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 Cven

Municipality of Ljutomer (Slovenia)

District heating in the Cven settlement in the Municipality of Cven

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CoolHeating website: www.coolheating.eu

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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 the Cven settlement in the Municipality of Ljutomer presents the results of checking the feasibility of the technical concept and individual business model of the potential project. 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 the business model and this feasibility check will be needed.

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

2 Technology assessment

The technical assessment in the Cven settlement in the Municipality of Ljutomer included one potential project. For this project, a technical concept was elaborated that includes the heat/cold and electricity (CHP) generation, heat distribution, and the heat use.

In 2016 the Ljutomer Municipality defined the Cven settlement as one of the most prospective locations for a potential new DH project. The location is a relatively small settlement with few industries and some public buildings. The objects in Cven are mainly heated by biomass and heating oil. About 40% of the households are heating with logwood, 15% with natural gas and 13% with both logwood and heating oil. About 22% of the households are producing their

[1] Source: 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).

domestic hot water with electricity, 22% with logwood and 19% with natural gas. 65% of the households have no cooling needs.[2]

The use of old inefficient stoves is creating significant air pollution and is impacting the quality of life in the winter months. There are several similar communities in Ljutomer municipality. Therefore, the Cven settlement could serve as a model for the future development of other settlements in Ljutomer Municipality and beyond.

In 2016 a survey was conducted in Cven to assess the existing heating practices of objects and the production of domestic hot water. The survey also checked the general attitude of Cven inhabitants towards a DH project. Based on survey data, the local availability of RES and the boarder conditions for DHC projects in Slovenia, a technical concept for a DH project was developed.[3] The technical concept was developed in several iterations where the feasibility of a DH project was assessed. Based on the outputs of the initial technical assessment of the heating demand, it was observed that whole Cven cannot be covered. In case of connecting whole Cven to a DH grid, the grid density would drop below 800 kWh/m per year which would make the project not feasible. Therefore, the DH grid was designated to cover only the more dense northern part of the Cven settlement, shown in Figure 1.

Figure 1: Cven settlement consumers and the DH grid in red line (yellow lines show the natural gas grid), location of the possible plant

[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

[3] http://www.coolheating.eu/images/downloads/concepts/Report-D4.4-technical-concept-Cven.pdf

The key assumptions for the development of the Cven DH project are:

- The Cven DH will have a minimum of 800 kWh/m per year grid density in order to comply with the relevant national grant subsidies for DHC projects.
- The domestic hot water production in Cven can be covered with a small CHP gasification unit (operated the whole year).
- The heating costs for customers connected to the DH grid will be less than 100€/MWh.
- The DH project in Cven will be feasible without charging a connection fee for the customers. Customers pay only for the delivered heat, no additional charge for covering the installations will be feasible.
- As Cven is a relatively small settlement, a high initial connection rate of households is required. A 90% connection rate is a prerequisite for the project to be feasible.
- The project shall utilise wood biomass and/or agricultural waste biomass (straw).

The detailed overview of the technical concept for Cven DH is available at the CoolHeating project website[4]. In the development phase the technical concept was developed and checked in many iterations in order to define a feasible technological layout of the DH plant, feasible and sustainable consumption of locally available RES and a feasible extent of the DH grid in the Cven settlement.

For the development of the technological layout of the heat production in the Cven DH project, three basic technological options were investigated: use of both wood and agricultural waste biomass, utilisation of heat pumps, and use of solar thermal energy. In general, the most favourable technology in Cven would be based on biomass. Agricultural residues and wood biomass could be also purchased from Cven inhabitants. Also solar thermal technologies would be accepted and sufficient land could be arranged, but was not considered feasible, due to a low share of total produced thermal energy necessary to cover heating needs and due to better impacts of biomass CHP technology on project economy. Also heat pumps could be used even if the permit procedures for use of groundwater can be long and problematic in Slovenia. Due to a high amount of needed ground water, this option was not considered within the concept. Cooling was not further assessed, because the low amount of cooling needs will not be feasible to supply from the plant.

The **heat generation** concept for Cven considers a small biomass CHP for the baseload, a biomass boiler and a natural gas peak load boiler. A 50 m³ buffer storage tank could decrease the peaks after night setback time in the morning, when most households starts heating again.

Figure 2 shows the annual load line of the planned heat production units. The baseload, especially also in summertime could be covered with 2 small biomass CHPs with 56kW_{el} each (based on a biomass gasifier CHP by Fröling). About half of the heat output could be used in the DH grid for drying the soft wood to 10% water content. The rest will be used for heating the DH grid consumers with about 57kW_{th} each. The wood dryer needs an annual heat demand of 943 MWh/a. The CHP should be operated 8,200 hours per year. About 918 MWh of electricity (gross) is planned to be produced annually to feed into the public grid.

The annual fuel consumption is 3,231 MWh/a of soft wood (at 10% water content) for the 2 CHP units, 2,338 MWh/a of wood chips (about 30 to 35% water content) for the biomass boiler (~82% annual efficiency, 800 kW nominal capacity) and 163 MWh/a for the natural gas peak load boiler (~80% annual efficiency, max. 2.2 MW).

[4] http://www.coolheating.eu/images/downloads/concepts/Report-D4.4-technical-concept-Cven.pdf

The nominal capacities (thermal load) of the boilers and other data are shown in Table 1.

Table 1: Calculation details for heat production units

	th. load in kW	produced heat in MWh/a	needed fuel energy in MWh/a	annual efficiency in %	share of total heat for DH in %	full load hours per year
Biomass CHP	230	1,886	3,231	87%	48%	8,200
Biomass boiler	800	1,917	2,338	82%	49%	2,397
Natural gas peak load boiler	2,225	130	163	80%	3%	58

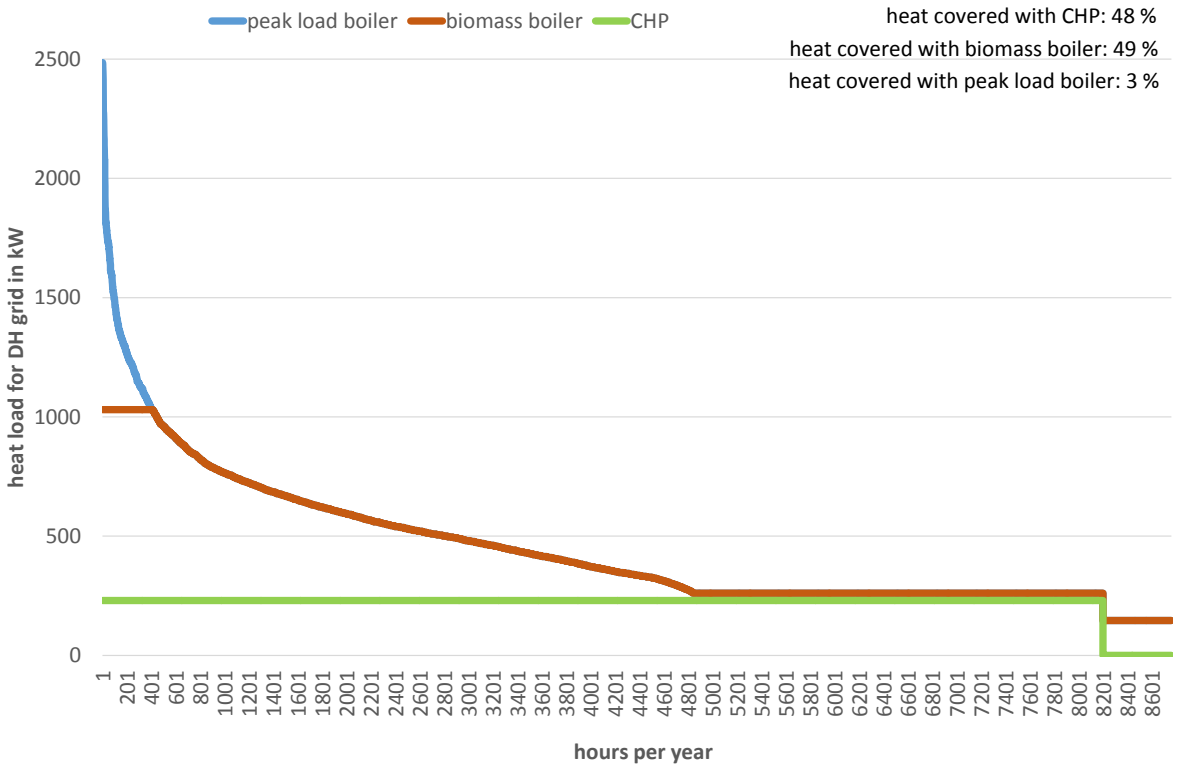


Figure 2: Annual load line of heat production units for DH grid Cven

The calculation shows that about 48% of the annual heat demand is produced by the CHP, about 49% with the biomass boiler and only 3% with the peak load boiler.

The main **DH pipelines** at the roads are about 2,000 m long, plus about 1,400 m pipes to the consumers (average 9 m connection to each consumer). The length of the grid here is only the length of the flow pipe. This leads to a total length of the DH grid of 3,400 m.

The grid density of a DH grid is an important indicator for the economy of a system, as well as for the DH grid losses. The grid density is calculated with the annual heat consumption of the consumers, divided by the grid length. The calculated grid density for Cven is 937 kWh per meter pipeline and per year (calculated without grid losses). The minimum value of 800 is achieved, according to the Slovene national support scheme. The higher grid density was the reason why the connection of some consumers at the south-west side of the town was not included in the concept.

For this grid, the annual heat losses for the DH grid in Cven were calculated with 19%, or 745 MWh/a.

As **heat consumers**, all public buildings could be included in the DH grid, as well as 90% of the households (90% connection rate) in the DH grid supplied area. Additionally, there should be a wood dryer installed. The domestic hot water production could also be done in summertime. There might be some hydraulic retrofitting's necessary at the consumer side, if these systems would cause high return flow temperatures.

About 2.24 GWh per year could be sold to the consumers, plus 943 MWh per year for wood drying. So, in total 3.93 GWh/a are needed to feed the DH grid.

The total heating system could be implemented within one stage. Due to the connected number of consumers, the system could start operation with only one CHP unit or only with the biomass boiler until there is enough heat demand to run all two CHP units. The **modularity** of the system is expandable, if there are for example more or larger heat consumers than expected. In that case, the full load hours of the biomass boiler would increase and also the natural gas peak load might increase a bit. Furthermore, the temperature level is variable to compensate peaks in flow, if there might be bottlenecks at the DH grid.

Only about 3% of the total heat demand would be covered with natural gas, so 97% of the heat could be generated from renewable energy sources. About 475 tons of CO_2 could be saved each year compared to the current state.

3 Business assessment

In the scope of economic feasibility assessment, the technical design of the project was transformed into the solid economic profile in order to test its potential and to obtain an image of the future project performance. This task included elements of financial statement analysis, asset selection, plan implementation and virtual ongoing monitoring of the investment in the project life-time. In this way a sustainable business model of the project was defined and justified through the employment of the simulation tools, in particular using the economic calculation tool[5]. Defining business model implies defining all the relevant dimensions/parameters of the project as a business case:

- Investment and financing structure of the project;
- Costs and revenues;
- Assets, liabilities and equity.

The structure of the defined business model is presented in detail in the document "Target community business model – Cven". In the scope of the feasibility check, a defined business model was extensively tested in order to prove its potential for realization and to provide an investor with a specific insight into the project through the definition of the feasible business case.

The in-depth simulation of the future economic performance of the project is presented as an appendix to this document. It is providing credibility to the indications presented throughout this chapter and shall assist the upcoming steps of the project realization: decisions about the most appropriate strategy and the best way to allocate resources, an overview of the total amount of resources needed to start and to expand the project, assessment of the relative efficiency and equity of project, and to assure cost-effective allocation of resources. In the scope of the economic feasibility assessment of the project, the following tasks were carried out:

- Calculation of projected revenues
- Costs and fixed assets calculation

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

- Current assets calculation
- Liabilities and equity calculation
- Income statement projection
- Balance sheet projection
- Cash-flow profile projection
- Assessment of the economic viability of the project (equity IRR, NPV…)
- Sensitivity analysis

The process of developing the business model for the project in Cven was iterative. Simultaneously with developing the model, all its assumptions were tested in the calculation tool. Based on the results of this iterative process a well-supported and sustainable business model was produced. In the scope of economic feasibility check a set of detailed future financial performance calculations of the model was produced which is required in order to assess the credibility and the solidity of the business model proposed.

As reflected in the attached economic feasibility check results, the proposed business model was tested for:

- its **potential to provide satisfactory economic results** for the potential investor: with the defined business model parameters[6] and the proposed heat price the project reaches 12% internal rate of return on invested equity. The same return rate on invested capital is used in the electricity feed-in definition methodology[7] of the Energy Agency of Slovenia as a benchmark for projects that are capable of attracting the potential investors. Depending on the investors motivation, on the other hand, the presented business model as well allows for the variation of defined business model parameters in order to either reach higher returns (in case the investor deems it necessary to outweigh the perceived project risk) or base the project entirely on non-profit assumptions (e.g. cooperative of villagers aiming at lowest possible heat price in exchange for potential profits). The main outcome of the feasibility check in this regard is that the project is feasible in different forms and suitable for different types of potential private investors;
- its **resistance to tackle unwanted developments** in the future: the defined business model was tested for its sensitivity through the variation of critical parameters – operating costs (mainly the fuel costs) and heat revenues. The main outcome of the feasibility check in this regard is that the proposed business model is capable of taking over potential negative developments. 20% variation of the operating cost and heat revenue levels still resulted in positive internal rate of return on invested equity.

The following paragraphs provide a closer insight into key aspects and outcomes of the economic feasibility check for the proposed investment project in Cven. A detailed economic simulation of the proposed business model is contained in the appendix and supporting the assumptions throughout this and related documents that are covering the investment project in Cven.

[6] Sunko R. et al. (2018) Target community business model LJUTOMER – Cven settlement – Skupina FABRIKA; CoolHeating Report available at www.coolheating.eu

[7] https://www.agen-rs.si/documents/10926/127379/Metodologija_CEPN_RSEE/6198654e-075a-4efa-b0c6-71e2adfb5695

Current costs and practices

Cven is a settlement which is situated among two main roads which intersect in the middle of the settlement. The existing heating needs in the settlement were assessed in a survey[8] where also the current heating costs were assessed. The existing annual expenses for heating in Cven amount from around 3,000 € to almost zero. Households who also own forests usually have very low expenses. But the ones who have to buy energy sources for heating have higher expenses. Around 12% of interviewed households have annual expenses of more than 1,600 €. The predominant heating energy sources are biomass (usually utilised in old and inefficient stoves) and fossil fuels (heating oil and natural gas). Due to rather extensive use of own wood, existing heating in Cven is not very expensive for the inhabitants. However, the use of old stoves in connection to relatively poor insulation of buildings is producing significant pollution in winter times. Furthermore, the aging population is appreciative of modern heating solutions that enable higher quality of life.

The existing specific cost for heating and preparation of hot domestic water in Cven is 77 €/MWh. This average heat price also contains households that are already using biomass from their own forest for the heat production, which also has a significant impact on the calculation of the heat cost balance in Cven.

Furthermore, it is important to note, that this heating cost is based on estimations of interviewed households in Cven. This estimation is undervalued as it does not include costs for operation and maintenance and the depreciation costs. Therefore, it is important to include this parameters in the calculated average heating cost for heating technologies in use in Cven.

It is most important to assess three basic heating options for households:

1. Heating with heating oil. A significant proportion of Cven households use heating oil. The calculated reference heating cost with heating oil is 123 €/MWh;
2. Heating with natural gas. The calculated reference cost of heating with natural gas is 97 €/MWh;*
   **Both above estimations include the average energy resource price for last quarter of 2017 without VAT[9]. It includes the annual average technology efficiency of 75% (the optimal efficiency is decreased for the factors of partial load and age of heating equipment). The calculations also include the investment costs with 10 years of amortisation and yearly maintenance and operation costs (servicing of the equipment and chimney service)[10]*
3. A proportion of households in Cven is being heated using biomass. The majority of households in Cven with very low existing heating costs are heated by biomass, in a large proportion from own woods. In order to provide as lucrative as possible conditions to attract them, a biomass for heat model has been developed. So those consumers can pay for the heat supplied to them in biomass from their woods. They don't have to bring that wood to the DH plant. The DH project can hire external forestry service which is available in the region. Then the heat consumers with low existing heating costs can get the same heating costs as they have at present. In addition, they can get a higher rate of comfort as they don't have to provide forestry labour and the heating of their objects is more comfortable while connected to a DH grid.

A very small share of households uses heat pumps for energy production. These households are not considered among those included in the assessed connection rates.

[8] Survey on the energy consumption and attitudes towards renewable heating and cooling in the CoolHeating target communities
http://www.coolheating.eu/images/downloads/CoolHeating_Survey_3.4.pdf
[9] Source: www2.arnes.si/~mlicen3/html/cene_energentov.html
[10] Source: www.brezice.si/mma/-/2017010423241219/?m=

Initial investment and operating costs of the project

The investment into the Cven DH project amounts to 1,995,000 €. The assessed investment costs are turn-key. They include all costs for the Cven DH project to start, including the heat transfer stations at the customers' side. The key revenue and costs parameters are described in detail in the business model and include forecasts for the development in time. Critical parameters also include a quantification of the year to year change. The project includes proven technologies described in previous paragraphs. The biomass boiler is complemented by two small biomass CHP gasification units and a peak fossil boiler. Heat is transferred to end users through the distribution network. A technical layout of the project allows for its modularity, respectively additional technologies may be added and new heat users may be attached.

The largest part in the cost structure of the Cven DH project is feed-stock price. The Cven project requires approximately 1,600 t of biomass yearly for its full load operation level. The project feasibility was analysed using the average biomass price of 55.51 €/t with a year to year price increase of 1%. The business model foresees also a possibility of consumers paying with biomass for delivered heat. The biomass availability in the municipality Ljutomer and the broader region of Pomurje is good and supply of DH Cven does not represent a disproportionate risk. A smaller part of the operating costs is connected to the peak operation needs for the natural gas boiler and electricity.

Operation and maintenance costs are assessed according to the manufacturers' specifications and experience from similar projects. Employed technologies are proven and mature which means that with the proper operating and maintenance procedures and practices operating costs may be controlled efficiently. Operating costs for selected technologies are considerable. However, they are variable by nature and thus tied to the amount of annual operating hours.

Smaller (less than 1MWth) and simple DH projects require very little presence of the personnel on site. The system incorporated in this business model can be controlled and operated remotely due to the maturity of employed technologies. Furthermore, the management of the project can be entirely outsourced and performed either by the investor or by the compatible partner (e.g. public utility company). Therefore, costs of labour are relatively low.

Performed sensitivity analysis (see the appendix) shows that the business model can resist 20% increase in operating costs.

Heat price

Revenues within the Cven DH project are generated by sales of thermal energy (55%) and sales of electricity (45%). The electricity related revenues for Cven DH project are defined on the basis of the national feed-in support scheme and available for a duration of 15 years. The Slovene Energy Agency[11] is preparing and managing the annual tender procedure in which investors apply for the feed-in tariff. This may represent a considerable risk for the DH project in Cven. The CHP technology represents a considerable investment cost and without the electricity feed-in support, the electricity generation is not economically justified. The business model does not foresee other revenue sources, as the connection fees for heat consumers are set to 0 € in order to stimulate high connection rate which is critical for the realisation of the project in the relatively small settlement of Cven. The absence of connection fees represents an important benefit for motivation of consumers to connect. However it also represents an important risk which should be mitigated through guaranteed heat supply contracts with a contractual ensured minimal annual heat consumption of connected heat consumers.

Sensitivity of the project on the heat price variation was carefully assessed and is presented in the scope of the attached simulation. The attached chart shows that the minimum heat price that would need to be charged from the consumers is 62 €/MWh for the project to reach the break-even in 15 years.

[11] www.agen-rs.si

The project in Cven has a single category of heat users with rather standard household energy needs. There are no important industrial or other users included in the consumer portfolio. For this reason, the proposed tariff scheme considers only one consumer category. **The proposed base price is 80 €/MWh**. The proposed heat price for heat consumers supplied in the Cven DH is the end price without VAT. No other additional costs for heat consumers will be added to this price. Furthermore, also no investment costs are asked to the heat consumers as they will be connected to the DH grid free of charge. The price model assumes this heat price to be fixed with standard annual price increase index of 2.0%. The effect of the proposed price model on the overall project economic performance has been simulated for the duration of 15 years, allowing for the investor to achieve **12% IRR on invested equity**. The detailed economic performance and simulations can be observed in the annex to this document. The reference heat price of 80 €/MWh is a feasible reference heat price, which still possesses tolerance for variation according to the ownership model, the specific vision of the investor and his motivation for financial profits or non-profit benefits. Performed sensitivity analysis (see the appendix) shows that the business model can resist 20% decrease in heat revenues. In case the DH Cven project will be realised through a cooperative or other ownership models with low or no motivation for profit the IRR can be lowered to compensate for a lower heat price. In any case it is advisable to establish the project with at least minimal IRR in order for the project to be able to compensate for potential drawbacks, unforeseen costs or other factors which could impact the economic feasibility of the project.

The price of 80 €/MWh represents a very competitive price in comparison to existing heating costs in Cven. In the survey on heating in Cven, conducted in 2016, the overall average heating cost for consumers who stated that would be willing to connect to the DH grid was estimated to 77 €/MWh. It is important to note, that this heating cost is based on estimations of interviewed households in Cven. This estimation is undervalued as it does not include costs for operation and maintenance and the depreciation costs of the equipment. Therefore, it is important to compare the proposed heating price of 80 €/MWh with a calculated average heating cost for heating technologies in use in Cven.

The proposed base price of 80€/MWh is 35% lower than the reference end price of heat from heating oil and 17% lower than the end price from natural gas. When also considering the biomass for heat model it can be said that the proposed price model represents an important element in reaching a high connection rate among the households.

Financing options

In order to finance the investment into the Cven DH project, one or more (in case of a cooperative ownership model) private partner will introduce own funds in the form of equity into the project in exchange for awarding a concession for the implementation of the public utility service (heat supply). The minimum share of own funds in the financing structure of the project is 20%. A private partner must provide its own funds from its own financial resources and not from potential heat consumers in the form of connection fees or similar charges.

The second part of the financing structure is a specialized investment grant from the JR DO OVE Slovenian call. The highest share of co-financing from this program is 55% of investment costs. The estimated share of financing of the investment from the grant in this business model is 40% of the overall investment costs. This means that the economic simulation does not consider the use of available grant in its whole extent. It should be possible for the investor into the DH Cven project to achieve a grant of that share. Higher share of the investment subsidy in the financing portfolio would have a positive impact on the feasibility of the proposed project.

Financing of the remaining share of the investment is planned through an investment loan from the specialized fund for environmental projects. Eco Fund, Slovenian Environmental Public Fund awards favourable loans for investments in the field of renewable energy sources. Investment loans for DH and CHP projects are currently available at 1.3% interest rate with a repayment period of up to 20 years. These investment parameters were used to simulate

economic feasibility for the DH Cven project. There are no specific obstacles for awarding of the subsidized loan to the Cven project.

The outlined financing structure represents a standard financing structure (combination of private equity, debt capital and the investment grant) with no specifics or potential risks related to it. The private equity can be introduced by a single partner or in case of a cooperative ownership model by members of the cooperative. It is very feasible that such investment structure can be realised and it is also possible that the financing structure could be even more favourable.

Licenses and permits required

The heat supply is a highly regulated industry which is governed and regulated by many of laws, regulations, ministries, agencies and local communities. They represent the framework conditions comprised of national legislation and also regional or even local regulative that influences civil works, energy production and supply, use of energy sources and also spatial planning and subsidies.

The Cven DH project shall be realised through a PPP. The basic regulative prerequisite for this is the decree on heat supply which defines all key elements of the DH project and the relationship between the municipality and the private partner. The decree has to be adopted by the municipal council. Based on this, the public tender for awarding the concession for heat supply in Cven settlement will be published. The concessionaire will require the energy permit. The private partner (concessionaire) will also obtain a declaration for a production facility that produces electricity from renewable energy sources (RES) and in a high-efficiency cogeneration of electricity and heat (CHP – combined heat and power) and that appropriate meters have been installed.

Details about the required permits, licenses and documentation for DHC projects are available in the Cven Business model document[12]. The procedures are specific, and due to the Slovene national regulation, the process of acquiring needed permits and documentation is rather long and elaborate. Timeframes of more than one year must be considered. This can represent and important risk factor in the Cven DH project realization.

Socio-environmental cost/benefits

The planned DH system in Cven is based on the utilization of locally available RES. It will provide energy with reduced emissions of greenhouse gasses. It will significantly improve the efficiency of heating and lower carbon emissions. DH project in Cven will also have significant social impacts. Utilization of local/regional available RES will increase security of energy supply and lower dependency on import of energy sources. Business model on which the DH Cven project realization is based on will also have a very positive impact on energy price stability and will represent a competitive source of energy.

Depending on the type of PPP chosen, the local community may also have the opportunity to own and financially benefit from the network. In order to leverage the social effects of the project it would be highly encouraged if local citizens establish the cooperative which would act as a private partner in the investment project.

[12] Sunko R. et al. (2018) Target community business model LJUTOMER – Cven settlement – Skupina FABRIKA; CoolHeating Report available at www.coolheating.eu

It is estimated that the realization of this project will trigger the following direct and indirect impacts on the local environment:

- Reduction of CO_2 emissions by 475 tons yearly.
- Lower energy costs, high level of energy supply comfort.
- 1 direct new employment and several other indirect employments due to the effects on local economies.
- Improved air quality will result in lower expenses in health services.
- New opportunities for forest and agricultural areas in providing biomass for the DH plant.
- Improved maintenance of forests.
- Decreased work load of an ageing population.

The Cven DH project will also replace a significant amount of non-renewable fuels in Cven settlement:

- 582 MWh of natural gas
- 231 MWh of heating oil
- 3 MWh of electric energy

The above presented energy carriers will be replaced by a highly efficient utilization of biomass. The annual cost of 3 GWh of energy (biomass, natural gas, heating oil and electricity) used for heating in Cven is more than 150,000 € annually. In realization of the Cven DH project this heating cost can be converted into a local economy based on purchase of locally available biomass.

4 Executive summary for policy makers (in English)

The main objective of this document has been to determine the feasibility of the investment into a district heating system in Slovenia in the relatively small settlement of Cven. The Cven settlement is located in the north-west of Slovenia and represents a model for many small rural settlements.

The heating demand and the attitude towards a new DH project was assessed within a survey. Based on the heat demand assessment, the technical concept for meeting the heating needs was developed. The estimation of the costs of all elements that entail the construction and operation of a district heating system was conducted; the construction and maintenance of the distribution network, the heat supply, and the interface between the distribution network and the customer's systems, the substations.

The new network can be economically competitive and additionally the system would drastically reduce the emissions and would enable the ageing population a much higher heating comfort and quality of life.

The new **heat generation concept** for Cven considers a small biomass CHP for the baseload, a biomass boiler and a natural gas peak load boiler. A 50 m³ buffer storage tank will decrease the peaks after night setback time in the morning, when most households starts heating again. The **investment** into the Cven DH project is estimated to 1,995,000 €. The assessed investment costs are turn-key.

In the proposed **technical design** about 48% of the annual heat demand is produced by the CHP, about 49% with the biomass boiler and only 3% with the peak load boiler. The main **DH pipelines** have about 2,000 m, plus about 1,400m pipes to the consumers. This leads to a total length of the DH grid of 3,400 m.

The Cven DH project shall be realised through a **PPP**. The basic regulative prerequisite for this is the decree on heat supply which defines all key elements of the DH project and the relationship between the municipality and the private partner.

In order to **finance** the investment into the Cven DH project the private partner will be required to introduce own funds in the form of equity into the project in exchange for awarding a concession for the implementation of the public utility service (heat supply). The second part of the financing structure is a specialized investment grant from the JR DO OVE Slovenian call. Financing of the remaining share of the investment is planned through an investment loan from the specialized fund for environmental projects.

As **heat consumers** all public buildings could be connected to the DH grid, as well as 90% of the households (90% connection rate) in the DH grid supplied area. Only about 3% of the total heat demand would be covered with natural gas, so 97% of the heat could be generated from renewable energy sources. About 475 tons of CO_2 could be saved each year compared to the current state.

The largest part in the **cost structure** of the Cven DH project is feed-stock price. The Cven project requires approximately 1,600 t of biomass yearly for its full load operation level. Project feasibility was analysed using the average biomass price of 55.51 €/t. The business model foresees also a possibility of consumers paying with biomass for delivered heat.

Revenues within the Cven DH project would be generated by sales of thermal energy (55%) and sales of electricity (45%). The electricity related revenues for Cven DH project are defined on the basis of the national feed-in support scheme and available for a duration of 15 years. The business model does not foresee other revenue sources, as the connection fees for heat consumers are set to 0 € in order to stimulate high connection rate which is critical for the realisation of the project in the relatively small settlement of Cven. **The proposed base price of supplied heat is 80 €/MWh**. The proposed heat price for heat consumers supplied in the Cven DH is the end price. No additional costs for heat consumers add to this price. Furthermore also no investment costs are asked to the heat consumers as they will be connected to the DH grid free of charge.

The proposed business model is feasible due to its **potential to provide satisfactory economic results** for the investor as it might generate rates or return that are higher than 10%; as well as due to its **resistance to tackle unwanted developments** in the future as it is capable of taking over potential negative developments (e.g. 20% variation of the operating costs and heat revenues).

The annual cost of 3 GWh of energy (biomass, natural gas, heating oil and electricity) used for heating in Cven is more than 150,000 € annually. In realization of the Cven DH project this heating cost can be converted into a local economy based on purchase of locally available biomass.

Overall, the proposed business model is robust, beneficial for the local community and fairly resistant to potential negative future developments. The main challenge is to achieve acceptance of the project among the local citizens and broader community in order to reach the defined connection rate and thus the critical size of the project.

5 Executive summary for policy makers (in Slovene language)

Glavni cilj tega dokumenta je previzkusiti izvedljivost naložbe v sistem daljinskega ogrevanja v Sloveniji, v relativno majhnem naselje Cven. Naselje Cven se nahaja v severovzhodnem delu Slovenije in predstavlja model za številna manjša podeželska naselja.

Potrebe po ogrevanju in odnos prebivalstva do projekta daljinske oskrbe s toplotno energijo so bili ocenjeni v okviru raziskave. Na podlagi ocenjenih letnih potreb po toplotni energiji je bil razvit tehnični koncept daljinskega ogrevanja. Izvedena je bila ocena stroškov vseh elementov investicije v izgradnjo in obratovanje sistema daljinskega ogrevanja; izgradnja in vzdrževanje distribucijskega omrežja, oskrba s toplotno energijo in priklop posameznih odjemnikov toplote s toplotnimi podpostajami.

Investicija v takšen sistem daljinskega ogrevanja je lahko ekonomsko upravičena in tak sistem lahko drastično zmanjša emisije ter omogoči veliko večje udobje ogrevanja in kakovost življenja starajočemu prebivalstvu.

Koncept daljinskega sistema ogrevanja za Cven vključuje majhno biomasno SPTE (soproizvodnja topotne in električne energije) za pasovno obremenitev, kotel za biomaso in vršni kotel na zemeljski plin ter 50 m³ zalogovnik za zmanjšanje obremenitve sistema zjutraj, ko večina gospodinjstev poveča obremenitev daljinskega sistema ogrevanja. **Naložba** v projekt daljinskega ogrevanja na Cvenu je ocenjena na 1.955.000 €. Ocenjeni stroški naložbe so »na ključ«.

V predlagani **tehnični zasnovi** se približno 48% letnega povpraševanja po toploti pokrije s soproizvodnjo toplote in električne energije, okoli 49% s kotlom na biomaso in le 3% z vršnim kotlom. **Primarni cevovodi toplovodnega omrežja** so dolgi 2.000 m, sekundarni pa približno 1.400 m. To predstavlja skupno dolžino distribucijskega omrežja 3.400 m.

Daljinska oskrba s toplotno energijo v naselju Cven se bo izvajala prek **javno zasebnega partnerstva**. Osnovni predpogoj za to je sprejem odloka o oskrbi s toplotno energijo, ki opredeljuje vse ključne elemente projekta daljinskega ogrevamja in razmerje med občino in zasebnim partnerjem.

Za **financiranje naložbe** v projekt daljinskega ogrevanja na Cvenu bo zasebni partner v projekt vključil lastna sredstva v obliki lastniškega kapitala v zameno za dodelitev koncesije za izvajanje javne gospodarske službe (oskrba s toploto). Drugi del strukture financiranja je specializirana investicijska podpora (nepovratna sredstva), ki jo je za tovrsten investicijski projekt mogoče pridobiti znotraj slovenskega razpisa JR DO OVE. Financiranje preostalega deleža naložbe se načrtuje s pomočjo investicijskega posojila iz specializiranega sklada za okoljske projekte.

Kot **potrošnike toplote** je mogoče na sistem daljinskega ogrevanja priklopiti vse javne objekte, pa tudi 90% gospodinjstev na območju, ki ga pokriva daljinski sistem. Samo približno 3% celotnih potreb po toploti bi bilo pokrito z zemeljskim plinom, tako da bi se 97% toplote lahko pridobilo iz obnovljivih virov energije. Vsako leto bi bilo mogoče prihraniti približno 475 ton CO_2 v primerjavi s sedanjim stanjem.

Največji del **stroškovne strukture** projekta daljinskega ogrevanja Cven predstavlja strošek goriva. Projekt Cven potrebuje letno približno 1.600 ton biomase za obratovanje. Izvedljivost projekta smo analizirali z uporabo povprečne cene biomase 55,51 €/t. Poslovni model predvideva tudi možnost, da potrošniki za dobavljeno toploto plačajo z biomaso.

Prihodki v okviru projekta daljinsko ogrevanje Cven bi bili ustvarjeni s prodajo toplotne energije (55%) in prodajo električne energije (45%). Prihodki, povezani z električno energijo, so opredeljeni na podlagi nacionalne sheme podpor in so na voljo za obdobje 15 let. Poslovni model ne predvideva drugih virov prihodkov, saj so pristojbine za priključitev porabnikov toplote določene na 0 €, da bi spodbudili visoko stopnjo priključitve, ki je ključnega pomena za izvedbo projekta v relativno majhnem naselju Cven. **Predlagana izhodiščna cena dobavljene toplote za odjemalce je 80 €/MWh**. Predlagana cena za toplotno energijo za

potrošnike toplote je končna cena brez davka na dodano vrednost. Nobeni dodatni stroški za potrošnike toplote, ki bi se prištevali k tej ceni niso predvideni. Poleg tega se od potrošnikov toplote ne zahtevajo nobeni naložbeni stroški, saj bodo brezplačno priključeni na omrežje daljinskega ogrevanja.

Predlagani poslovni model je izvedljiv, investitorju omogoča zadovoljive **ekonomske rezultate**, saj lahko ustvarja stopnje donosa, ki so višje od 10%; pa tudi zaradi ustrezne stopnje **odpornosti na morebitne tveganja**, saj lahko obvladuje tudi potencialne negativne dogodke (na primer 20-odstotno spremembo obratovalnih stroškov ali prihodkov od toplote).

Letni stroški 3 GWh energije (biomasa, zemeljski plin, kurilno olje in elektrika), ki se uporabljajo za ogrevanje na Cvenu trenutno, znašajo več kot 150.000 € letno. Pri realizaciji projekta Cven DH se stroški ogrevanja lahko pretvorijo v pozitivni razvoj **lokalnega gospodarstva** na podlagi nakupa lokalno razpoložljive biomase in s tem povezanih učinkov.

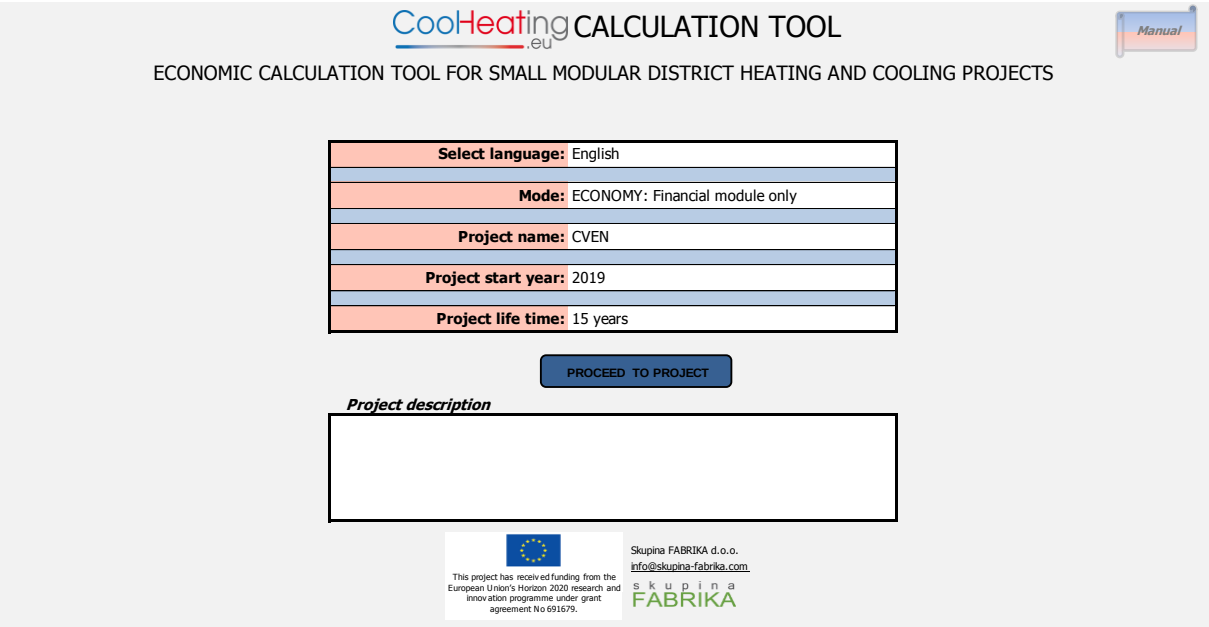
V splošnem je predlagani poslovni model robusten, koristen za lokalno skupnost in precej odporen na morebitna tveganja. Glavni izziv je doseči sprejetje projekta med lokalnim prebivalstvom in širšo skupnostjo, da bi dosegli načrtovano stopnjo pokritosti in s tem kritično velikost projekta.

6 Appendix

6.1 Map details

Figure 3: Cven settlement consumers and the DH grid in red line (yellow lines show the natural gas grid), location of the possible plant

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



15 year project life-time period is considered for all calculations and for the simulation period. This is the life-time period used also in the official methodologies of the Energy of Agency for the similar projects as this is also the period after which the initial feed-in tariff agreement expires.

4,2% discount rate is employed in the simulations of the economic performance of the project. The calculation of the total required return on the invested equity is based on the calculation of the weighted average cost of capital (WACC), which is calculated according to the following formula:

$$WACC = w_{EQ} * r_{EQ} + w_{DE} * r_{DE} = 0,2 * 12,0\% + 0,4 * 4,5\% = 4,2\%$$

where

w_{EQ} share of equity
w_{DE} share of debt
r_{EQ} return on equity
r_{DE} interest rate on commercial loan

Detailed economic calculations are contained in the following pages.

Projected investment cost in €	Value	Share %
1. Buildings and construction works	100.000	5,0%
2. Plot	0	0,0%
3. Equipment/Machinery	1.870.000	93,7%
A. PROPERTY, PLANT AND EQUIPMENT	**1.970.000**	**98,7%**
B. PROJECT AND INVESTMENT DOCUMENTATION	**25.000**	**1,3%**
C. INTANGIBLE ASSETS	**0**	**0,0%**
D. INVESTMENT COST (A+B+C)	**1.995.000**	**100,0%**
E. INITIAL WORKING CAPITAL	**0**	**0,0%**
F. TOTAL INVESTMENT COST (D+E)	**1.995.000**	**100,0%**

Sources of investment cost financing in €	Value	Share %
A. PRIVATE EQUITY	**399.000**	**20,0%**
B. BANK LOANS	**801.250**	**40,2%**
C. CONNECTION FEES	**0**	**0,0%**
D. INVESTMENT SUBSIDIES	**794.750**	**39,8%**
Bridging loan	*794.750*	
E. TOTAL FINANCING (A+B+C+D)	**1.995.000**	**100,0%**

Source of revenue in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. ELECTRICITY REVENUES	144.126	144.558	144.992	145.427	145.863	146.301	146.740	147.180	147.622	148.064	148.509	148.954	149.401	149.849	150.299
2. HEAT REVENUES	179.200	182.784	186.440	190.168	193.972	197.851	201.808	205.844	209.961	214.161	218.444	222.813	227.269	231.814	236.451
3. OPERATING SUBSIDIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. GROSS OPERATING REVENUES	**323.326**	**327.342**	**331.432**	**335.596**	**339.835**	**344.152**	**348.548**	**353.024**	**357.583**	**362.225**	**366.952**	**371.767**	**376.670**	**381.664**	**386.749**
1. INVESTMENT SUBSIDIES	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738
2. FINANCIAL REVENUES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. OTHER REVENUES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. OTHER SOURCES OF REVENUES	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**	**39.738**
C. TOTAL REVENUES (A + B)	**363.064**	**367.080**	**371.169**	**375.333**	**379.573**	**383.890**	**388.286**	**392.762**	**397.320**	**401.963**	**406.690**	**411.504**	**416.407**	**421.401**	**426.487**

Cost type in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Energy source costs	108.066	109.311	110.574	111.853	113.151	114.466	115.800	117.152	118.524	119.914	121.324	122.755	124.205	125.677	127.169
2. Operation and maintainance costs	39.400	40.385	41.395	42.429	43.490	44.577	45.692	46.834	48.005	49.205	50.435	51.696	52.989	54.313	55.671
A. TOTAL OPERATING COSTS (1+2)	**147.466**	**149.696**	**151.968**	**154.283**	**156.641**	**159.044**	**161.492**	**163.987**	**166.529**	**169.119**	**171.760**	**174.451**	**177.194**	**179.990**	**182.841**
1. Cost of management, insurance and lease	31.700	32.493	33.305	34.137	34.991	35.866	36.762	37.681	38.623	39.589	40.579	41.593	42.633	43.699	44.791
2. Cost of promotional activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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)	**31.700**	**32.493**	**33.305**	**34.137**	**34.991**	**35.866**	**36.762**	**37.681**	**38.623**	**39.589**	**40.579**	**41.593**	**42.633**	**43.699**	**44.791**
C. COSTS OF LABOUR	**10.000**	**10.100**	**10.201**	**10.303**	**10.406**	**10.510**	**10.615**	**10.721**	**10.829**	**10.937**	**11.046**	**11.157**	**11.268**	**11.381**	**11.495**
D. DEPRECIATION AND AMORTIZATION COSTS	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**
E. FINANCIAL COSTS	**28.009**	**9.490**	**8.845**	**8.191**	**7.529**	**6.858**	**6.179**	**5.490**	**4.793**	**4.086**	**3.370**	**2.645**	**1.910**	**1.166**	**412**
F. OTHER EXPENSES AND LOSSES	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
G. INCOME TAXES	**8.766**	**12.455**	**12.749**	**13.047**	**13.349**	**13.654**	**13.963**	**14.275**	**14.591**	**14.911**	**15.235**	**15.563**	**15.894**	**16.229**	**16.568**
H. TOTAL COSTS (A+B+C+D+E+F+G)	**325.691**	**313.983**	**316.818**	**319.712**	**322.666**	**325.681**	**328.761**	**331.905**	**335.115**	**338.393**	**341.740**	**345.159**	**348.650**	**352.215**	**355.856**

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	23.395	23.753	24.118	24.490	24.869	25.255	25.649	26.050	26.459	26.875	27.300	27.733	28.175	28.625	29.084
D. RESOURCES NEEDED TO FINANCE INVENTORIES	3.846	3.905	3.965	4.026	4.088	4.152	4.216	4.282	4.349	4.418	4.488	4.559	4.631	4.705	4.781

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	26.575	26.905	27.241	27.583	27.932	28.286	28.648	29.016	29.390	29.772	30.160	30.556	30.959	31.370	31.788
D. RESOURCES NEEDED TO FINANCE THE ACCOUNTS RECEIVABLE	2.184	2.211	2.239	2.267	2.296	2.325	2.355	2.385	2.416	2.447	2.479	2.511	2.545	2.578	2.613
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	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
2. Equipment, plant, vehicles, mechanization	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750
B. TOTAL PROPERTY, PLANT AND EQUIPMENT (1+2)	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**
C. TOTAL (A+B)	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**	**99.750**

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	95.000	90.000	85.000	80.000	75.000	70.000	65.000	60.000	55.000	50.000	45.000	40.000	35.000	30.000	25.000
2. Equipment, plant, vehicles, mechanization	1.800.250	1.705.500	1.610.750	1.516.000	1.421.250	1.326.500	1.231.750	1.137.000	1.042.250	947.500	852.750	758.000	663.250	568.500	473.750
B. TOTAL PROPERTY, PLANT AND EQUIPMENT (1+2)	**1.895.250**	**1.795.500**	**1.695.750**	**1.596.000**	**1.496.250**	**1.396.500**	**1.296.750**	**1.197.000**	**1.097.250**	**997.500**	**897.750**	**798.000**	**698.250**	**598.500**	**498.750**
C. TOTAL (A+B)	**1.895.250**	**1.795.500**	**1.695.750**	**1.596.000**	**1.496.250**	**1.396.500**	**1.296.750**	**1.197.000**	**1.097.250**	**997.500**	**897.750**	**798.000**	**698.250**	**598.500**	**498.750**

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	14.726	14.974	15.228	15.487	15.751	16.020	16.295	16.575	16.862	17.154	17.452	17.757	18.068	18.385	18.709
D. DELIVERIES FINANCED BY SUPPLIERS	1.210	1.231	1.252	1.273	1.295	1.317	1.339	1.362	1.386	1.410	1.434	1.459	1.485	1.511	1.538
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	3.846	3.905	3.965	4.026	4.088	4.152	4.216	4.282	4.349	4.418	4.488	4.559	4.631	4.705	4.781
2. Resources needed to finance the accounts receivable	2.184	2.211	2.239	2.267	2.296	2.325	2.355	2.385	2.416	2.447	2.479	2.511	2.545	2.578	2.613
3. Deliveries financed by suppliers	1.210	1.231	1.252	1.273	1.295	1.317	1.339	1.362	1.386	1.410	1.434	1.459	1.485	1.511	1.538
A. WORKING CAPITAL SURPLUS (+) OR DEFICIT (-) (3-2-1)	**-4.820**	**-4.885**	**-4.952**	**-5.020**	**-5.089**	**-5.160**	**-5.232**	**-5.305**	**-5.379**	**-5.455**	**-5.532**	**-5.611**	**-5.691**	**-5.773**	**-5.856**

Debt financing	Prinicpal in €	Interest rate	Repayment starting year	Number of instalments
Loan 1	801.250	1,30%	2018	180
Bridge financing	**Prinicpal in €**	**Interest rate**	**Payment due after**	**Number of instalments**
Bridge financing loan	794.750	4,50%	6 months	1
TOTAL LOANS in €	**1.596.000**			

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	**752.554**	**703.221**	**653.243**	**602.612**	**551.318**	**499.353**	**446.709**	**393.377**	**339.346**	**284.610**	**229.157**	**172.980**	**116.067**	**58.411**	**0**
Annual Loan 1 payments	48.696	49.333	49.978	50.632	51.294	51.965	52.644	53.333	54.030	54.737	55.452	56.178	56.912	57.657	58.411
Bridge financing loan payments	794.750	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. TOTAL ANNUAL LOAN PAYMENTS	**843.446**	**49.333**	**49.978**	**50.632**	**51.294**	**51.965**	**52.644**	**53.333**	**54.030**	**54.737**	**55.452**	**56.178**	**56.912**	**57.657**	**58.411**
Annual payments of interests on Loan 1	10.127	9.490	8.845	8.191	7.529	6.858	6.179	5.490	4.793	4.086	3.370	2.645	1.910	1.166	412
Annual payments of interests on bridge financing loan	17.882	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. TOTAL ANNUAL PAYMENTS OF INTERESTS ON LOANS	**28.009**	**9.490**	**8.845**	**8.191**	**7.529**	**6.858**	**6.179**	**5.490**	**4.793**	**4.086**	**3.370**	**2.645**	**1.910**	**1.166**	**412**

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	399.000	436.372	489.469	543.820	599.442	656.349	714.557	774.082	834.939	897.145	960.715	1.025.664	1.092.010	1.159.768	1.228.954
2. Retained earnings	37.372	53.096	54.351	55.621	56.907	58.208	59.525	60.857	62.206	63.570	64.950	66.346	67.758	69.186	70.630
TOTAL EQUITY (1 to 2)	**436.372**	**489.469**	**543.820**	**599.442**	**656.349**	**714.557**	**774.082**	**834.939**	**897.145**	**960.715**	**1.025.664**	**1.092.010**	**1.159.768**	**1.228.954**	**1.299.585**

Acquisition and consumption of investment subsidies in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Subsidies	794.750														
2. Subsidized fixed assets on 31st of December	1.995.000	1.895.250	1.795.500	1.695.750	1.596.000	1.496.250	1.396.500	1.296.750	1.197.000	1.097.250	997.500	897.750	798.000	698.250	598.500
3. Share of subsidies in subsidized fixed assets	39,8%														
4. Depreciation cost	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750
5. Other sources of revenues	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738
LONG-TERM ACCRUED COSTS AND DEFERRED REVENUES ON 31ST OF DECEMBER	**755.013**	**715.275**	**675.538**	**635.800**	**596.063**	**556.325**	**516.588**	**476.850**	**437.113**	**397.375**	**357.638**	**317.900**	**278.163**	**238.425**	**198.688**

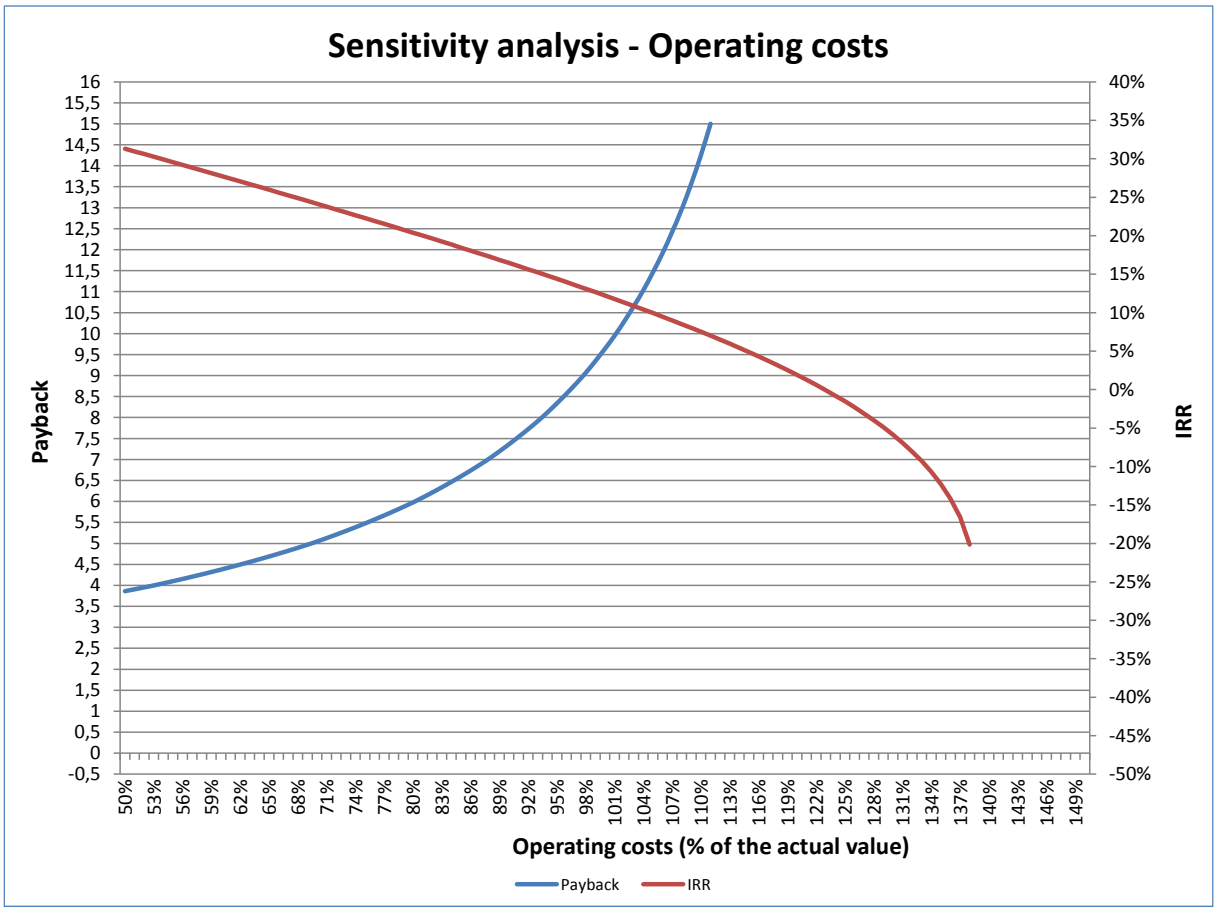
Income statement in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
1. Total operating income	323.326	327.342	331.432	335.596	339.835	344.152	348.548	353.024	357.583	362.225	366.952	371.767	376.670	381.664	386.749
2. Investment subsidies	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738	39.738
3. Total cost of goods and services	179.166	182.189	185.273	188.420	191.632	194.909	198.254	201.668	205.152	208.708	212.339	216.044	219.827	223.689	227.632
a) Total operating costs	147.466	149.696	151.968	154.283	156.641	159.044	161.492	163.987	166.529	169.119	171.760	174.451	177.194	179.990	182.841
1. Energy source costs	108.066	109.311	110.574	111.853	113.151	114.466	115.800	117.152	118.524	119.914	121.324	122.755	124.205	125.677	127.169
2. Operation and maintainance costs	39.400	40.385	41.395	42.429	43.490	44.577	45.692	46.834	48.005	49.205	50.435	51.696	52.989	54.313	55.671
b) Total cost of operating services	31.700	32.493	33.305	34.137	34.991	35.866	36.762	37.681	38.623	39.589	40.579	41.593	42.633	43.699	44.791
1. Cost of management, insurance and lease	31.700	32.493	33.305	34.137	34.991	35.866	36.762	37.681	38.623	39.589	40.579	41.593	42.633	43.699	44.791
2. Cost of promotional activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Cost of other services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Cost of labour	10.000	10.100	10.201	10.303	10.406	10.510	10.615	10.721	10.829	10.937	11.046	11.157	11.268	11.381	11.495
EBITDA	***47,90%***	***47,62%***	***47,34%***	***47,05%***	***46,77%***	***46,49%***	***46,21%***	***45,92%***	***45,64%***	***45,36%***	***45,07%***	***44,79%***	***44,50%***	***44,22%***	***43,93%***
5. Depreciation and amortization	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750
1. Intangible assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Property, plant and equipment	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750
2.1. Buildings and constructions	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
2.2. Equipment, plant, vehicles, mechanization	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750	94.750
EBIT	***20,42%***	***20,44%***	***20,46%***	***20,48%***	***20,49%***	***20,51%***	***20,52%***	***20,53%***	***20,54%***	***20,54%***	***20,55%***	***20,55%***	***20,55%***	***20,55%***	***20,54%***
6. Revenues from financial activities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Financial costs	28.009	9.490	8.845	8.191	7.529	6.858	6.179	5.490	4.793	4.086	3.370	2.645	1.910	1.166	412
8. Other revenues and gains	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9. Other expenses and losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10. INCOME BEFORE TAXES	**46.139**	**65.551**	**67.100**	**68.668**	**70.256**	**71.862**	**73.488**	**75.133**	**76.797**	**78.481**	**80.185**	**81.908**	**83.652**	**85.415**	**87.198**
EBT	***12,71%***	***17,86%***	***18,08%***	***18,30%***	***18,51%***	***18,72%***	***18,93%***	***19,13%***	***19,33%***	***19,52%***	***19,72%***	***19,90%***	***20,09%***	***20,27%***	***20,45%***
11. Income taxes	8.766	12.455	12.749	13.047	13.349	13.654	13.963	14.275	14.591	14.911	15.235	15.563	15.894	16.229	16.568
12. NET INCOME	**37.372**	**53.096**	**54.351**	**55.621**	**56.907**	**58.208**	**59.525**	**60.857**	**62.206**	**63.570**	**64.950**	**66.346**	**67.758**	**69.186**	**70.630**
13. Number of employees	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5

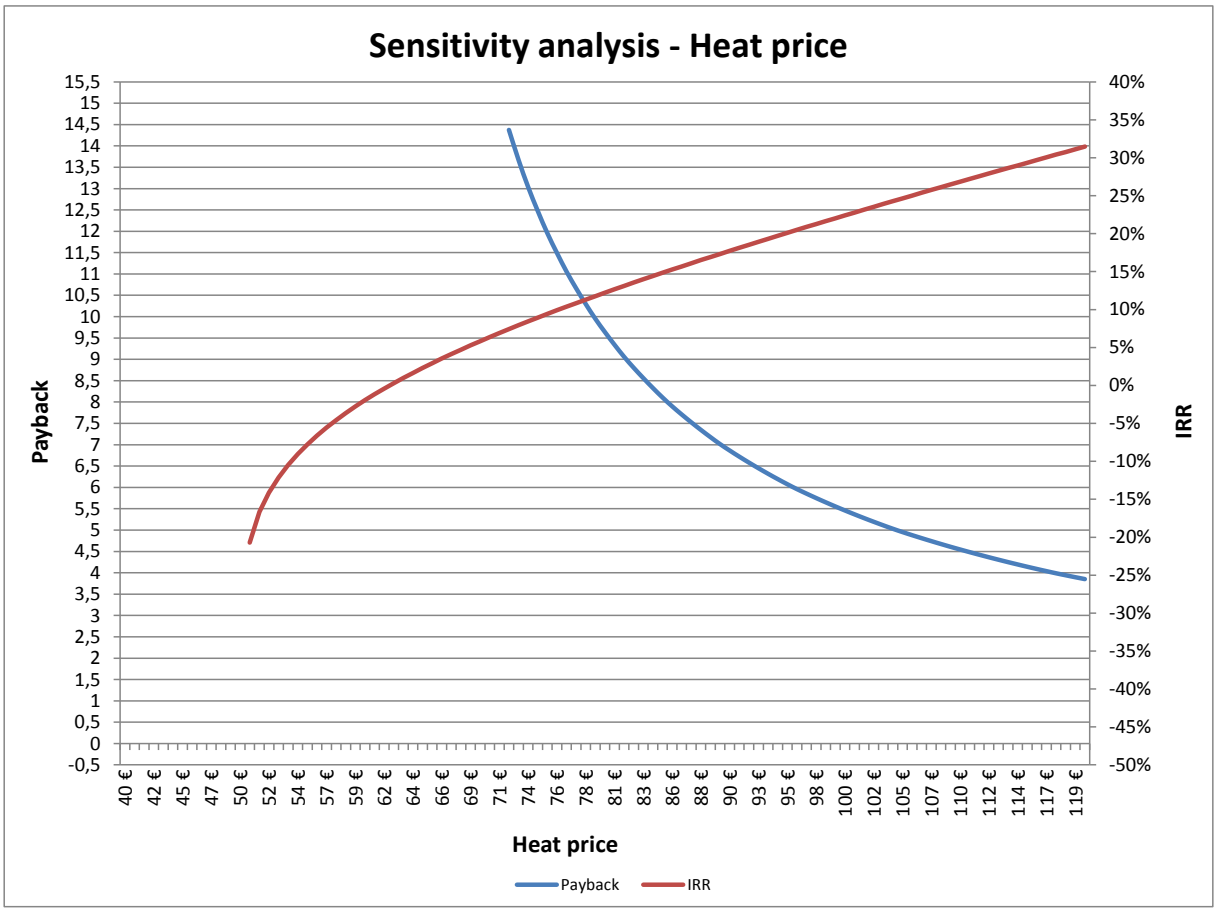
Balance sheet on 31st of December in €	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
A. FIXED ASSETS	**1.895.250**	**1.795.500**	**1.695.750**	**1.596.000**	**1.496.250**	**1.396.500**	**1.296.750**	**1.197.000**	**1.097.250**	**997.500**	**897.750**	**798.000**	**698.250**	**598.500**	**498.750**
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	1.895.250	1.795.500	1.695.750	1.596.000	1.496.250	1.396.500	1.296.750	1.197.000	1.097.250	997.500	897.750	798.000	698.250	598.500	498.750
1. Buildings and constructions	95.000	90.000	85.000	80.000	75.000	70.000	65.000	60.000	55.000	50.000	45.000	40.000	35.000	30.000	25.000
2. Equipment, plant, vehicles, mechanization	1.800.250	1.705.500	1.610.750	1.516.000	1.421.250	1.326.500	1.231.750	1.137.000	1.042.250	947.500	852.750	758.000	663.250	568.500	473.750
III. Long-term accounts receivable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. CURRENT ASSETS	**63.415**	**127.440**	**192.079**	**257.340**	**323.230**	**389.755**	**456.923**	**524.741**	**593.216**	**662.354**	**732.162**	**802.647**	**873.816**	**945.675**	**1.018.232**
I. Inventories	23.395	23.753	24.118	24.490	24.869	25.255	25.649	26.050	26.459	26.875	27.300	27.733	28.175	28.625	29.084
II. Accounts receivable	26.575	26.905	27.241	27.583	27.932	28.286	28.648	29.016	29.390	29.772	30.160	30.556	30.959	31.370	31.788
III. Cash and cash equivalents	13.445	76.781	140.720	205.267	270.429	336.213	402.627	469.676	537.367	605.706	674.701	744.358	814.682	885.681	957.360
TOTAL ASSETS	**1.958.665**	**1.922.940**	**1.887.829**	**1.853.340**	**1.819.480**	**1.786.255**	**1.753.673**	**1.721.741**	**1.690.466**	**1.659.854**	**1.629.912**	**1.600.647**	**1.572.066**	**1.544.175**	**1.516.982**
A. OWNER'S EQUITY	**436.372**	**489.469**	**543.820**	**599.442**	**656.349**	**714.557**	**774.082**	**834.939**	**897.145**	**960.715**	**1.025.664**	**1.092.010**	**1.159.768**	**1.228.954**	**1.299.585**
B. PROVISIONS AND LONG-TERM ACCRUED COSTS AND DEFERRED REVENUES	**755.013**	**715.275**	**675.538**	**635.800**	**596.063**	**556.325**	**516.588**	**476.850**	**437.113**	**397.375**	**357.638**	**317.900**	**278.163**	**238.425**	**198.688**
C. LONG-TERM LIABILITIES	**703.221**	**653.243**	**602.612**	**551.318**	**499.353**	**446.709**	**393.377**	**339.346**	**284.610**	**229.157**	**172.980**	**116.067**	**58.411**	**0**	**0**
I. Long-term financial liabilities	703.221	653.243	602.612	551.318	499.353	446.709	393.377	339.346	284.610	229.157	172.980	116.067	58.411	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	**64.059**	**64.952**	**65.860**	**66.780**	**67.715**	**68.664**	**69.627**	**70.606**	**71.598**	**72.607**	**73.630**	**74.669**	**75.725**	**76.796**	**18.709**
I. Short-term financial liabilities	49.333	49.978	50.632	51.294	51.965	52.644	53.333	54.030	54.737	55.452	56.178	56.912	57.657	58.411	0
II. Accounts payable	14.726	14.974	15.228	15.487	15.751	16.020	16.295	16.575	16.862	17.154	17.452	17.757	18.068	18.385	18.709
TOTAL LIABILITIES AND OWNER'S EQUITY	**1.958.665**	**1.922.940**	**1.887.829**	**1.853.340**	**1.819.480**	**1.786.255**	**1.753.673**	**1.721.741**	**1.690.466**	**1.659.854**	**1.629.912**	**1.600.647**	**1.572.066**	**1.544.175**	**1.516.982**

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	46.139	65.551	67.100	68.668	70.256	71.862	73.488	75.133	76.797	78.481	80.185	81.908	83.652	85.415	87.198
2. Depreciation and amortization	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750	99.750
3. Income taxes	-8.766	-12.455	-12.749	-13.047	-13.349	-13.654	-13.963	-14.275	-14.591	-14.911	-15.235	-15.563	-15.894	-16.229	-16.568
4. Decrease (- increase) in accounts receivable	-26.575	-330	-336	-342	-348	-355	-361	-368	-375	-382	-389	-396	-403	-410	-418
5. Decrease (- increase) in inventories	-23.395	-358	-365	-372	-379	-386	-394	-401	-409	-417	-425	-433	-441	-450	-459
6. Increase (- decrease) in accounts payable	14.726	248	254	259	264	269	275	281	286	292	298	305	311	317	324
7. Financial costs	28.009	9.490	8.845	8.191	7.529	6.858	6.179	5.490	4.793	4.086	3.370	2.645	1.910	1.166	412
8. Income related to long-term accrued costs and deferred revenues (subsidies)	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738	-39.738
Net cash flow from operating activities	**90.150**	**122.159**	**122.761**	**123.370**	**123.985**	**124.607**	**125.236**	**125.872**	**126.514**	**127.162**	**127.818**	**128.479**	**129.147**	**129.822**	**130.502**
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	-1.995.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net cash flow from investing activities	**-1.995.000**	**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 (-)	399.000	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	1.519.295	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823	-58.823
Net cash flow from financing activities	**1.918.295**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**	**-58.823**
D. NET BALANCE IN CASH AND CASH EQUIVALENTS															
1. Net cash flow	13.445	63.336	63.938	64.547	65.162	65.785	66.413	67.049	67.691	68.340	68.995	69.656	70.324	70.999	71.679
2. Cash and cash equivalents, beginning of year	0	13.445	76.781	140.720	205.267	270.429	336.213	402.627	469.676	537.367	605.706	674.701	744.358	814.682	885.681
3. Cash and cash equivalents, end of year	**13.445**	**76.781**	**140.720**	**205.267**	**270.429**	**336.213**	**402.627**	**469.676**	**537.367**	**605.706**	**674.701**	**744.358**	**814.682**	**885.681**	**957.360**

Profitability	**Cash flow**
Initial capital investment (discounted for received subsidies)	1.200.250,00
Private equity invested	399.000,00
Equity net present value (NPV)	**284.188,43**
Equity internal rate of return (IRR)	**12,22%**

CASH FLOW in €		**Discount rate:** 4,20%
Year	**Cash flow**	**Discounted Cash flow**
C0	-399.000	-399.000
CF1	13.445	12.903
CF2	63.336	58.333
CF3	63.938	56.514
CF4	64.547	54.753
CF5	65.162	53.047
CF6	65.785	51.395
CF7	66.413	49.795
CF8	67.049	48.245
CF9	67.691	46.743
CF10	68.340	45.289
CF11	68.995	43.880
CF12	69.656	42.516
CF13	70.324	41.193
CF14	70.999	39.912
CF15	71.679	38.670
TOTAL	**558.360**	**Payback: 8,3 years**


Sensitivity analysis - Operating costs
Payback
IRR
Operating costs (% of the actual value)
Payback
IRR


Sensitivity analysis - Heat price
Payback
IRR
Heat price
Payback
IRR

Project performance in €	2019	2020	2021	2022	2023
1. Total income	363.064	367.080	371.169	375.333	379.573
2. Total costs of goods and services	179.166	182.189	185.273	188.420	191.632
3. Cost of labour	10.000	10.100	10.201	10.303	10.406
4. Depreciation and amortization	99.750	99.750	99.750	99.750	99.750
5. Financial costs	28.009	9.490	8.845	8.191	7.529
6. Other costs	0	0	0	0	0
7. EBT	46.139	65.551	67.100	68.668	70.256

Balance sum	1.958.665	1.922.940	1.887.829	1.853.340	1.819.480
Cash Flow	13.445	63.336	63.938	64.547	65.162
Cost of MWh heat sold	145	140	141	143	144
Cost of MWh energy sold (heat + electricity)	103	99	100	101	102

Private equity invested	399.000 €
Net present value (NPV)	284.188 €
Equity internal rate of return (IRR)	12,22%
Payback (discount rate: 4,2%)	8,3 years