Market uptake of small modular renewable district heating and cooling grids for communities

Project No: 691679

Feasibility Check of a small modular renewable heating and cooling grid in Ozalj

Municipality of Ozalj (Croatia)

District heating in Ozalj

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CoolHeating website: www.coolheating.eu

Contents

1 Introduction

The heating and cooling demand in Europe accounts for around half of the EU's final energy consumption. Renewable energy policies often mainly focus on the electricity market, whereas policies for renewable heating and cooling are usually much weaker and less discussed in the overall energy debate. Therefore, it is important to support and promote renewable heating and cooling concepts, the core aim of the CoolHeating project.

The objective of the CoolHeating project, funded by the EU's Horizon2020 programme, is to support the implementation of "small modular renewable heating and cooling grids" for communities in South-Eastern Europe. This is achieved through knowledge transfer and mutual activities of partners in countries where renewable district heating and cooling examples exist (Austria, Denmark, Germany) and in countries which have less development (Croatia, Slovenia, Macedonia, Serbia, Bosnia-Herzegovina). Core activities, besides techno-economical assessments, include measures to stimulate the interest of communities and citizens to set-up renewable district heating systems as well as the capacity building on financing and business models. The outcome is the initiation of new small renewable district heating and cooling grids in five target communities up to the investment stage. These lighthouse projects will have a long-term impact on the development of "small modular renewable heating and cooling grids" at the national levels in the target countries.

For each of the CoolHeating target municipalities one or two potential projects have been identified in which small modular renewable heating and cooling grids could be implemented. For these potential projects, technical concepts and individual business models were elaborated by the projects partners from the target countries in cooperation with experts from Austria, Denmark and Germany.

The current document on “Feasibility Check of a small modular renewable heating and cooling grid in Ozalj presents the results of checking the feasibility of the technical concepts and individual business models of the potential projects. The results are summarized in the executive summaries in English and national language in order to be promoted among decision makers of the target municipalities.

Please note this is not a feasibility study (more costly and time-consuming task[1]), and that main purpose of this Feasibility Check is to provide a base for the activities of investment promotion, starting with an information day for attracting the investors, before the investment phase. It is likely that during the direct negotiations in the investment phase the modifications of this Feasibility Check will be needed.

All prices, costs and revenues in this document are without VAT.

2 Technology assessment

The technical assessment in Ozalj included five potential projects in the municipality. For this project, a technical concept was elaborated, which includes heat generation by the means of a biomass combined heat and power (CHP) unit, a natural gas peak load boiler and flat plate solar collectors, heat distribution by the means of distribution pipes, and the heat use of private households and public buildings. District cooling has not been considered for the project in Ozalj.

The first step in the process of district heating project development was the heat demand mapping. Mapping was done both on the 100x100 m level and on the individual building level. Even though the method which has been used already provides results with high precision, it

[1] Behrens, W., Hawranek, P.M., and Organization, United Nations Industrial Development (1991), Manual for the Preparation of Industrial Feasibility Studies (United Nations Industrial Development Organization).

has been complemented by the results of the survey[2] carried out as a part of the CoolHeating project. This way, existing buildings could be divided into 8 categories, with real average data on specific consumption for every category. This increased the precision of the method, providing accurate heat demands of the whole area of the city of Ozalj.

Questionnaire also included questions regarding the opinion of the citizens to connect to the renewable district heating system in case the project is passed. The results were favourable, with more than 50% of the citizens immediately agreeing with connecting to a district heating system if it were to be implemented. It is important to note that among the citizens who said they wouldn't connect, the majority listed not knowing the benefits of such system as the main reason for their decision. Therefore, when implementing the project it is expected that with the detailed promotional activities the connection rate to the district heating system could be up to 80%. It is beneficial that more than 80% of the surveyed households already have a centralized heating system installed. This means that the only investment for that households would be the cost of substations. This also supports the expected connection rate of up to 80% since no major investments have to be made in the heating system inside of the households.

The highest heat demands in the city are located in the city centre, which is expected since most of the public buildings and all of the apartment buildings are located in that area. Even though two scenarios have been developed, one covering the heat demand of the city centre and the other covering the demand of the whole city south of the river, only the central scenario (including only the city centre) is selected for the project implementation, as discussed with the representatives of the city of Ozalj. Heat demands of individual households and the distribution pipes of the selected distribution scenario are shown in Figure 1.

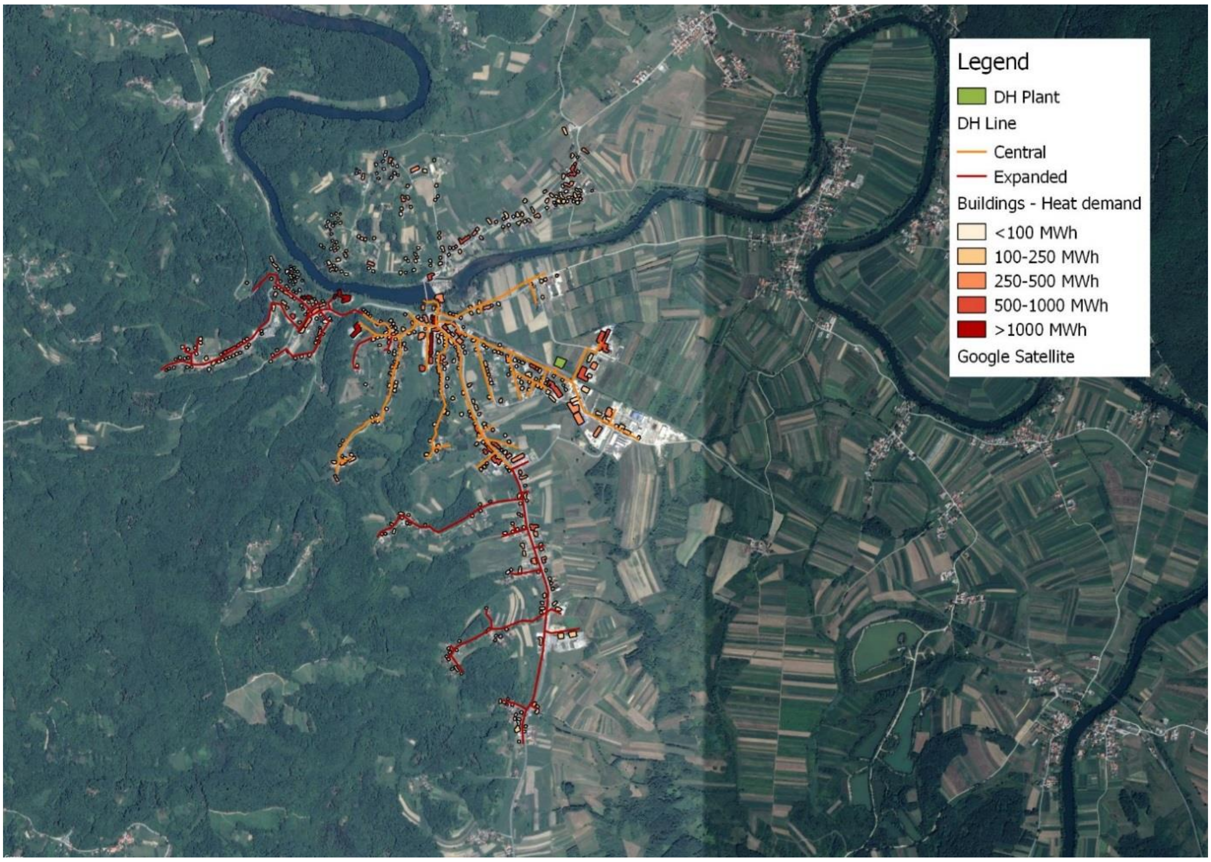


Figure 1. Distribution area of the selected scenario (Central scenario – orange)

[2] Pukšec T. et al. (2016) Survey on the energy consumption and attitudes towards renewable heating and cooling in the CoolHeating target communities. – University of Zagreb FSB; CoolHeating Report available at www.coolheating.eu

The area, which was selected for the production plant is located near the industrial zone of the city and is surrounded by open land. Therefore, there is enough space to implement the project at one plot, including the CHP and natural gas boiler houses, seasonal thermal storage and the flat plate solar collectors. These technologies were selected among other potential scenarios due to the combination of cogeneration and solar thermal technology, which enable no generation costs during the summer, since the demand is covered by solar energy and full load operation of the CHP plant during the winter. Furthermore, electricity production increases the revenues of the project, making it more feasible since there are no subsidies for heat production in Croatia, but they can be received for the electricity production.

All the scenarios were modelled and optimized in the energyPRO software. However, in the discussion with the representatives of the city of Ozalj, it has been decided that the project of interest is the biomass CHP/solar thermal due to the above mentioned reasons. Therefore, the feasibility check has been performed only for this scenario. First the operation of the system was optimized by the software in order to get the results on fuel consumption, production of every technology (both heat and electricity), the number of full load hours and the installed capacities. These were used as input data for the economic calculation tool[3] developed as a part of the CoolHeating project. The tool requires data on investment costs, expected revenues, operational costs, financing, etc. in order to calculate the key economic indicators of the project, i.e. the payback period, net present value of the project and internal rate of return.

Finally, the proposed project consist of the following main **heat generation** units and components:

- 10 MW_{th} biomass CHP plant
- 26 MW natural gas peak load boiler
- 18,000 m^2 flat plate solar collectors
- 20,000 m^3 pit seasonal thermal storage

The **heat generation** concept for Ozalj considers a biomass CHP and solar collectors for baseload and a natural gas peak load boiler. A seasonal thermal storage will be used for storing heat for several months, including from summer to winter.

The combination of biomass and solar energy for heat production is especially interesting for this area since more than 50% of the surrounding area is covered by forests. Furthermore, this part of Croatia has high average annual values of solar irradiation, with global horizontal irradiation of more than 1,200 $kWh/m^2/a$. Therefore, solar energy already represents an important energy source and its potential should be further exploited. Since a high share of citizens own a part of the forest, it is recommended that they supply the biomass to the district heating plant, that way lowering their energy bills or presenting revenue. Relatively low biomass cost in Croatia is taken into account, which increases the feasibility of the project. There is enough heat from solar energy to completely cover the demands for domestic hot water preparation during the summer. Combined with seasonal thermal storage, the produced heat from solar collectors will be stored and used in the autumn, that way reducing the cost of the system by replacing the production from the more expensive production units. Overall, around 25% of heat is produced from the solar collectors. Although the proposed system components can be imported from various producers in the European Union, all these

[3] http://www.coolheating.eu/images/downloads/D5.2_CoolHeating_Economic-tool.xlsm

technologies can also be produced by local companies, increasing the social benefits of the project.

Technical and operation details of the proposed system are shown in Table 1.

The overall production of the heat production facility equals to 43.9 GWh. This includes covering the heat demand of the selected area but also the amount of heat which has to be produced to cover the losses in the system, equalling to 2.4 GWh annually. Furthermore, the electricity production from the biomass CHP plant equals to 10,668 MWh/annually. The installed electrical capacity of the CHP is about 3.5 MW. Load duration curve of the district heating system in Ozalj is shown in Figure 2.

Table 1 Summary of production technologies

	Installed capacity	Produced heat in MWh/a	Needed fuel energy in MWh/a	Annual thermal efficiency in %	Share of total heat for DH in %	Operating hours per year
Biomass CHP	10 MW_{th}	30,510.4	45,765.6	66%	69.4	3,505
Natural gas peak load boiler	26 MW	2,302.9	2,418	95%	5.2	348
Flat plate solar collectors	18,000 m^2	11,182.7	-	-	25.4	2,062

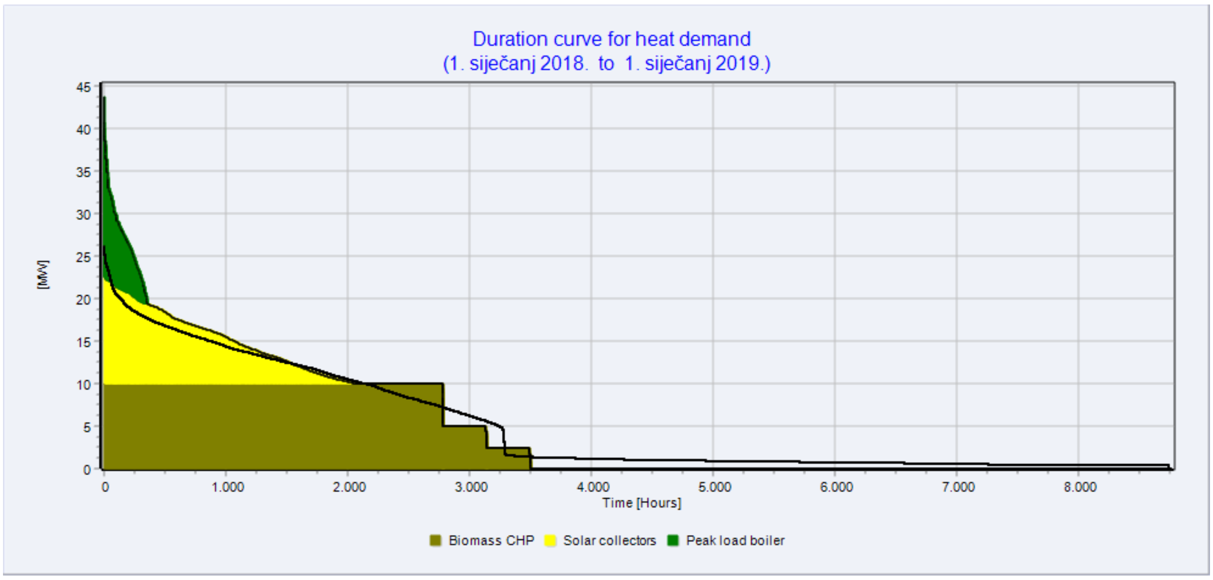


Figure 2. Load duration curve of heat production units of the district heating system in Ozalj

Overall, 69.4% of heat is produced in the CHP unit, 25.4% of heat is produced in the flat plate solar collectors and 5.2% in the peak load boiler. Regarding the consumption of fuel for heat production, 13,883 tonnes of biomass are consumed for the CHP unit and 222,685 m^3 of natural gas for the peak load boiler.

In total, the above figures show that the system has a share of renewable energy production of just below 95%. Installing a larger seasonal thermal storage could make it a 100% renewable project, however, this would significantly increase the cost of the system.

Regarding the **distribution network** which has to be built in order to transfer the heat to the final consumers, the total length of the pipes equals to 8,798 m. This presents the trench length, i.e. the length of the supply pipe. The insulated double pipes are proposed for this concept. The losses of the distribution network have been calculated at 2.4 GWh annually, as previously mentioned. This amounts to 6.7% of the overall produced heat in the system. The grid density has been calculated at 4,594 kWh per meter annually. This presents an important indicator of the economic feasibility of the project and the calculated values show great potentials.

Consumers of the district heating grid could mostly be private households and the public buildings. Since their consumption patterns and the demands are similar, they will not be separated into different consumer categories. It is expected that up to 80% of potential consumers in the selected area will connect to the district heating grid. Prior to the project implementation, detailed promotional activities should be carried out in order to educate citizens about the benefits of such a way of heating. Carefully planned promotional activities should significantly increase the willingness of the citizens to connect, achieving the expected 80% of connection rate.

The district heating project in Ozalj will be implemented in one phase, meaning that all the expected consumers in the city centre of Ozalj will be connected in this phase. However, further **expansion** of the system is possible, since the grid density of the other parts of the city is still high enough for the district heating utilization.

3 Business assessment

The business assessment in Ozalj included one potential project in the municipality. For this project, an individual business model was elaborated that includes the description of the technical concept and all the needed investments, ownership model and the financing sources, all the revenues being produced in the project, all the costs being incurred by the project and finally the socio-environmental impacts of the project.

The business model of Ozalj is presented in more detail in the document Target community business model – Ozalj. All the input parameters have been used for the calculation of the project feasibility, which is intended for the future investors in the district heating system in Ozalj to prove the potential of the implementation of such a project.

The CoolHeating economic calculation tool was used to simulate the economic performance of the project in Ozalj: all the input data and the results of the simulations are presented in the appendix of this document. The business model has been developed in an iterative way, with the simulations in the economic calculation tool being done in parallel with the development of the business model. That way, relevant parameters could be adjusted in order to receive favourable economic indicators and produce the sustainable business model. Potential developments of costs and revenues have also been taken into the account in the calculations and the sensitivity analysis has been performed both for the changes in heat price and the operation costs.

Current costs and practices

The existing heating costs have been assessed as a part of the CoolHeating survey. It has to be taken into account that this information includes only the fuel costs and not the Operation and maintenance costs, nor the investments in the individual boilers. The expenses of the heating sector for the final consumers are currently distributed rather evenly. Citizens who own a part of the forest have low expenses but the ones who use fuel oil or have to buy logwood have much higher expenses, with 6 % having annual expenses of more than 1,600 € which is rather high for Croatian standards.

The average cost of heating for the households in Ozalj could be assumed at 1,000 €/year. It must be noted that heating is not expensive in Ozalj due to high shares of citizens who own a part of the forest, therefore having zero fuel costs. However, since the share of biomass in the overall heating supply is more than 50% and the furnaces are old and inefficient, this results in high emissions of local pollutants, e.g. carbon monoxide, nitrous oxides and particulate matter.

Three main fuel sources are currently used in Ozalj, as listed below:

- Liquefied petroleum gas – the price of this energy source, which has to be transported to the storage tank of the final consumers equals to 65 €/MWh
- Fuel oil – this energy source also has to be transported to the final consumer and filled in the storage tanks at the premises of the consumer. Its price equals to 80 €/MWh
- Wood logs – this is the most frequently used fuel source, with also the lowest price at around 15 €/MWh

However, all the above listed prices are based on the energy unit of fuel and not the produced heat. If the individual heating solutions are to be compared to the district heating system, where the customer pays for the heat delivered, the prices have to be based on the received heat unit, taking into account the annual efficiency of the individual boilers:

- Liquefied petroleum gas – the price of produced heat 90 €/MWh
- Fuel oil - the price of produced heat 105 €/MWh
- Wood logs – the price of produced heat 25 €/MWh

Despite high heat costs from natural gas and fuel oil, most of the citizens still use highly inexpensive biomass. Therefore advanced models will have to be applied in order to attract the potential consumers to connect to the district heating system. This includes the model of supplying the biomass to the district heating plant in order to lower the energy bills.

Initial investment and operating costs of the project

The investment costs of the proposed project have several major components, as shown in Table 2. It has to be noted that the assessed investment costs are turn-key. The overall investment cost equals to 21,614,400 €, with the highest investment being the biomass CHP plant, at 12,000,000 €. This is a relatively high investment because the project consists of several heat production technologies (biomass CHP, flat plate solar collectors and natural gas peak load boiler), as well as the seasonal thermal storage unit. The substations are also included in the investment cost since it is expected that the investor will finance it instead of the consumers, which is reflected in the price of heat being proposed for the consumers.

Table 2. Investment costs breakdown.

Investment parameter	Investment cost (€)
Planning, feasibility study and project documentation	25,000
Land for the DH plant	Free of charge (municipality input)
Civil works	200,000
CHP unit 10 MW_{th}	12,000,000
Natural gas peak load boiler 26 MW	1,750,000
Flat plate solar collectors 18,000 m^2	3,500,000
Seasonal thermal storage 20,000m^3	700,000
District heating network 8,798m	2,639,400
Heating stations	800,000
TOTAL	**21,614,400**

Regarding the operating costs of the project, feedstock costs have the highest share. All the operating costs are shown in Table 3. Both the cost of wood chips and natural gas have the assumed year to year price increase of 2%. The price increase of 1% is expected for the operation and maintenance and cost of labour, while 2% is expected for the costs of management, insurance and lease. The operation and maintenance costs are specific for each technology and are dependent on the number of working hours. The presented annual value is obtained by calculating and summing up operation and maintenance costs of all the production technologies. The sensitivity analysis has been performed in order to analyse the effect of increasing operation costs on the feasibility of the project and it showed that the business model can resist 25% increase in operating costs. The results of the sensitivity analysis are shown in Appendix.

Table 3. Operation costs breakdown

Operation parameter	Operation costs
Cost of wood chips	35 €/t
Cost of natural gas	0.63 €/m^3
Operation and maintenance cost	205,262 €/a
Cost of management, insurance and lease	1% of investment
Cost of labour	24,000 €/a

Heat price

When it comes to the revenues of the district heating project in Ozalj, sold heat is not the only source of revenue. Since one of the production units is a biomass CHP, sold electricity also represents a source of revenue. Even though there is currently no legislative which would define the subsidy for the electricity production from highly efficient cogeneration, as defined in the Energy Efficiency Law, it is known that the old way of incentivizing renewable project via feed in tariffs will not be implemented any more. Instead of that, feed in premiums will be used. However, the prices are still not known and therefore, for the purpose of this feasibility check, 70 €/MWh is the assumed electricity price, being sold to the national power grid. It has not been assumed to increase over the years despite its low initial value, since the electricity prices are decreasing constantly.

Since the heating sector in Ozalj currently consists of individual heating systems, there is no district heating system from which the reference heat price could be taken. Therefore, as the first step in the calculations, the price of heat from the district heating system in the nearby city of Karlovac has been taken into account. The suggested price consist of both the price for connection capacity and the price of energy. In order to simplify the calculation for the potential investors, it has been shown in €/MWh unit format. Since the project was feasible when calculated with the reference price from Karlovac, the heat price has been set to 70€/MWh, in order to achieve the internal rate of return of 12.05 % and the payback period of 9.69 years. The simulation was done for the period of 15 years.

Since the ownership model of the project will be a public private partnership, the potential private investor has to be attracted by a profit and therefore, the goal was to achieve lowest payback period, while still taking into account the local framework conditions and keeping the price of heat as low as possible. The year to year increase of the heat price has also been included in the calculations since the starting price is relatively low and the increasing feedstock prices could dictate the prices in the future. The increase equals to 1% annually.

If no profits were expected from the project, i.e. if the ownership model is based on a non-profit cooperative, the minimum heat price which could be achieved with the technical and financial assumptions made in the calculations is 63 €/MWh. This shows that the heat price is relatively low, but this is realistic if a high connection rate needs to be achieved.

Comparing the price of heat from the district heating system with the existing individual boilers, it is significantly lower than the natural gas and fuel oil individual heating, which is beneficial for the promotion of such a system. However, when biomass is used in the individual boilers, it still has much lower costs for the final consumer. This problem should be tackled by awareness campaigns regarding the environmental issues of using the individual biomass boilers, as well as by promoting the model in which the citizens can supply their own biomass to the district heating plant in order to reduce their energy bills.

Furthermore, as a way of stimulating the citizens to connect to a district heating system, no connection fees will be charged from them in the initial phase of the project. Consumers who connect after the first phase of the project will have to pay 4,000 € for the connection. Since the investment in substations is covered by the investor, there is a need to contractually ensure the consumption of the connected consumers in order to guarantee the investor the return on the investment from heat sales.

Financing options

As mentioned earlier, the project will be developed as a public private partnership. This means that the private investor will enter the project with their own funds. At least 20% of the investment should be covered by the private investor. It is than awarded a concession for the duration of 20 years during which it acts as a public utility supplying the heat to the final consumers.

Regarding the other 80% of the investment, it is expected that it will be funded by the Croatian Bank for Reconstruction and Development[4]. Specifically, it will be funded by the environmental protection investment loan, which offers favourable crediting conditions. The specifics of the loan assumed in the feasibility checks are: duration of loan is 14 years and the interest rate is 5%.

Licenses and permits required

When implementing the energy production projects in Croatia, the amount of licenses and permits which has to be gathered is relatively high. This results in long procedures and the overall implementation time is often more than one year. One of the drastic examples is the renewable district heating for the city of Pokupsko, where the implementation of the project lasted for 6 years, from the first documentation until the start of the plant operation.

It is relevant to mention that since the project is being developed as a public private partnership, it requires contracts between the public body, i.e. the municipality and the private owner in which all the terms are defined. Furthermore, since the project in question also implements a CHP unit, it will be necessary to acquire the status of the eligible electricity producer, which is given for the period of 14 years. This procedure can be divided into 5 main parts: preliminary energy approval; energy approval; preliminary decision on acquiring EP status; contract on the electricity purchase; and decision on acquiring EP status.

More detailed description of the necessary licenses and permits can be obtained in the Ozalj Business Model document.

Socio-environmental cost/benefits

There are significant social and environmental benefits of implementing a renewable district heating system in the city of Ozalj. Currently used imported fuels, i.e. natural gas and fuel oil will be replaced by the local resources in the form of biomass and solar energy. This will increase the sustainability of the city and further increase the life standard of its citizens. Also, the security of energy supply will be increased.

Furthermore, more than 50% of the existing individual heating systems use biomass as their primary fuel. Since most of these boilers are old and inefficient, the emissions of local pollutants, i.e. carbon monoxide, nitrous oxides and particulate matter is significant. This causes severe pollution during the winter months, which consequently leads to health

[4] https://www.hbor.hr/kreditni_program/zastita-okolisa/

problems among the population. Therefore, switching to a renewable and highly efficient district heating system will lower the health costs and increase the air quality in the city.

The installation of a new district heating system in the city will also support the employment rate, by directly employing 2 people. Other local companies will benefit from the installation works, production of equipment, etc. Forest residues will be used as the feedstock for the district heating plant, therefore the maintenance of the local forest will be increased, resulting in higher quality soil and improved vegetation.

It has been calculated that replacing the individual heating with the proposed district heating system in Ozalj would lower the CO_2 emissions by 4.380 tonnes annually. Furthermore, it has been shown for a similar scenario[5] that district heating implementation lowers the local pollutant emissions by more than 90% compared to the current situation.

4 Executive summary for policy makers (in English)

Heating and cooling is the most energy intensive sector in the European Union, with around 50 % of final energy being consumed in it. However, only 13 % of the European heat demand is covered by district heating technologies. This shows the great potential for improvement, since these systems offer a clean and efficient way of supplying the heat to the final consumers. In order to achieve the greenhouse gas reduction goals until 2050, heat will have to be produced as efficient as possible, by utilising renewable energy sources. This has been recognized by the European Commission, which passed the first heating and cooling strategy in February 2016, in which it strongly promotes the use of district heating systems specifically if the energy source being used is renewable.

Regarding the district heating sector in Croatia, the situation is rather similar to the European level, with around 14% of heat being supplied from these systems. However, the potential is much higher. Currently, the majority of heat consumers use individual heating systems, mostly fired by fossil fuels (i.e. fuel oil and natural gas) and biomass, especially in the rural areas. Although biomass can be considered a renewable fuel, it is burned in old and inefficient boilers, resulting in high emissions of local pollutants, which can cause severe air pollution in the surrounding area. Therefore, individual heating should be replaced by collective heating systems, i.e. district heating based on renewable energy sources, wherever this is technically possible. Certain levels of heat demand density have to be achieved for this. Nevertheless, it has been proven by calculations done as a part of the CoolHeating project that even small rural cities like Ozalj have high enough heat demand densities to cover high shares of the demand with a district heating system. A lot of best practice examples for renewable district heating systems already exist in Europe, but also in Croatia as shown in Best practice examples report[6].

Ozalj represents the Croatian target city in the CoolHeating project and is also a typical rural city in Croatia. This means that the results of the project can easily be replicated to other similar cities in the region. Throughout the project, several analyses have been performed, providing the highly valuable input data for the feasibility checks. One of the main outputs were the results of the survey carried out among the citizens. They provided data on energy consumption, citizen opinions towards district heating systems, their current costs, etc. This was used in order to map the heating demand of the city and to devise the scenarios for heat supply.

The second step was to analyse different technologies which could cover the demand. The chosen combination of technologies included flat plate solar collectors, biomass CHP and natural gas peak load boiler. CHP is an interesting technology since it increases the feasibility of the project due to dual revenues, both from the electricity and heat sales. Furthermore, subsidies can be received for electricity production from highly efficient cogeneration facilities.

[5] http://www.mdpi.com/1996-1073/11/3/575
[6] http://www.coolheating.eu/images/downloads/D2.1_Best_Practice.pdf

The production from these units has been optimized using the energyPRO software. Furthermore, these results have been used to calculate the feasibility of the proposed project. Under the given assumptions regarding the heat and electricity prices, both at 70 €/MWh and investment and cost data gathered from technology data sheets, the project showed to be feasible, with a payback period of 9.69 years and the internal rate of return of 12.05%. Therefore, the investor can return his investment and make a profit in the given project period of 15 years. The heat price which could be achieved for the final consumers is competitive compared to the fossil fuelled boilers, while lower costs of individual biomass heating can be tackled by implementing a biomass to heat model, which would lower the energy bills in exchange for delivered biomass for the production plant. Therefore, district heating implementation results both in the economic and environmental benefits for the city.

The main policy recommendations which could be drawn are that incentives are needed also for renewable heat production, since they are currently given only for the electricity production technologies.

5 Executive summary for policy makers (in Croatian)

Grijanje i hlađenje predstavlja energetski najintenzivniji sektor u Europskoj uniji, pri čemu se u te svrhe troši oko 50% finalne energije. Međutim, samo 13% europskih toplinskih potreba pokriva se centraliziranim toplinskim sustavima. Ovo pokazuje veliki potencijal za daljnjim povećanjem udjela, budući da ovi sustavi nude ekološki prihvatljiv i učinkovit način opskrbe toplinom krajnjih potrošača. Kako bi se postigli ciljevi smanjenja emisija stakleničkih plinova do 2050. godine, toplina će morati biti proizvedena što je moguće učinkovitije korištenjem obnovljivih izvora energije. To je prepoznala i Europska komisija, koja je u veljači 2016 objavila prvu strategiju grijanja i hlađenja, u kojoj snažno promiče korištenje centraliziranih toplinskih sustava, posebno ako je izvor energije koji se koristi obnovljiv.

Što se tiče sektora toplinarstva u Hrvatskoj, situacija je slična europskoj razini, pri čemu se oko 14% toplinskih potreba pokriva proizvodnjom u ovim sustavima. Međutim, potencijal je mnogo veći. Trenutno, većina potrošača topline koristi individualne sustave grijanja, koja uglavnom koriste fosilna goriva i biomasu, posebno u ruralnim područjima. Iako se biomasa može smatrati obnovljivim gorivom, spaljuje se u starim i neučinkovitim kotlovima, što rezultira visokim emisijama onečišćujućih tvari. To može uzrokovati ozbiljno onečišćenje zraka u okolici. Stoga, individualno grijanje treba zamijeniti centraliziranim toplinskim sustavima temeljenim na obnovljivim izvorima energije, gdje god je to tehnički moguće. Za to je potrebno postići određene razine gustoće toplinskih potreba. Međutim, u sklopu proračuna koji su napravljeni u CoolHeating projektu, dokazano je da čak i mali ruralni gradovi poput Ozlja imaju dovoljno visoku gustoću toplinskih potreba kako bi visok udio svojih potreba mogli pokriti proizvodnjom iz centraliziranih toplinskih sustava. U Europi postoji već mnogo primjera najbolje prakse obnovljivih centraliziranih toplinskih sustava, ali primjeri postoje i u Hrvatskoj, kao što je prikazano u izvješću o primjerima najbolje prakse.

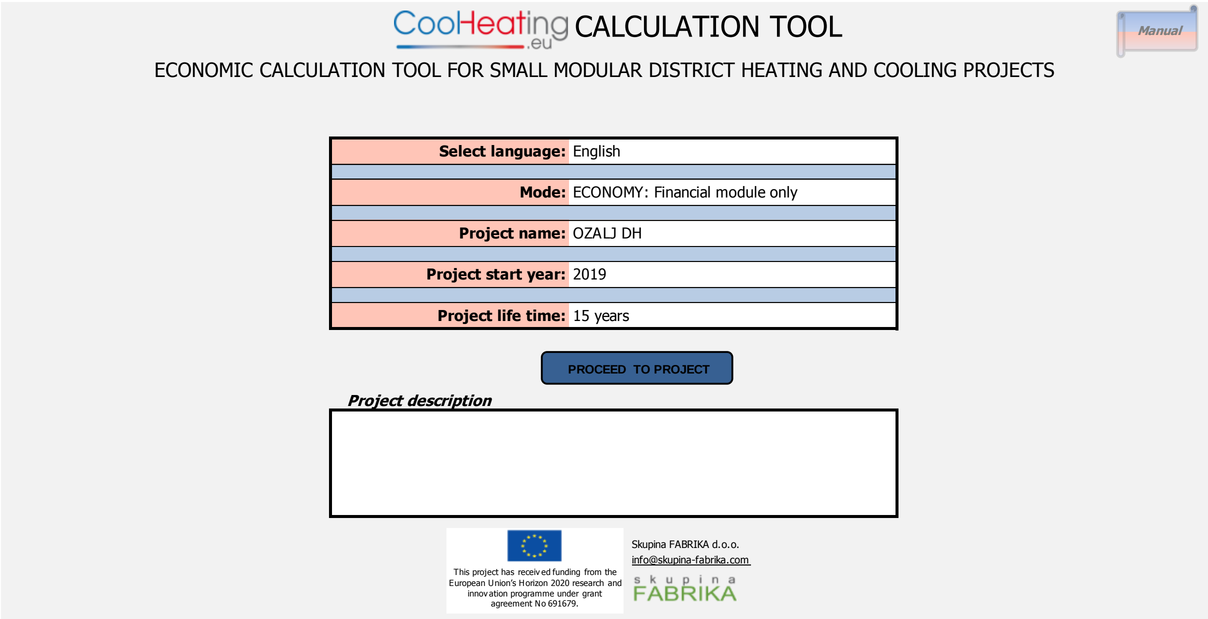
Ozalj predstavlja hrvatski ciljani grad u projektu CoolHeating i tipičan hrvatski ruralni grad. To znači da se rezultati projekta lako mogu replicirati u druge slične gradove u regiji. Tijekom cijelog projekta provedeno je nekoliko analiza, pružajući vrlo vrijedne ulazne podatke za provjere izvedivosti. Jedan od glavnih rezultata bili su rezultati ankete provedene među građanima. Oni su dali podatke o potrošnji energije, mišljenjima građana prema centraliziranim toplinskim sustavima, njihovim godišnjim troškovima za grijanje, itd. Ti podaci su korišteni za mapiranje toplinskih potreba grada te razvoj scenarija za proizvodnju topline.

Drugi je korak bio analizirati različite tehnologije proizvodnje toplinske energije. Odabrana kombinacija tehnologija uključuje pločaste solarne kolektore, kogeneracijsko postrojenje na biomasu i kotlove na prirodni plin za pokrivanje vršnog opterećenja. Kogeneracija je zanimljiva tehnologija jer povećava isplativost projekta zbog više izvora prihoda, kako od prodaje električne energije tako i od prodaje toplinske energije. Nadalje, subvencije se mogu dobiti za proizvodnju električne energije iz visoko učinkovitih kogeneracijskih postrojenja. Proizvodnja iz tih jedinica optimizirana je korištenjem softvera energyPRO. Nadalje, ovi rezultati korišteni su za izračunavanje izvedivosti predloženog projekta. Pod navedenim pretpostavkama o cijenama toplinske i električne energije (obje cijene pretpostavljene 70 €/MWh), kao i o podacima o investicijskim troškovima prikupljenim iz raznih kataloga, projekt se pokazao isplativim s periodom povrata investicije od 9,69 godina i unutarnjom stopom povrata od 12,05 %. Stoga investitor može vratiti isplatiti investiciju i ostvariti dobit u zadanom vijeku trajanja od 15 godina. Niski trošak individualnog grijanja biomasom se može riješiti primjenom modela u kojem potrošači prodaju biomasu operatoru centraliziranog toplinskog sustava, što bi smanjilo račune za toplinu u zamjenu za isporučenu biomasu. Stoga, implementacija centraliziranog toplinskog sustava rezultira i ekonomskim i ekološkim prednostima za grad.

Glavne legislativne preporuke koje se mogu dati s obzirom na trenutnu situaciju su da su poticaji također potrebni za proizvodnju toplinske energije iz obnovljivih izvora energije, s obzirom da se trenutno daju samo za proizvodnju električne energije.

6 Appendix

6.1 Simulation results from Economic calculation tool for small modular district heating and cooling projects



Projected investment cost in €	Value	Share %
1. Buildings and construction works	200.000	0,9%
2. Plot	0	0,0%
3. Equipment/Machinery	21.389.400	99,0%
A. PROPERTY, PLANT AND EQUIPMENT	**21.589.400**	**99,9%**
B. PROJECT AND INVESTMENT DOCUMENTATION	**25.000**	**0,1%**
C. INTANGIBLE ASSETS	**0**	**0,0%**
D. INVESTMENT COST (A+B+C)	**21.614.400**	**100,0%**
E. INITIAL WORKING CAPITAL	**0**	**0,0%**
F. TOTAL INVESTMENT COST (D+E)	**21.614.400**	**100,0%**

Sources of investment cost financing in €	Value	Share %
A. PRIVATE EQUITY	**4.322.400**	**20,0%**
B. BANK LOANS	**17.292.000**	**80,0%**
C. CONNECTION FEES	**0**	**0,0%**
D. INVESTMENT SUBSIDIES	**0**	**0,0%**
E. TOTAL FINANCING (A+B+C+D)	**21.614.400**	**100,0%**

Source of revenue in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. ELECTRICITY REVENUES	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520	695.520
2. HEAT REVENUES	2.922.850	2.952.079	2.981.599	3.011.415	3.041.529	3.071.945	3.102.664	3.133.691	3.165.028	3.196.678	3.228.645	3.260.931	3.293.541	3.326.476	3.359.741
3. OPERATING SUBSIDIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. GROSS OPERATING REVENUES	**3.618.370**	**3.647.599**	**3.677.119**	**3.706.935**	**3.737.049**	**3.767.465**	**3.798.184**	**3.829.211**	**3.860.548**	**3.892.198**	**3.924.165**	**3.956.451**	**3.989.061**	**4.021.996**	**4.055.261**
1. INVESTMENT SUBSIDIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. FINANCIAL REVENUES	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100
3. OTHER REVENUES	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100
B. OTHER SOURCES OF REVENUES	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**200**	**200**	**200**	**200**	**200**
C. TOTAL REVENUES (A + B)	**3.618.370**	**3.647.599**	**3.677.119**	**3.706.935**	**3.737.049**	**3.767.465**	**3.798.184**	**3.829.211**	**3.860.548**	**3.892.198**	**3.924.365**	**3.956.651**	**3.989.261**	**4.022.196**	**4.055.461**

Cost type in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Energy source costs	627.738	640.293	653.098	666.160	679.484	693.073	706.935	721.073	735.495	750.205	765.209	780.513	796.123	812.046	828.287
2. Operation and maintainance costs	205.262	207.315	209.388	211.482	213.596	215.732	217.890	220.069	222.269	224.492	226.737	229.004	231.294	233.607	235.943
A. TOTAL OPERATING COSTS (1+2)	**833.000**	**847.607**	**862.486**	**877.642**	**893.080**	**908.806**	**924.825**	**941.142**	**957.764**	**974.697**	**991.946**	**1.009.517**	**1.027.418**	**1.045.653**	**1.064.230**
1. Cost of management, insurance and lease	215.894	220.212	224.616	229.108	233.691	238.364	243.132	247.994	252.954	258.013	263.174	268.437	273.806	279.282	284.868
2. Cost of promotional activities	0	0	0	0	0	0	0	0	0	0	5.000	5.000	5.000	5.000	5.000
3. Cost of other services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. TOTAL COSTS OF SERVICES (1+2+3)	**215.894**	**220.212**	**224.616**	**229.108**	**233.691**	**238.364**	**243.132**	**247.994**	**252.954**	**258.013**	**268.174**	**273.437**	**278.806**	**284.282**	**289.868**
C. COSTS OF LABOUR	**24.000**	**24.240**	**24.482**	**24.727**	**24.974**	**25.224**	**25.476**	**25.731**	**25.989**	**26.248**	**26.511**	**26.776**	**27.044**	**27.314**	**27.587**
D. DEPRECIATION AND AMORTIZATION COSTS	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**
E. FINANCIAL COSTS	**844.724**	**799.946**	**752.877**	**703.401**	**651.392**	**596.724**	**539.258**	**478.852**	**415.355**	**348.610**	**278.450**	**204.701**	**127.179**	**45.690**	**0**
F. OTHER EXPENSES AND LOSSES	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
G. INCOME TAXES	**155.008**	**168.718**	**182.984**	**197.834**	**213.298**	**229.407**	**246.193**	**263.693**	**281.941**	**300.977**	**319.641**	**340.375**	**362.024**	**384.634**	**398.264**
H. TOTAL COSTS (A+B+C+D+E+F+G)	**3.153.346**	**3.141.443**	**3.128.166**	**3.113.433**	**3.097.156**	**3.079.245**	**3.059.604**	**3.038.132**	**3.014.724**	**2.989.266**	**2.965.442**	**2.935.527**	**2.903.190**	**2.868.293**	**2.860.669**

Inventories in stock and resources needed in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. Average days of inventory	60,0														
B. Inventory turnover ratio	6,08														
C. INVENTORIES IN STOCK ON 31ST OF DECEMBER	136.931	139.333	141.779	144.270	146.808	149.393	152.026	154.708	157.441	160.224	163.060	165.948	168.891	171.888	174.942
D. RESOURCES NEEDED TO FINANCE INVENTORIES	22.509	22.904	23.306	23.716	24.133	24.558	24.991	25.432	25.881	26.338	26.804	27.279	27.763	28.256	28.758

Accounts receivable and resources needed in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. Accounts receivable collection period	30,0														
B. Accounts receivable turnover ratio	12,17														
C. ACCOUNTS RECEIVABLE ON 31ST OF DECEMBER	297.400	299.803	302.229	304.680	307.155	309.655	312.180	314.730	317.305	319.907	322.534	325.188	327.868	330.575	333.309
D. RESOURCES NEEDED TO FINANCE THE ACCOUNTS RECEIVABLE	24.444	24.641	24.841	25.042	25.246	25.451	25.659	25.868	26.080	26.294	26.510	26.728	26.948	27.171	27.395
E. LONG-TERM ACCOUNTS RECEIVABLE ON 31ST OF DECEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Depreciation cost in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. INTANGIBLE ASSETS	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
1. Buildings and constructions	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
2. Equipment, plant, vehicles, mechanization	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720
B. TOTAL PROPERTY, PLANT AND EQUIPMENT (1+2)	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**
C. TOTAL (A+B)	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**	**1.080.720**

Fixes assets value on 31st of December in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. INTANGIBLE ASSETS	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
1. Buildings and constructions	190.000	180.000	170.000	160.000	150.000	140.000	130.000	120.000	110.000	100.000	90.000	80.000	70.000	60.000	50.000
2. Equipment, plant, vehicles, mechanization	20.343.680	19.272.960	18.202.240	17.131.520	16.060.800	14.990.080	13.919.360	12.848.640	11.777.920	10.707.200	9.636.480	8.565.760	7.495.040	6.424.320	5.353.600
B. TOTAL PROPERTY, PLANT AND EQUIPMENT (1+2)	**20.533.680**	**19.452.960**	**18.372.240**	**17.291.520**	**16.210.800**	**15.130.080**	**14.049.360**	**12.968.640**	**11.887.920**	**10.807.200**	**9.726.480**	**8.645.760**	**7.565.040**	**6.484.320**	**5.403.600**
C. TOTAL (A+B)	**20.533.680**	**19.452.960**	**18.372.240**	**17.291.520**	**16.210.800**	**15.130.080**	**14.049.360**	**12.968.640**	**11.887.920**	**10.807.200**	**9.726.480**	**8.645.760**	**7.565.040**	**6.484.320**	**5.403.600**

Accounts payable and deliveries financed by suppliers in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. Days payable	30,0														
B. Accounts payable turnover ratio	12,17														
C. ACCOUNTS PAYABLE ON 31ST OF DECEMBER	86.210	87.766	89.351	90.966	92.611	94.288	95.996	97.737	99.511	101.319	103.571	105.448	107.361	109.310	111.296
D. DELIVERIES FINANCED BY SUPPLIERS	7.086	7.214	7.344	7.477	7.612	7.750	7.890	8.033	8.179	8.328	8.513	8.667	8.824	8.984	9.148
E. LONG-TERM ACCOUNTS PAYABLE ON 31ST OF DECEMBER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Working capital requirements in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Resources needed to finance inventories	22.509	22.904	23.306	23.716	24.133	24.558	24.991	25.432	25.881	26.338	26.804	27.279	27.763	28.256	28.758
2. Resources needed to finance the accounts receivable	24.444	24.641	24.841	25.042	25.246	25.451	25.659	25.868	26.080	26.294	26.510	26.728	26.948	27.171	27.395
3. Deliveries financed by suppliers	7.086	7.214	7.344	7.477	7.612	7.750	7.890	8.033	8.179	8.328	8.513	8.667	8.824	8.984	9.148
A. WORKING CAPITAL SURPLUS (+) OR DEFICIT (-) (3-2-1)	**-39.867**	**-40.332**	**-40.803**	**-41.281**	**-41.766**	**-42.259**	**-42.759**	**-43.266**	**-43.782**	**-44.304**	**-44.801**	**-45.340**	**-45.887**	**-46.442**	**-47.005**

Debt financing	Prinicpal in €	Interest rate	Repayment starting year	Number of instalments
Loan 1	17.292.000	5,00%	2019	168
Bridge financing	**Prinicpal in €**	**Interest rate**	**Payment due after**	**Number of instalments**
Bridge financing loan	0			
TOTAL LOANS in €	**17.292.000**			

Trend of loans and payment of principal and interest in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. TOTAL LOAN BALANCE ON 31ST OF DECEMBER	**16.416.784**	**15.496.790**	**14.529.727**	**13.513.188**	**12.444.640**	**11.321.424**	**10.140.742**	**8.899.654**	**7.595.069**	**6.223.739**	**4.782.250**	**3.267.011**	**1.674.250**	**0**	**0**
Annual Loan 1 payments	875.216	919.994	967.063	1.016.539	1.068.547	1.123.216	1.180.682	1.241.088	1.304.585	1.371.330	1.441.489	1.515.239	1.592.761	1.674.250	0
Bridge financing loan payments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. TOTAL ANNUAL LOAN PAYMENTS	**875.216**	**919.994**	**967.063**	**1.016.539**	**1.068.547**	**1.123.216**	**1.180.682**	**1.241.088**	**1.304.585**	**1.371.330**	**1.441.489**	**1.515.239**	**1.592.761**	**1.674.250**	**0**
Annual payments of interests on Loan 1	844.724	799.946	752.877	703.401	651.392	596.724	539.258	478.852	415.355	348.610	278.450	204.701	127.179	45.690	0
Annual payments of interests on bridge financing loan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. TOTAL ANNUAL PAYMENTS OF INTERESTS ON LOANS	**844.724**	**799.946**	**752.877**	**703.401**	**651.392**	**596.724**	**539.258**	**478.852**	**415.355**	**348.610**	**278.450**	**204.701**	**127.179**	**45.690**	**0**

Shareholders equity in € on 31st of December	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Owner's equity	4.322.400	4.787.424	5.293.579	5.842.532	6.436.035	7.075.929	7.764.149	8.502.729	9.293.808	10.139.632	11.042.564	12.001.487	13.022.612	14.108.683	15.262.585
2. Retained earnings	465.024	506.155	548.953	593.503	639.894	688.220	738.580	791.079	845.824	902.932	958.923	1.021.125	1.086.071	1.153.903	1.194.792
TOTAL EQUITY (1 to 2)	**4.787.424**	**5.293.579**	**5.842.532**	**6.436.035**	**7.075.929**	**7.764.149**	**8.502.729**	**9.293.808**	**10.139.632**	**11.042.564**	**12.001.487**	**13.022.612**	**14.108.683**	**15.262.585**	**16.457.377**

Acquisition and consumption of investment subsidies in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Subsidies	0														
2. Subsidized fixed assets on 31st of December	21.614.400	20.533.680	19.452.960	18.372.240	17.291.520	16.210.800	15.130.080	14.049.360	12.968.640	11.887.920	10.807.200	9.726.480	8.645.760	7.565.040	6.484.320
3. Share of subsidies in subsidized fixed assets	0,0%														
4. Depreciation cost	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720
5. Other sources of revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LONG-TERM ACCRUED COSTS AND DEFERRED REVENUES ON 31ST OF DECEMBER	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Income statement in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Total operating income	3.618.370	3.647.599	3.677.119	3.706.935	3.737.049	3.767.465	3.798.184	3.829.211	3.860.548	3.892.198	3.924.165	3.956.451	3.989.061	4.021.996	4.055.261
2. Investment subsidies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Total cost of goods and services	1.048.894	1.067.819	1.087.102	1.106.751	1.126.771	1.147.170	1.167.956	1.189.136	1.210.718	1.232.710	1.260.119	1.282.954	1.306.224	1.329.935	1.354.098
a) Total operating costs	833.000	847.607	862.486	877.642	893.080	908.806	924.825	941.142	957.764	974.697	991.946	1.009.517	1.027.418	1.045.653	1.064.230
1. Energy source costs	627.738	640.293	653.098	666.160	679.484	693.073	706.935	721.073	735.495	750.205	765.209	780.513	796.123	812.046	828.287
2. Operation and maintainance costs	205.262	207.315	209.388	211.482	213.596	215.732	217.890	220.069	222.269	224.492	226.737	229.004	231.294	233.607	235.943
b) Total cost of operating services	215.894	220.212	224.616	229.108	233.691	238.364	243.132	247.994	252.954	258.013	268.174	273.437	278.806	284.282	289.868
1. Cost of management, insurance and lease	215.894	220.212	224.616	229.108	233.691	238.364	243.132	247.994	252.954	258.013	263.174	268.437	273.806	279.282	284.868
2. Cost of promotional activities	0	0	0	0	0	0	0	0	0	0	5.000	5.000	5.000	5.000	5.000
3. Cost of other services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Cost of labour	24.000	24.240	24.482	24.727	24.974	25.224	25.476	25.731	25.989	26.248	26.511	26.776	27.044	27.314	27.587
EBITDA	***70,35%***	***70,06%***	***69,77%***	***69,48%***	***69,18%***	***68,88%***	***68,58%***	***68,27%***	***67,97%***	***67,65%***	***67,21%***	***66,90%***	***66,58%***	***66,25%***	***65,93%***
5. Depreciation and amortization	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720
1. Intangible assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Property, plant and equipment	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720
2.1. Buildings and constructions	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
2.2. Equipment, plant, vehicles, mechanization	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720	1.070.720
EBIT	***40,48%***	***40,43%***	***40,38%***	***40,32%***	***40,26%***	***40,20%***	***40,13%***	***40,05%***	***39,97%***	***39,89%***	***39,67%***	***39,58%***	***39,48%***	***39,38%***	***39,28%***
6. Revenues from financial activities	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100
7. Financial costs	844.724	799.946	752.877	703.401	651.392	596.724	539.258	478.852	415.355	348.610	278.450	204.701	127.179	45.690	0
8. Other revenues and gains	0	0	0	0	0	0	0	0	0	0	100	100	100	100	100
9. Other expenses and losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. INCOME BEFORE TAXES	**620.033**	**674.873**	**731.937**	**791.337**	**853.192**	**917.627**	**984.774**	**1.054.771**	**1.127.765**	**1.203.909**	**1.278.564**	**1.361.500**	**1.448.095**	**1.538.537**	**1.593.056**
EBT	***17,14%***	***18,50%***	***19,91%***	***21,35%***	***22,83%***	***24,36%***	***25,93%***	***27,55%***	***29,21%***	***30,93%***	***32,58%***	***34,41%***	***36,30%***	***38,25%***	***39,28%***
11. Income taxes	155.008	168.718	182.984	197.834	213.298	229.407	246.193	263.693	281.941	300.977	319.641	340.375	362.024	384.634	398.264
12. NET INCOME	**465.024**	**506.155**	**548.953**	**593.503**	**639.894**	**688.220**	**738.580**	**791.079**	**845.824**	**902.932**	**958.923**	**1.021.125**	**1.086.071**	**1.153.903**	**1.194.792**
13. Number of employees	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Balance sheet on 31st of December in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. FIXED ASSETS	**20.533.680**	**19.452.960**	**18.372.240**	**17.291.520**	**16.210.800**	**15.130.080**	**14.049.360**	**12.968.640**	**11.887.920**	**10.807.200**	**9.726.480**	**8.645.760**	**7.565.040**	**6.484.320**	**5.403.600**
I. Intangible assets and long-term deferred costs and accrued revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II. Property, plant and equipment	20.533.680	19.452.960	18.372.240	17.291.520	16.210.800	15.130.080	14.049.360	12.968.640	11.887.920	10.807.200	9.726.480	8.645.760	7.565.040	6.484.320	5.403.600
1. Buildings and constructions	190.000	180.000	170.000	160.000	150.000	140.000	130.000	120.000	110.000	100.000	90.000	80.000	70.000	60.000	50.000
2. Equipment, plant, vehicles, mechanization	20.343.680	19.272.960	18.202.240	17.131.520	16.060.800	14.990.080	13.919.360	12.848.640	11.777.920	10.707.200	9.636.480	8.565.760	7.495.040	6.424.320	5.353.600
III. Long-term accounts receivable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. CURRENT ASSETS	**756.739**	**1.425.175**	**2.089.371**	**2.748.669**	**3.402.381**	**4.049.781**	**4.690.108**	**5.322.559**	**5.946.292**	**6.560.422**	**7.160.828**	**7.749.311**	**8.325.253**	**8.887.575**	**11.165.073**
I. Inventories	136.931	139.333	141.779	144.270	146.808	149.393	152.026	154.708	157.441	160.224	163.060	165.948	168.891	171.888	174.942
II. Accounts receivable	297.400	299.803	302.229	304.680	307.155	309.655	312.180	314.730	317.305	319.907	322.534	325.188	327.868	330.575	333.309
III. Cash and cash equivalents	322.407	986.040	1.645.363	2.299.719	2.948.418	3.590.734	4.225.902	4.853.121	5.471.546	6.080.291	6.675.235	7.258.175	7.828.495	8.385.112	10.656.821
TOTAL ASSETS	**21.290.419**	**20.878.135**	**20.461.611**	**20.040.189**	**19.613.181**	**19.179.861**	**18.739.468**	**18.291.199**	**17.834.212**	**17.367.622**	**16.887.308**	**16.395.071**	**15.890.293**	**15.371.895**	**16.568.673**
A. OWNER'S EQUITY	**4.787.424**	**5.293.579**	**5.842.532**	**6.436.035**	**7.075.929**	**7.764.149**	**8.502.729**	**9.293.808**	**10.139.632**	**11.042.564**	**12.001.487**	**13.022.612**	**14.108.683**	**15.262.585**	**16.457.377**
B. PROVISIONS AND LONG-TERM ACCRUED COSTS AND DEFERRED REVENUES	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
C. LONG-TERM LIABILITIES	**15.496.790**	**14.529.727**	**13.513.188**	**12.444.640**	**11.321.424**	**10.140.742**	**8.899.654**	**7.595.069**	**6.223.739**	**4.782.250**	**3.267.011**	**1.674.250**	**0**	**0**	**0**
I. Long-term financial liabilities	15.496.790	14.529.727	13.513.188	12.444.640	11.321.424	10.140.742	8.899.654	7.595.069	6.223.739	4.782.250	3.267.011	1.674.250	0	0	0
II. Long-term accounts payable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. CURRENT LIABILITIES	**1.006.204**	**1.054.829**	**1.105.890**	**1.159.513**	**1.215.828**	**1.274.970**	**1.337.085**	**1.402.322**	**1.470.841**	**1.542.808**	**1.618.810**	**1.698.210**	**1.781.611**	**109.310**	**111.296**
I. Short-term financial liabilities	919.994	967.063	1.016.539	1.068.547	1.123.216	1.180.682	1.241.088	1.304.585	1.371.330	1.441.489	1.515.239	1.592.761	1.674.250	0	0
II. Accounts payable	86.210	87.766	89.351	90.966	92.611	94.288	95.996	97.737	99.511	101.319	103.571	105.448	107.361	109.310	111.296
TOTAL LIABILITIES AND OWNER'S EQUITY	**21.290.419**	**20.878.135**	**20.461.611**	**20.040.189**	**19.613.181**	**19.179.861**	**18.739.468**	**18.291.199**	**17.834.212**	**17.367.622**	**16.887.308**	**16.395.071**	**15.890.293**	**15.371.895**	**16.568.673**

Cash-flow statement in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. CASH FLOW FROM OPERATING ACTIVITIES															
1. Income before taxes	620.033	674.873	731.937	791.337	853.192	917.627	984.774	1.054.771	1.127.765	1.203.909	1.278.564	1.361.500	1.448.095	1.538.537	1.593.056
2. Depreciation and amortization	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720
3. Income taxes	-155.008	-168.718	-182.984	-197.834	-213.298	-229.407	-246.193	-263.693	-281.941	-300.977	-319.641	-340.375	-362.024	-384.634	-398.264
4. Decrease (- increase) in accounts receivable	-297.400	-2.402	-2.426	-2.451	-2.475	-2.500	-2.525	-2.550	-2.576	-2.601	-2.627	-2.654	-2.680	-2.707	-2.734
5. Decrease (- increase) in inventories	-136.931	-2.401	-2.446	-2.491	-2.538	-2.585	-2.633	-2.682	-2.732	-2.783	-2.835	-2.888	-2.943	-2.998	-3.054
6. Increase (- decrease) in accounts payable	86.210	1.556	1.585	1.615	1.645	1.677	1.708	1.741	1.774	1.808	2.253	1.877	1.913	1.949	1.986
7. Financial costs	844.724	799.946	752.877	703.401	651.392	596.724	539.258	478.852	415.355	348.610	278.450	204.701	127.179	45.690	0
8. Income related to long-term accrued costs and deferred revenues (subsidies)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net cash flow from operating activities	**2.042.347**	**2.383.573**	**2.379.263**	**2.374.296**	**2.368.639**	**2.362.255**	**2.355.108**	**2.347.159**	**2.338.365**	**2.328.685**	**2.314.883**	**2.302.881**	**2.290.259**	**2.276.557**	**2.271.710**
B. CASH FLOW FROM INVESTING ACTIVITIES															
1. Receipts (+) and disbursements (-) in intangible assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Receipts (+) and disbursements (-) in property, plant and equipment	-21.614.400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net cash flow from investing activities	**-21.614.400**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
C. CASH FLOW FROM FINANCING ACTIVITIES															
1. Receipts from capital pay-in (+) and dividends paid (-)	4.322.400	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Receipts (+) and disbursements (-) in financial liabilities and accrued costs and deferred revenues	15.572.060	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	-1.719.940	0
Net cash flow from financing activities	**19.894.460**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**-1.719.940**	**0**
D. NET BALANCE IN CASH AND CASH EQUIVALENTS															
1. Net cash flow	322.407	663.633	659.323	654.356	648.699	642.315	635.168	627.219	618.425	608.745	594.943	582.941	570.319	556.617	2.271.710
2. Cash and cash equivalents, beginning of year	0	322.407	986.040	1.645.363	2.299.719	2.948.418	3.590.734	4.225.902	4.853.121	5.471.546	6.080.291	6.675.235	7.258.175	7.828.495	8.385.112
3. Cash and cash equivalents, end of year	**322.407**	**986.040**	**1.645.363**	**2.299.719**	**2.948.418**	**3.590.734**	**4.225.902**	**4.853.121**	**5.471.546**	**6.080.291**	**6.675.235**	**7.258.175**	**7.828.495**	**8.385.112**	**10.656.821**

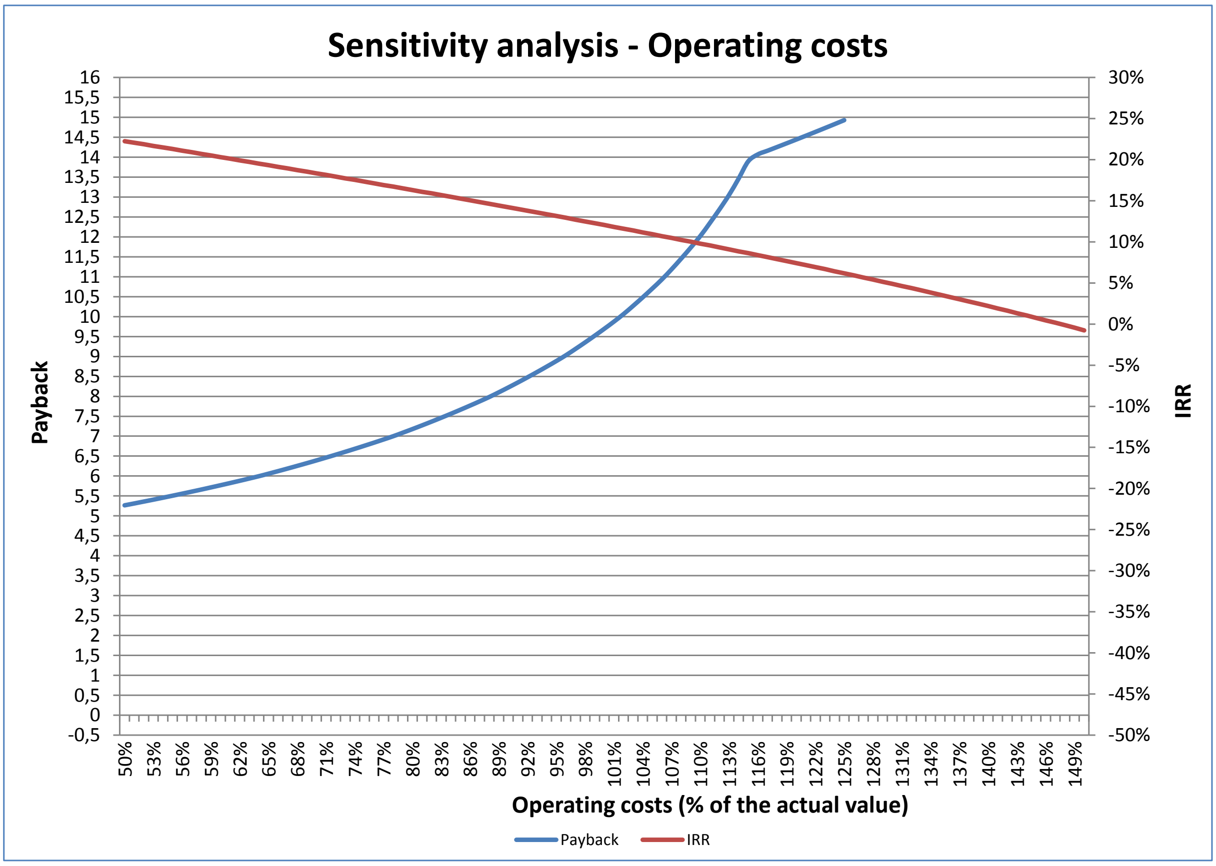
Profitability	Cash flow
Initial capital investment (discounted for received subsidies)	21.614.400,00
Private equity invested	4.322.400,00
Equity net present value (NPV)	**2.168.343,88**
Equity internal rate of return (IRR)	**12,05%**

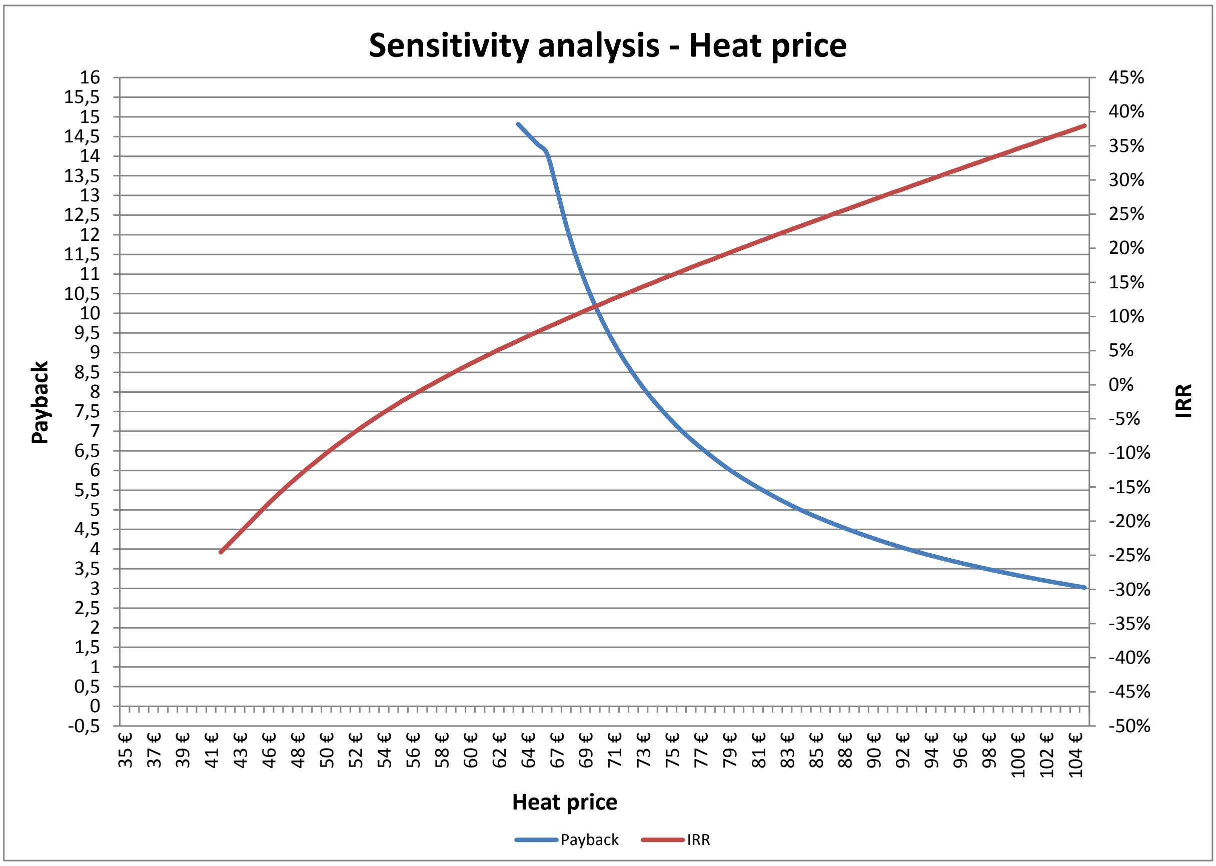
CASH FLOW in €		**Discount rate:** 6,00%
Year	**Cash flow**	**Discounted Cash flow**
C0	-4.322.400	-4.322.400
CF1	322.407	304.157
CF2	663.633	590.631
CF3	659.323	553.580
CF4	654.356	518.312
CF5	648.699	484.746
CF6	642.315	452.807
CF7	635.168	422.423
CF8	627.219	393.525
CF9	618.425	366.045
CF10	608.745	339.920
CF11	594.943	313.409
CF12	582.941	289.704
CF13	570.319	267.388
CF14	556.617	246.192
CF15	2.271.710	947.905
TOTAL	**6.334.421**	**Payback: 9,69 years**

Project performance in €	2019	2020	2021	2022	2023
1. Total income	3.618.370	3.647.599	3.677.119	3.706.935	3.737.049
2. Total costs of goods and services	1.048.894	1.067.819	1.087.102	1.106.751	1.126.771
3. Cost of labour	24.000	24.240	24.482	24.727	24.974
4. Depreciation and amortization	1.080.720	1.080.720	1.080.720	1.080.720	1.080.720
5. Financial costs	844.724	799.946	752.877	703.401	651.392
6. Other costs	0	0	0	0	0
7. EBT	620.033	674.873	731.937	791.337	853.192

Balance sum	21.290.419	20.878.135	20.461.611	20.040.189	19.613.181
Cash Flow	322.407	663.633	659.323	654.356	648.699
Cost of MWh heat sold	76	75	75	75	74
Cost of MWh energy sold (heat + electricity)	61	61	61	60	60

Private equity invested	4.322.400 €
Net present value (NPV)	2.168.344 €
Equity internal rate of return (IRR)	12,05%
Payback (discount rate: 6%)	9,69 years




Sensitivity analysis - Heat price
Payback
IRR
Heat price
Payback
IRR