with the citizens from Kær halvø has been a pleasure. We especially worked with Jørgen Wilkenskjeldt and Svend Aage Voss, and those two were very engaged in the project, and are very cooperative.

All in all, it has been a pleasure to contribute to Project Zeros master plan: to make Sønderborg CO_2-neutral in 2029.

Our recommendations

<u>Kær halvø households:</u>

It is sure that the main recommendation for the household on Kær halvø, is that they should be aware of how well their house are insulated. This means, getting roof isolations and changing windows in order to keep down the waste of heat energy.

Apart from that aspect, we recommend that district heating should be implemented in as many households as possible since this is the most beneficial solution at this given time. Looking at a larger scope, it could be more beneficial to use heating pumps and solar panels for each of the houses – it is though not possible to use these solutions right now since they will all have to isolate their house properly first. Also, it would be a bigger

[17] 71% of the 57 answered questionnaires at Kær bygade and Ormstoft.

investment and since the district conservation plan prohibits almost any newer installations this plan will have to be changed before these future installations can be planned.

Outer areas of Kær Halvø:

In some of the smaller isolated areas of Kær halvø we recommend the households to investigate what their possibilities of making joint solutions are. We investigated how well a geothermal plant in Hestehaven would work, and we saw that only one of the household in the cluster wouldn't have an economic benefit of joining the solution. There are though still lots of possibilities of making similar plants other places on Kær Halvø. In case the district conservation plan will be changed in the future, many more solutions will be possible as mentioned for the solutions at Kær Bygade and Ormstoft.

Sønderborg Airport:

We recommend that the airport should implement a geothermal plant solution with four heating pumps and two groundwater wells. The calculations shows that this solution will give a payback time of less than 7 years *at least* and is guaranteed to give annual savings of more than 50 % of their current consumption.
In order to make this solution even more beneficial for both the environment and the airport, it may be possible to combine the solution with solar collectors that have a buffer tank. This means that the heating pumps will be able to power down when the sun is up. Also, a small windmill may be able to combine with the heating pumps to provide the needed electricity – in this way we can make the airport 100 % CO_2-neutral regarding heating.

Recommending that the airport should get district heating would just be a kludge, since the goal of the municipality of Sønderborg is to be CO_2-neutral in 2029.

Overslagsberegning over økonomien i et varmepumpeanlæg:

Navn:	0		
Adresse:	Hestehaven 14		
Postnr:	6400	By:	**Sønderborg**

Beregnet af fir	**Nilan**
Att:	**0**

Ejendomsdata: **Eksisterende Hus**

Husets opvarmede areal				**107**	m2
	Heraf gulvvarme			0	m2
	Heraf radiatorvarme			107	m2
Husets varmet	83,7 kWh/m2/år	Antal beboere		4	pers.

Nuværende opvarmningssystem:

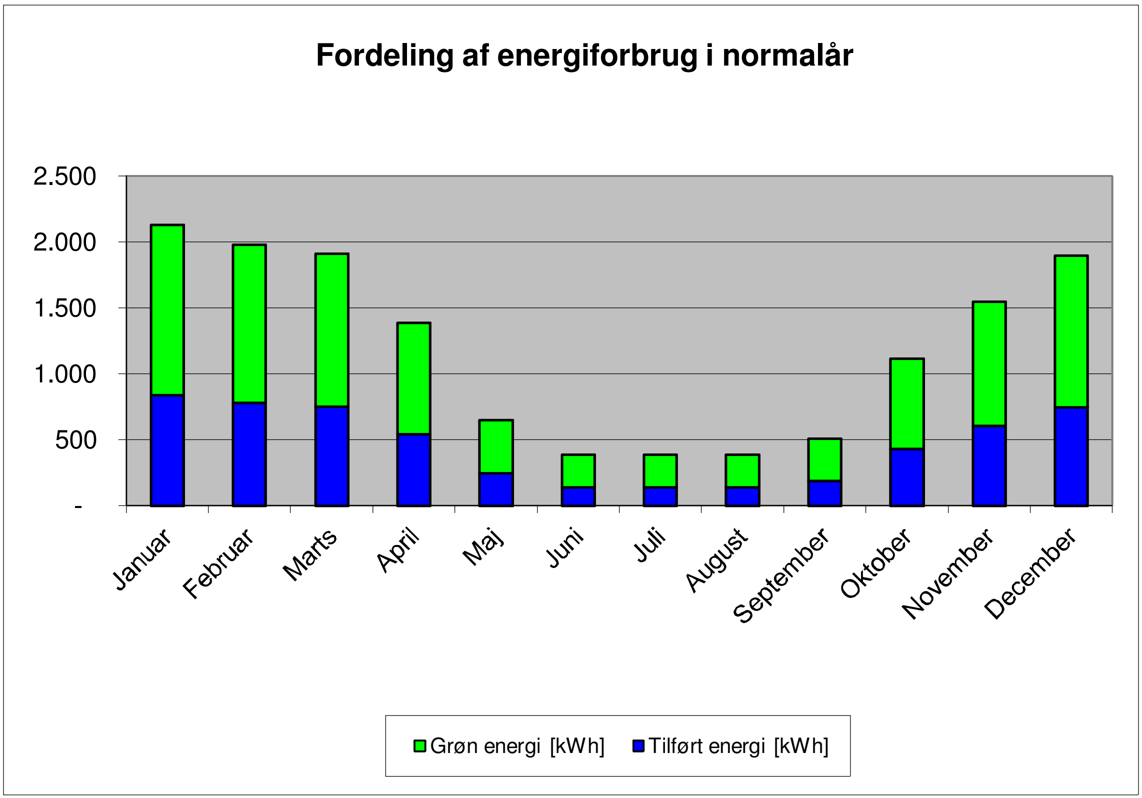
Forbrug pr. år:

Primær opvarmningsform	olie	Forbrug	1.700	liter
	oliepris		10,00	kr/liter
Sekundær opvarmningsform	**Intet valg**	Forbrug	-	FALSK
			-	FALSK

Virkningsgrad for nuværende opvarmningssystem	80%	
Rumvarmebehov	8.956	kWh/år
Brugsvandsbehov	4.656	kWh/år
Varmebehov v. -12 C (incl. brugsvand)	5	kW
Varmebehov v. -12 C (excl. brugsvand)	42	W/m2
Samlet varmeregning	**17.000**	**kr/år**

Fremtidigt jordvarmeanlæg: Nilan JVP 105 - 5,2 kW

Varmepumpens dækningsgrad (incl. sekundær opvarmning)	100%	
Nødvendig jordslangelængde	207	m
Nødvendigt areal til jordslanger, anslået	310	m2
**** husk at der skal tillægges afstand til skel m.m i udregnet nødvendigt areal***		
Beregnet årsnyttevirkningsgrad (COP)	2,80	
Varme produceret af varmepumpe	13.612	kWh/år
Elforbrug til varmepumpe	4.861	kWh/år
Elpatron leverer	-	kWh/år
Elforbrug til pumper	673	kWh/år
Samlet energiforbrug til varme og varmt brugsvand	5.534	kWh/år
Samlet varmeregning 2,17 (kr.pr.kWh)	11.567	kr/år
El Kr/kWh		
Årlig varmebesparelse:	**5.433**	kr



Måned		Energi fra varmepumpe [kWh]	Energi forbrug Varmepumpe [kWh]	El supplering [kWh]	I alt [kWh]
Jan		1289	839	0	2128
Feb		1200	779	0	1979
Mar		1160	752	0	1913
Apr		847	542	0	1389
Maj		406	244	0	650
Jun		249	139	0	388
Jul		249	139	0	388
Aug		249	139	0	388
Sep		321	187	0	507
Okt		683	431	0	1114
Nov		940	604	0	1545
Dec		1150	746	0	1896

Overslagsberegning over økonomien i et varmepumpeanlæg:

Navn:	0		
Adresse:	Hestehave 18		
Postnr:	6400	By:	**Sønderborg**

Beregnet af fir	**Nilan**
Att:	**0**

Ejendomsdata: **Eksisterende Hus**

Husets opvarmede areal			**159**	m2
Heraf gulvvarme			0	m2
Heraf radiatorvarme			159	m2
Husets varmet	71,4 kWh/m2/år	Antal beboere	4	pers.

Nuværende opvarmningssystem:

Forbrug pr. år:

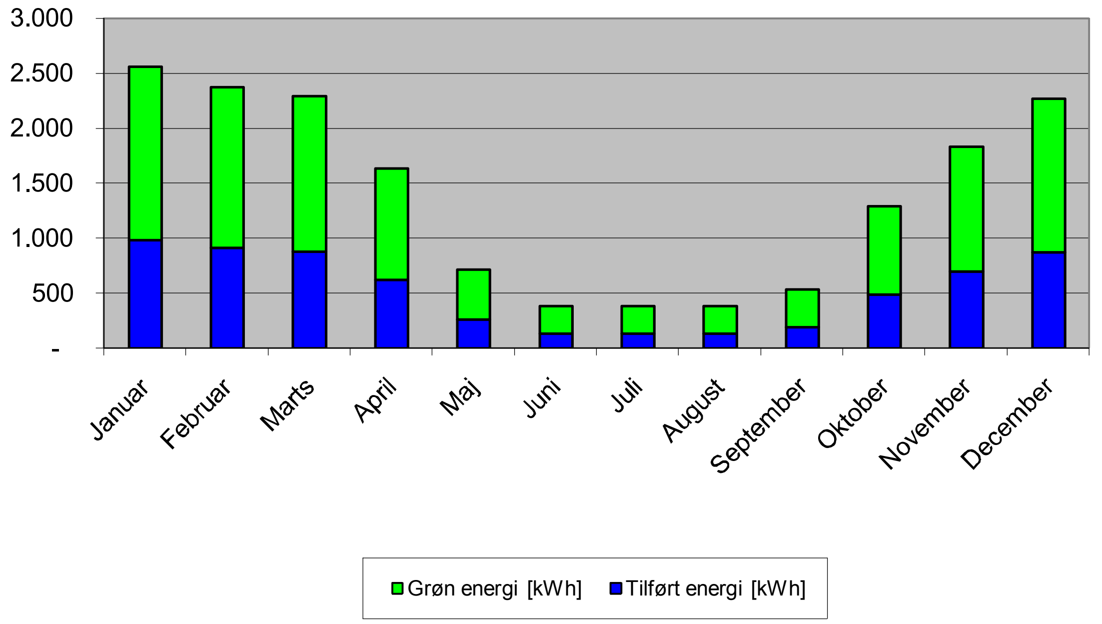
Primær opvarmningsform	olie	Forbrug	2.000	liter
	oliepris		10,00	kr/liter
Sekundær opvarmningsform	**Intet valg**	Forbrug	-	FALSK
			-	FALSK

Virkningsgrad for nuværende opvarmningssystem	80%	
Rumvarmebehov	11.356	kWh/år
Brugsvandsbehov	4.656	kWh/år
Varmebehov v. -12 C (incl. brugsvand)	6	kW
Varmebehov v. -12 C (excl. brugsvand)	36	W/m2
Samlet varmeregning	**20.000**	**kr/år**

Fremtidigt jordvarmeanlæg: Nilan JVP 107 - 7,1 kW

Varmepumpens dækningsgrad (incl. sekundær opvarmning)	103%	
Nødvendig jordslangelængde	256	m
Nødvendigt areal til jordslanger, anslået	383	m2
**** husk at der skal tillægges afstand til skel m.m i udregnet nødvendigt areal***		
Beregnet årsnyttevirkningsgrad (COP)	2,90	
Varme produceret af varmepumpe	16.012	kWh/år
Elforbrug til varmepumpe	5.521	kWh/år
Elpatron leverer	-	kWh/år
Elforbrug til pumper	673	kWh/år
Samlet energiforbrug til varme og varmt brugsvand	6.194	kWh/år
Samlet varmeregning 2,17 (kr.pr.kWh)	12.946	kr/år
El Kr/kWh		
Årlig varmebesparelse:	**7.054**	kr

Fordeling af energiforbrug i normalår



		Energi	Energi forbrug	El supplering	
Måned		fra varmepumpe	Varmepumpe		I alt
		[kWh]	[kWh]	[kWh]	[kWh]
Jan		1575	987	0	2562
Feb		1462	914	0	2376
Mar		1411	882	0	2293
Apr		1012	626	0	1639
Maj		450	265	0	715
Jun		250	138	0	388
Jul		250	138	0	388
Aug		250	138	0	388
Sep		341	196	0	537
Okt		803	492	0	1295
Nov		1131	702	0	1833
Dec		1398	874	0	2272

NILAN

Overslagsberegning over økonomien i et varmepumpeanlæg:

Navn:	0		
Adresse:	Hestehave 18		
Postnr:	6400	By:	**Sønderborg**

Beregnet af fir	**Nilan**
Att:	**0**

Ejendomsdata: **Eksisterende Hus**

Husets opvarmede areal			**200**	m2
	Heraf gulvvarme		0	m2
	Heraf radiatorvarme		200	m2
Husets varmet	76,8 kWh/m2/år	Antal beboere	4	pers.

Nuværende opvarmningssystem:

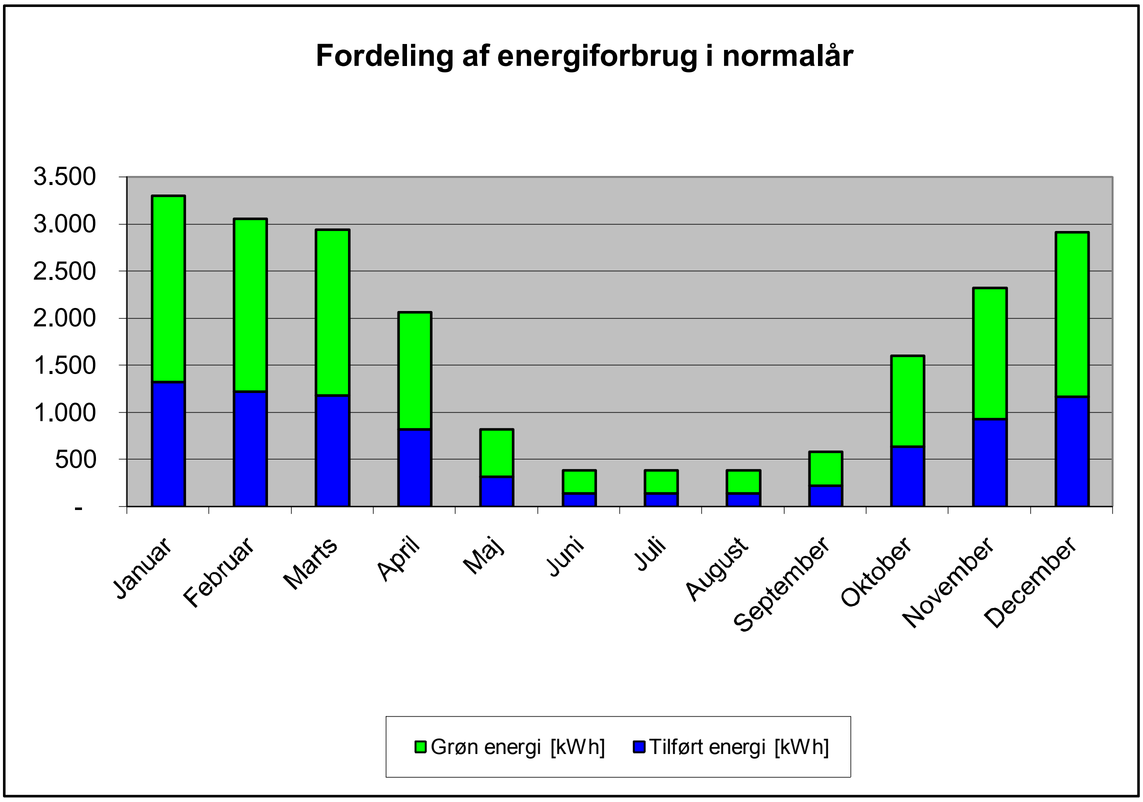
Forbrug pr. år:

Primær opvarmningsform	olie	Forbrug	2.500	liter
	oliepris		10,00	kr/liter
Sekundær opvarmningsform	**Intet valg**	Forbrug	-	FALSK
			-	FALSK

Virkningsgrad for nuværende opvarmningssystem	80%	
Rumvarmebehov	15.356	kWh/år
Brugsvandsbehov	4.656	kWh/år
Varmebehov v. -12 C (incl. brugsvand)	8	kW
Varmebehov v. -12 C (excl. brugsvand)	38	W/m2
Samlet varmeregning	**25.000**	**kr/år**

Fremtidigt jordvarmeanlæg: Nilan JVP 109 - 8,9 kW

Varmepumpens dækningsgrad (incl. sekundær opvarmning)	101%	
Nødvendig jordslangelængde	337	m
Nødvendigt areal til jordslanger, anslået	506	m2
husk at der skal tillægges afstand til skel m.m i udregnet nødvendigt areal		
Beregnet årsnyttevirkningsgrad (COP)	2,70	
Varme produceret af varmepumpe	20.012	kWh/år
Elforbrug til varmepumpe	7.412	kWh/år
Elpatron leverer	-	kWh/år
Elforbrug til pumper	779	kWh/år
Samlet energiforbrug til varme og varmt brugsvand	8.191	kWh/år
Samlet varmeregning 2,17 (kr.pr.kWh)	17.119	kr/år
El Kr/kWh		
Årlig varmebesparelse:	**7.881**	kr



Måned		Energi fra varmepumpe	Energi forbrug Varmepumpe	El supplering	I alt
		[kWh]	[kWh]	[kWh]	[kWh]
Jan		1977	1327	0	3304
Feb		1828	1226	0	3054
Mar		1762	1181	0	2943
Apr		1240	825	0	2065
Maj		503	323	0	827
Jun		242	146	0	388
Jul		242	146	0	388
Aug		242	146	0	388
Sep		361	227	0	588
Okt		966	638	0	1604
Nov		1395	931	0	2326
Dec		1745	1170	0	2915

Overslagsberegning over økonomien i et varmepumpeanlæg:

Navn:	0		
Adresse:	Hestehaven 31		
Postnr:	6400	By:	**Sønderborg**

Beregnet af fir	**Nilan**
Att:	**0**

Ejendomsdata: **Eksisterende Hus**

Husets opvarmede areal			**150**	m2
Heraf gulvvarme			0	m2
Heraf radiatorvarme			150	m2
Husets varmet	76,1 kWh/m2/år	Antal beboere	4	pers.

Nuværende opvarmningssystem:

Forbrug pr. år:

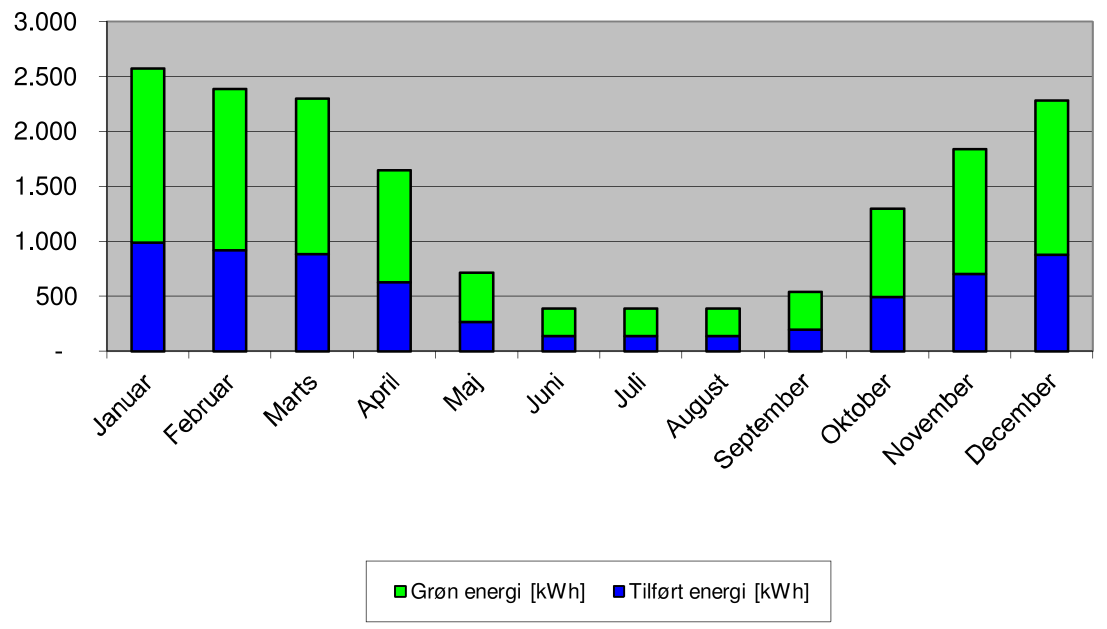
Primær opvarmningsform	el	Forbrug	5.500	kWh
	elpris		2,17	kr/kWh
Sekundær opvarmningsform	**brænde**	Forbrug	10	rm
	brændepris		600,00	kr/rm
Virkningsgrad for nuværende opvarmningssystem			80%	

Rumvarmebehov	11.409	kWh/år
Brugsvandsbehov	4.656	kWh/år
Varmebehov v. -12 C (incl. brugsvand)	6	kW
Varmebehov v. -12 C (excl. brugsvand)	38	W/m2
Samlet varmeregning	**17.935**	**kr/år**

Fremtidigt jordvarmeanlæg: Nilan JVP 107 - 7,1 kW

Varmepumpens dækningsgrad (incl. sekundær opvarmning)		103%	
Nødvendig jordslangelængde		257	m
Nødvendigt areal til jordslanger, anslået		385	m2
**** husk at der skal tillægges afstand til skel m.m i udregnet nødvendigt areal***			
Beregnet årsnyttevirkningsgrad (COP)		2,90	
Varme produceret af varmepumpe		16.065	kWh/år
Elforbrug til varmepumpe		5.539	kWh/år
Elpatron leverer		-	kWh/år
Elforbrug til pumper		673	kWh/år
Samlet energiforbrug til varme og varmt brugsvand		6.212	kWh/år
Samlet varmeregning	2,17 (kr.pr.kWh)	12.984	kr/år
El Kr/kWh			
Årlig varmebesparelse:		**4.951**	kr

Fordeling af energiforbrug i normalår



Måned		Energi fra varmepumpe	Energi forbrug Varmepumpe	El supplering	I alt
		[kWh]	[kWh]	[kWh]	[kWh]
Jan		1582	989	0	2571
Feb		1468	916	0	2384
Mar		1418	884	0	2301
Apr		1017	627	0	1644
Maj		451	266	0	717
Jun		251	137	0	388
Jul		251	137	0	388
Aug		251	137	0	388
Sep		342	196	0	538
Okt		806	493	0	1299
Nov		1136	703	0	1839
Dec		1405	875	0	2280

Overslagsberegning over økonomien i et varmepumpeanlæg:

Navn:	0		
Adresse:	Hestehaven 33		
Postnr:	6400	By:	**Sønderborg**

Beregnet af fir	**Nilan**
Att:	**0**

Ejendomsdata: **Eksisterende Hus**

Husets opvarmede areal			**300**	m2
	Heraf gulvvarme		0	m2
	Heraf radiatorvarme		300	m2
Husets varmet	98,3 kWh/m2/år	Antal beboere	4	pers.

Nuværende opvarmningssystem:

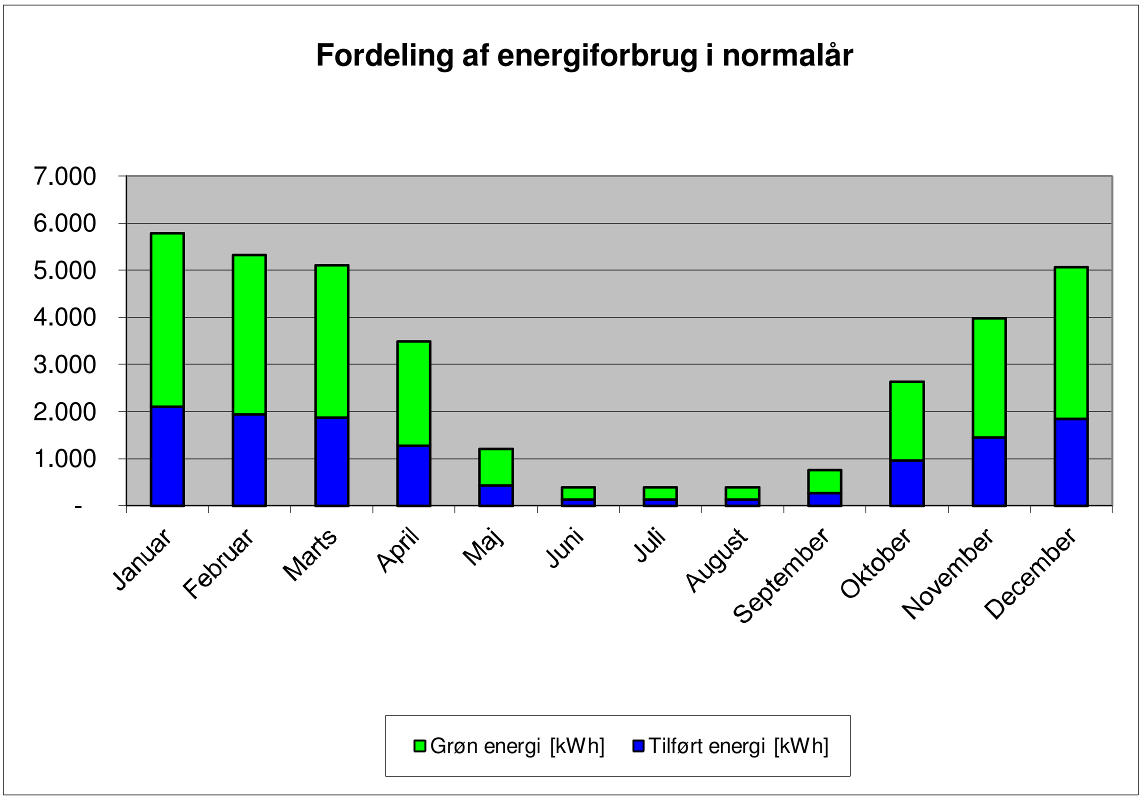
Forbrug pr. år:

Primær opvarmningsform	træpiller	Forbrug	9	ton
	træpillepris		######	kr/ton
Sekundær opvarmningsform	**Intet valg**	Forbrug	-	FALSK
			-	FALSK

Virkningsgrad for nuværende opvarmningssystem	80%	
Rumvarmebehov	29.500	kWh/år
Brugsvandsbehov	4.656	kWh/år
Varmebehov v. -12 C (incl. brugsvand)	16	kW
Varmebehov v. -12 C (excl. brugsvand)	49	W/m2
Samlet varmeregning	**14.960**	**kr/år**

Fremtidigt jordvarmeanlæg: Nilan JVP 115 - 13,0 kW

Varmepumpens dækningsgrad (incl. sekundær opvarmning)	97%	
Nødvendig jordslangelængde	626	m
Nødvendigt areal til jordslanger, anslået	939	m2
**** husk at der skal tillægges afstand til skel m.m i udregnet nødvendigt areal***		
Beregnet årsnyttevirkningsgrad (COP)	2,70	
Varme produceret af varmepumpe	33.044	kWh/år
Elforbrug til varmepumpe	12.238	kWh/år
Elpatron leverer	1.112	kWh/år
Elforbrug til pumper	329	kWh/år
Samlet energiforbrug til varme og varmt brugsvand	13.679	kWh/år
Samlet varmeregning 2,17 (kr.pr.kWh)	28.590	kr/år
El Kr/kWh		
Årlig varmebesparelse:	**(13.630)**	kr



Måned		Energi fra varmepumpe	Energi forbrug Varmepumpe	El supplering	I alt
		[kWh]	[kWh]	[kWh]	[kWh]
Jan		3670	2109	201	5980
Feb		3377	1940	184	5500
Mar		3246	1865	176	5287
Apr		2217	1272	116	3605
Maj		764	435	30	1229
Jun		249	139	0	388
Jul		249	139	0	388
Aug		249	139	0	388
Sep		484	274	14	771
Okt		1676	961	84	2721
Nov		2523	1448	134	4105
Dec		3214	1846	174	5234

Takstblad

Sønderborg Fjernvarme

Investeringsbidrag

		Ekskl. moms	Inkl. moms
ENFAMILIEHUSE INDTIL 300 m²			
Efter forbrugers valg enten som:			
Installation leveret klar til ibrugtagning*	Kr.	56.000	70.000,00
Beløbet betales med 7.000 kr. pr. år over 10 år			
Opkrævningen følger den løbende a conto og der tilskrives ikke renter			
eller som:			
Installation afsluttet med 2 ventiler indenfor mur	Kr.	24.000	30.000,00
Standardunit (TD-unit) jf. tekniske bestemmelser	Kr.	5.200	6.500,00
eller S-unit med termostatstyring og A-pumpe jf. tekniske bestemmelser	Kr.	7.600	9.500,00
eller S-unit SL 110 vejrkompensering og A-pumpe jf. tekniske bestemmelser	Kr.	11.200	14.000,00
eller Unit VX 2000 Akva Lux med vejrkompensering jf. tekniske bestemmelser	Kr.	12.800	16.000,00
Ovenstående er uden brugsvandscirkulation			
+ evt. rør og ventilsæt til brugsvandscirkulation	Kr.	600	750,00
Beløbet betales ved arbejdets påbegyndelse			
ØVRIGE EJENDOMME:			
Kr. 15.000,00 + efter bolig- og erhvervsareal oplyst i BBR-registret pr. m²	Kr./m²	60	75,00
(lager til erhvervsformål medregnes kun i effektbidraget jf. side 1)			
FOR ALLE EJENDOMME GÆLDER:			
Indtil 20 meter stik på egen grund er iberegnet herudover pr. meter	Kr.	1.400	1.750,00
En måler iberegnet. For yderligere målere betales pr. stk.	Kr.	3.500	4.375,00

***Tilbydes i forbindelse med velfungerende vandbårne varmeanlæg og forudsætter Fjernvarmens accept.**
Inkluderet er:

- Indtil 20 meter stik på egen grund inkl. retablering.
- Standardunit uden brugsvandscirkulation.
- Demontering af eksisterende kedel/varmepumpeanlæg.
- Demontering af el-installation fra kedel/varmepumpeanlæg til nærmeste kontakt.
- Indtil 15 meter vvs-installationer til færdig drift og isolering af nye rør.
- Eventuel udskiftning af op til 10 radiatorventiler med forindstilling.
- Afbrydelse af eksisterende gasforsyning efter retningslinjer fra DONG.
- Demontering og bortskaffelse af overflade- eller jordlagt olietank.
- Demontering og bortskaffelse af eksisterende stålskorsten samt vandtæt inddækning af tag.
- Erstatning af op til 2 radiatorer, hvis de ikke tåler trykprøvningen.
- Indregulering af varmeanlæg, energirådgivning og aflevering.
- Koordinering.

Inkluderet er ikke:

- Bygningsmæssige arbejder som reetablering af murværk, klinker/fliser, lofter, tapet mv.
- Enhver form for omkostninger og analyser ved evt. forurenet jord.

BYGGEMODNINGSBIDRAG:

I udstykningsområder betaler grundudstykkeren investeringer til hoved- og stikledninger frem til skel

Sønderborg Fjernvarme

Årlige bidrag

		Ekskl. moms	Inkl. moms
ABONNEMENTSBIDRAG			
For hver måler, hvor forbrugerne ikke stiller el og telefon til rådighed, betales	Kr.	800	1.000,00
For hver måler, hvor forbrugerne stiller el og telefon til rådighed, betales	Kr.	550	687,50
For hver installeret standardunit (TD-unit) betales	Kr.	60	75,00
For hver installeret S-unit med termostatstyring og A pumpe betales	Kr.	220	275,00
For hver installeret S-unit med SL 110 vejrkompensering og A pumpe betales	Kr.	380	475,00
For hver installeret unit VX 2000 Akva Lux med vejrkompensering betales	Kr.	440	550,00
For hver installeret system til lækage-alarmering betales	Kr.	200	250,00
Ejendomme med mere end 1000 m²: Energispareabonnement	Kr./m²	1	1,25
Er der ikke betalt etableringsbidrag mv. betales yderligere et individuelt fast bidrag.			
EFFEKTBIDRAG			
Efter bolig- og erhvervsareal oplyst i BBR-registret	Kr./m²	20	25,00
Loft for erhverv: Bidraget kan maksimalt udgøre 60% af varmeregningen for et år. Dette forudsætter et helt års normalt forbrug for ejendommen.			
FORBRUGSBIDRAG			
Efter målt energiforbrug	Kr./GJ	80	100,00

A CONTO

Alle bidrag opkræves a conto. I 2011 forfalder betalingen i februar, april, juni, august og november. I 2012 i januar, marts, maj, august og november.

A conto betales efter et forventet normalt årsforbrug.

SLUTOPGØRELSE

Varmeårets skæringsdato er 31. december med efterfølgende regulering.

Gebyrer

Gebyrer følger standardgebyrer på el, gas og varmeområdet, som er godkendt af Energitilsynet.

Rykkerskrivelse	Kr.		100,00
Rentetillæg ved overskridelse af betalingsfrist er Nationalbankens udlånsrente tillagt	% p.a.		7
Inkassomeddelelse	Kr.		100,00
Lukkebesøg	Kr.		375,00
Genoplukning indenfor normal åbningstid	Kr.	300	375,00
Betalingsordning	Kr.		100,00
Fogedforretning, udkørende	Kr.	330	412,50
Selvaflæsningskort, rykker	Kr.	65	81,25
Aflæsningsbesøg	Kr.	270	337,50
Slutaflæsning foretaget af forbruger	Kr.	100	125,00
Slutaflæsning foretaget af selskabet	Kr.	100	125,00
Nedtagning af måler	Kr.	600	750,00
Genetablering af måler	Kr.	600	750,00
Ekstraordinær måleraflæsning med regning	Kr.	200	250,00
Udskrift af regningskopi	Kr.	35	43,75
Målerundersøgelse på stedet	Kr.	335	418,75
Udbringning af måler	Kr.	165	206,25
Planlagte servicearbejder, herunder målere, unit og ventiludskiftning udenfor normal arbejdstid afregnes efter medgået tid. Pr. time	Kr.	225	281,25
Servicearbejder, indenfor normal arbejdstid og servicearbejder, som skyldes svigtende varmeforsyning, afregnes ikke.			
Minimumsafregning for flyttere	Kr.		40,00

Afkølingssanktion

Der kan opkræves ekstra bidrag, hvis afkølingen er mindre end, hvad fremgår af Tekniske Bestemmelser.

Variabelt bidrag: 0,5% pr. ⁰C årsafkølingen er mindre end afkølingskravet, alternativt oktober til maj.

Fast bidrag: 2,5% pr. ⁰C afkølingen er mindre end afkølingskravet.

Bidraget kan opkræves for det regnskabsår, hvor overskridelsen konstateres.

Sønderborg Fjernvarme A.m.b.a. · Nørrekobbel 54 · 6400 Sønderborg · Tlf. 73 43 50 00 · CVR 35 60 23 13
www.sonderborg-fjernvarme.dk · e-mail post@sonderborg-fjernvarme.dk

Spørgeskema angående projekt for Sønderborg kommune i samarbejde med Kær Halvø
Informationerne er kun til intern brug og vil ikke på nogen måde blive offentliggjort.
Ønsker du at svare på spørgeskemaet elektronisk kan dette gøres på internetsiden, www.bit.ly/nhFcdc.

Adresse:
Skriv venligst vej samt husnummer.

____

Din boligs isoleringsår:
Skriv venligst hvilket år din bolig er isoleret. Hvis boligen ikke er efterisoleret, skriv venligst byggeår.

____

Opvarmet boligareal:
Skriv venligst hvor mange m^2 af din bolig der er opvarmet.

____

Opvarmningskilde:
Kryds venligst af ved den opvarmningskilde du bruger i din bolig. Bruger du ikke en af de nævnte kilde, så skriv venligst din varmekilde under 'Andet'.

□ Gasfyr
□ Oliefyr
□ Pillefyr
□ Halmfyr
□ Elvarme
□ Jordvarme
□ Fjernvarme
□ Naturgas
□ Andet
____

Energiruder:
Kryds venligst af om der er energiruder i din bolig eller ej.

□ Ja
□ Nej

Årlige varmeomkostninger:
Skriv venligst ca. hvad dine årlige omkostninger på varme er.

____

Årligt elforbrug:
Skriv venligst ca. hvad dine årlige omkostninger på el er.

____

Interesse i fjernvarme:
Svar venligst ja eller nej til om du ville være interesseret i at få fjernvarme tilsluttet til din bolig.

□ Ja
□ Nej

Mange tak fordi du ville tage tid til at svare.