DEVELOPMENT STRATEGY OF COMPANY TREBIŠOVSKÁ ENERGETICKÁ, S.R.O.

Project GII00101

SINBIO - Sustainable Innovation In Bioenergy

Cooperation with common values

Biomass – our energetic future

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Supported by a grant from Norway
Co-financed by the State Budget of the Slovak Republic
www.eeagrants.sk

CONTENT

SUMMARY

This report designs the strategic path forward for the company Trebišovská energetická, s.r.o., as main project partner of project SINBIO (Sustainable Innovation in Bioenergy) supported by Norwegian Grants in Slovak Republic under Green Industry Innovation programme. The company was acquired by new owners in 2013, two years after this report was commissioned to help its new leaders think about a coherent direction into the future.

Project SINBI0

Project SINBIO presents unique project in bioenergy sector in Slovakia. The main mission of the project is to ensure sustainable heat production from local renewable sources (biomass) and support local economy of backward regions.

Activities of project SINBIO are taking place in each part of energy value chain – starting with biomass production, through its processing to heat production intended for final consumers.

Project SINBIO is realized in 4 regions of Central and Eastern Slovakia within the cooperation of 6 Slovak and 3 Norwegian project partners.

The main outputs of the project present newly built biomass boiler houses in towns Poltár, Tlmače and Trebišov with total power output of 12,5 MW. Installed boilers have replaced the old systems of central heating running on coal and gas.

SINBIO will also help to extent and improve logistic activities linked with processing of biomass and also with research of energy crop suitable to grow on idle field in Eastern Slovakia. Thanks to the project will be reconstructed training center and service center for biomass operation machinery and new trucks will be bought.

Main project contribution lies in long-term decrease of environmental pollution by GHG and creation of several new green job vacancies. By the change of fuel base from imported fossil fuels to local renewables, the local economies will be supported every year by amount of 2 mil. EUR, that will stay in the region.

IDN role

Main tasks of International Development Norway (IDN) in SINBIO project consisted of drawing strategy for further development of energy facility in Trebišov. The task comprised conducting of investment and risk analysis, analysis of future business direction and analysis of new technical solutions suitable for integration with current energy facility. The results of the work are presented in this report and summarized below.

Main findings and recommendations of report

The company Trebišovská energetická, s.r.o. operates in the district heating sector. District heating is seen as one of promising solution to reach future Europe energy targets and it is mainly due to:

- Reduction in GHG emissions
- Lower local emissions
- Utilization of energy resources that would otherwise be wasted

- High security of supply
- Simple and maintenance-free for the customer
- Increased flexibility of energy supply

The company effort in last years was devoted to change its whole heat production system. In 2015 was finally announced installation of new biomass boiler house.

The new system running on biomass should save <u>more than 7 800 t of CO2 emissions</u> per year.

While the company should continue with successful completion of the project, it needs also to simultaneously reposition strategically due to continuous changing of market conditions (such as decreased demand caused by warm winters, competition and introduced regulatory policies).

With the regards to current investment and based on its **cash flow projection**, the report recommends the company to:

- pro-actively engage in new (de)regulation policy development,
- play with different scenarios (run financial simulations),
- realize marketing (PR) activities to attract new prospects (and conduct analysis of new current/future potential clients),
- plan development of new (pro-customer oriented) services,
- get in touch with professionals from other DH companies with the same technology operations.

With regards to **company business direction**, the report recommends to introduce new services (such as district cooling) to company clients and address new potential consumers mainly from private sector to connect to DH network.

With regards to **prospective technical solution**, the report suggests to install the innovative water treatment plant on company premises in the future or one of other two proposed options – biogas station or geothermal wells for DH. It shall be emphasized, that any of mentioned technical solution should be implemented only based on detailed feasibility study and cash flow projection.

ABBREVATIONS

JV	Joint Venture
DH	District Heating
RONI	Regulatory Office for Network Industries of Slovakia
RES	Renewable Sources
DHV	Domestic Hot Water
BGS	Biogas station
GHG	GreenHouse Gases

LIST OF GRAPH AND TABLES

1. Investment (cash flow) and risks analysis of Trebišovská energetická, s.r.o.

First chapter of the report presents investment and risks analysis of company Trebišovská energetická, s.r.o., one of main partners in project SINBIO (Sustainable Innovation in Bioenergy).

The purpose of our work was to **provide second-opinion on financial viability of presented investment intention.**

The part of this chapter consists also from identification of different categories of risks the project implementation is facing and defining their importance in relation to successful implementation of the project.
The risks analysis was conducted based on the findings (result) of the cash-flow analysis and based on our understanding of SINBIO project and business model of company Trebišovská energetická, s.r.o. from provided materials and discussions with its managers.

The aim of our work (based on our calculations and expert opinion) was **to stipulate recommendations** that we advise to be taken by the company management **to ensure financial viability and long-term sustainability of the project.**

1.1 Input data

The basis (input data) for the cash-flow/risks analysis, provided by management of the company Trebišovská energetická, s.r.o. and management of project promoter Intech Slovakia, s.r.o. presented:

- Project investment budget
- Financing sources structure
- (Operating) revenues and costs projection
- Business model of current company operation

Below we describe first three items more in details.

1.1.1 Project investment budget

At the beginning we would like to emphasize, that the investments of company Trebišovská energetická, s.r.o. is realized with support of Norwegian Grants under Green Industry Innovation programme in Slovakia. Therefore in relation to project investment budget we considered as important to distinguish in our analysis terms: eligible investment costs (grant management/financing/accounting rules applies here) and non-eligible investment costs.

Eligible investment budget consists of items, which were approved by Norwegian grants Programme Operator during the grant approval process. Every budget item had to fall under one of the following areas of energy value chain – Biomass production, Logistics centre, Energy production.

Non eligible investment budget consists of items, which either could not be included in the eligible costs due to rules applied by Norwegian Grant programme (costs such as project management, tendering, financial consulting, etc.) or they exceed maximum total grant amount for all project partners (5 000 000 EUR), the latter applies in this case.

The total investment budget of Trebišovská energetická, s.r.o. illustrates table below:

Table 1 Trebišovská energetická, s.r.o. investment budget in project SINBIO

ITEM	COSTS (WITHOUT VAT)
Biomass boiler house (4 MW wood chips + 4 MW straw)	**4 963 101 €**
Pipeline connection and centralization to existing district heating pipelines network	**4 449 818 €**
ELIGIBLE INVESTMENT COSTS -SUM	**7 449 599 €**
NON-ELIGIBLE INVESTMENT COSTS	**1 963 320 €**
TOTAL INVESTMENT COSTS OF TREBIŠOVSKÁ ENERGETICKÁ, s.r.o.	**9 412 919 €**

Source: Intech Slovakia, s.r.o.

The total project investment budget of the company presents amount of 9 412 919 €.

The share of eligible investment costs on total investment budget presents 79%. All eligible investment costs fall under area of Energy production, so it is important to say that the company Trebišovská energetická, s.r.o. will realize its investments only in this area, since **it main scope of business is heat production and distribution in form of district heating in Slovak town Trebišov.**

Other partners in SINBIO project will cover remaining areas - Biomass production (local farmer Ľubica Takáčová) and Logistics centre (Intech Slovakia, s.r.o., EPPROS, s.r.o.). Due to contractual character of partnerships between the entities, we have excluded their investments from the analysis.

Table below depicts total investment budget of whole SINBIO project. The share of eligible investment costs of company Trebišovská energetická, s.r.o. on total costs is significant and it presents 77%. Ihe investment activities of the company are crucial for the SINBIO project success and viability.

Table 2 Eligible investment costs of SINBIO project partners

PROJECT PARTNER	INVESTMENT COSTS
Intech Slovakia, s.r.o.	**1 854 333,00 €**
EPPROS, s.r.o.	**300 000,00 €**
Ľubica Takáčová	**98 700,00 €**
Trebišovská energetická, s.r.o.	**7 449 599 €**
TOTAL INVESTMENT COSTS OF PROJECT SINBIO	**9 702 632 €**

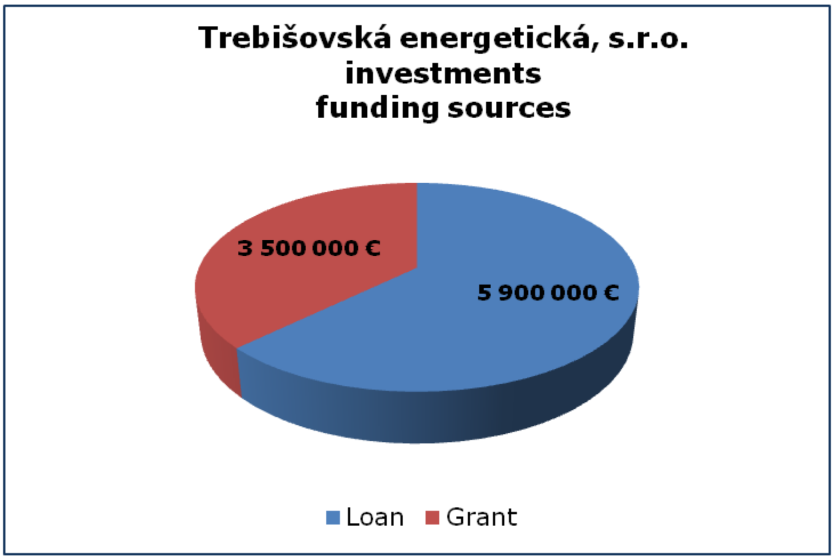
Source: Intech Slovakia, s.r.o.

While we will keep in mind overall SINBIO project scope, we will focus our analysis only on the company Trebišovská energetická, s.r.o. and its business.

1.1.2 Project financial sources

The company uses combination of 2 funding sources to realize its investments – mentioned grant funding and debt service. Share of individual source depicts graph below:

Graph 1 Trebišovská energetická, s.r.o. project funding sources



Source: Intech Slovakia, s.r.o.

Debt service presents around 63% share on total project investments; remaining 37% is grant funding.

Regarding grant financing there is strict rule, which has to be applied – 46,98% of eligible investment costs shall be covered from the grant (regardless potential investment costs savings), the rest has to be covered by other sources.

The investment loan of 5 900 000 € will be provided under interest rate of (not disclosed) and is anticipated payment period presents 15 years.

1.1.3 Revenues and costs projection

Prior conducting of cash-flow analysis the company Trebišovská energetická, s.r.o. provided us plan of its operating revenue and costs over next 15 years, also loan amortization schedule (plus interests) and investment assets depreciation schedule, which prorates asset's cost over its life (based on Slovak accounting/tax law rules).

We have used the data in elaborated cash-flow projection below.

1.2 Cash flow analysis

In relation to calculated cash flow projection we would like to emphasize, that the calculation shall be considered as strongly indicative due to following reasons:

- calculation fully relies on the numbers provided by client,

- depreciation costs of investment assets were calculated using indicative date of entry of the assets into the accounting (beginning of year 2016/first year of operation),

- calculation does not include any aspect of VAT settlement or any other loans (such as VAT facility)

- and it does not consider any other investments potentially needed during the projected period.

The main 3 calculated indicators in our cash flow projection present:

- "Substraction" from Debt Service
  (Depreciations + Loan interests – Grant amortization) – (Loan principal payments + Loan Interests)

The indicator shows what amount of the loan has to be covered from the net profit (or other own sources) in the respective year. It is very important indicator for project management board to know, because it shows, what is required minimum profit project has to reach to pay its liability towards co-financing bank.

- EBITDA/EBIDA
  (Net profit + Income tax + Depreciations + Loan Interests – Grant amortization)/
  (Net profit + Depreciations + Loan Interests – Grant amortization)

A measurement of a company's operating profitability. Because EBITDA excludes depreciation and amortization, EBITDA margin can provide an investor with a cleaner view of a company's core profitability.

- Debt-Service Coverage Ratio (DSCR)
  (EBITDA: Net profit + Income tax + Depreciations + Loan Interests – Grant amortization)/(Loan principal payments + Loan Interests)
  *respectively DSCR II. – using EBIDA (excluded Income tax)

The ratio measures the cash flow available to pay current debt obligations. The debt service coverage ratio is important not only to the project management, but also co-financing bank since this ratio measures a firm's ability to make its current debt obligations.

The final cash flow projection is depicted by table below. The table presents our calculation with retained data from the company.

Table 3 **Trebišovská energetická, s.r.o. project cash flow projection**

Not disclosed

Source: IDN

We can say, that the development of the company revenues and costs over analyzed period reflects the situation in district heating sector in Slovakia. The sector is highly regulated and a new trend of decreasing of heat consumption and customer's disconnection from the network has emerged in recent years.

Both, revenues and costs over whole projected period are on the same level comparing to baseline year. The revenues of the company (and related costs) will come only from selling of the heat in form of space heating and DHW to the customers in town Trebišov.

<u>**The initial revenue - cost calculation was based on the assumption that the company will on one side lose some of its customers, but at the same time will attract new clients willing to connect to the DH network.**</u>

Based on the result of the calculation it can be generally stated, that the new investments in heat production from biomass boilers will bring the company (besides other advantages) also positive cash flow. <u>The cumulative cash flow netto over 15 years will present more than 5 mil. €.</u>

DSCR II. ratio in this case would reach over 15 years period range between 1,21 – 1,38, what fulfills co-financing bank minimum requirements (<u>the minimum ratio value per year that would be accepted by the bank, when considering loan provision presents value around 1,2)</u> and the company would not have problem to repay its loan. **The company will be able in this situation to pay its loan obligations by the reached depreciations.**

<u>We consider presented cash-flow calculation (based on the data provided by the client) as conservative scenario.</u> As far as we have learned it is mainly due to the unstable environment on district heating market caused by unpredictable, but strong regulation effort.

In the sub-charter 1.3.1 Sensitivity analysis on critical quantitative parameters we present different scenarios of financial figures development, when the project operation will not evolve as it was planned (in pessimistic, but also optimistic way). We will point out the critical values of most important parameters that shall not be exceeded to ensure project viability.

1.3 Risk analysis

While they are prevailing advantages of operating district heating facilities with strong tradition in Slovakia, there are also related risks (some of them already mentioned) the company may face in the future.

Risk analysis is used to identify and assess factors that may jeopardize the success of the project (investment) or achieving its goals.

In relation to realization of investments of the company Trebišovská energetická, s.r.o. we have identified following risks (see table below), which are divided in the 6 main categories.

For every risk we defined, if its cause is of external nature (comes from the outside environment) or of internal nature (emerged from the company operation itself). We also identified what consequences the individual risk may have on the company cash flow.

Table 4 Risks definition for Trebišovská energetická, s.r.o.

	RISK	DESCRIPTION	EXOGENOUS (EX) OR ENDOGENOUS (EN) TO THE INVESTMENT	CONSEQUENCE (IMPACT) ON PROJECT OBJECTIVES
1. POLITICAL RISKS				
1.1	REGULATORY	Regulatory risk presents introducing of new unfavorable conditions for district heating sector due to changes in energy and climate policy, environmental permitting, energy regulation. *Heat energy sector in Slovakia is strongly regulated industry by RONI (Regulatory Office for Network Industries) under the Act on thermal energy. The price regulation applies to the production, distribution and supply of heat.*	EX	• Decreased profit (forced - artificial influencing of costs/revenues)
1.2	FISCAL	Fiscal risk presents introduction of new unfavorable changes in taxation rates, in applicable allowances (amortization, etc.). *The example of fiscal risk which may impact BLC operation include mainly:* – *Income tax or VAT rate changes* – *Changes in the assets depreciation methods* – *Changes in the tax eligible costs and revenues items*	EX	• Increased income tax • Increased costs - decreased profit
1.3	LEGAL	Legal risk presents weak independent justice, enforcement of court awards mainly in the case of *contractual relationship disputes (unpaid invoices by customers)*	EX	• Write-off of receivables (Decreased revenues) • Increased other operation costs (for legal services, etc.)
1.4	INFRASTRUCTURE INVESTMENTS	This risk presents lack of infrastructure investments or favoring investments in other regions which may cause, that *potential new large client will open his premises in other*	EX	• Slowed/prevented future expansion

		district heating region due to better business conditions.		of sales
2. ECONOMIC RISKS				
2.1	FINANCIAL	The financial risk presents lower project profitability as projected and consequent problems with repayment of provided debt service. *Project foresees steady costs and revenues over the projected period, but due to many other risks involved the anticipated numbers could not be met.*	EN	• Increased interest rate of loans (introduced unfavorable debt service conditions) • Decreased net cash flow
2.2	CUSTOMER DEMAND	The risk of not meeting demand expectations, reduced demand due to customer actions and/or behavior.	EX	• Decreased revenues
2.3	CONTRACTUAL	The risk presents counterparty (supplier/client) default - bankruptcy, force majeure.	EN	• Unavailable fuel on time • Decreased sold heat volume – decreased revenues
2.4	COMPETITION	The risk presents *competition of other heating forms* (such as heat pumps, solar collectors, gas boilers, individual boiler houses, etc). There is also risk of launching new break-through technologies for energy production.	EX	• Decreased revenues • Slowed/prevented future expansion of sales
3. SOCIAL RISKS				
3.1	PUBLIC ACCEPTANCE	The risk presents resistance of public and interest groups in supporting heat production by new biomass boilers. Biomass business can be viewed as exploitation of natural sources.	EX	• Project Reputation • Slowed/prevented future expansion of sales
4. ENVIRONMENTAL/ECOLOGICAL RISKS				
4.1	EMISSIONS	Risk of increased "local" emissions emerged from heat production in the newly build biomass boiler house.	EN	• Increased additional investment costs in more ecological technology • Project Reputation
4.2	WASTE	Risk of increased production of operating waste - ash and its	EN	• Increased

		inappropriate treatment.		operation costs
4.3	DISASTERS	Risk of occurrence of natural disasters directly affecting company operation/facilities.	EX	• Increased investment and operation costs • Decreased revenues due to heat supply interruption
		5. TECHNICAL RISKS		
5.1	PERFORMANCE AND SERVICE FACTOR	Risk of low quality, reliability and efficiency of used technology.	EN	• Increased operation costs for maintenance and service • New investment costs
		6. MANAGERIAL RISKS		
6.1	LACK OF EXPERIENCE	Risk of uneffective management decision caused by complexity of new company operation and lack of previous experience (no previous experience with heat production from straw).	EN	• Extended project duration (schedule) and associated increased operation/investment costs

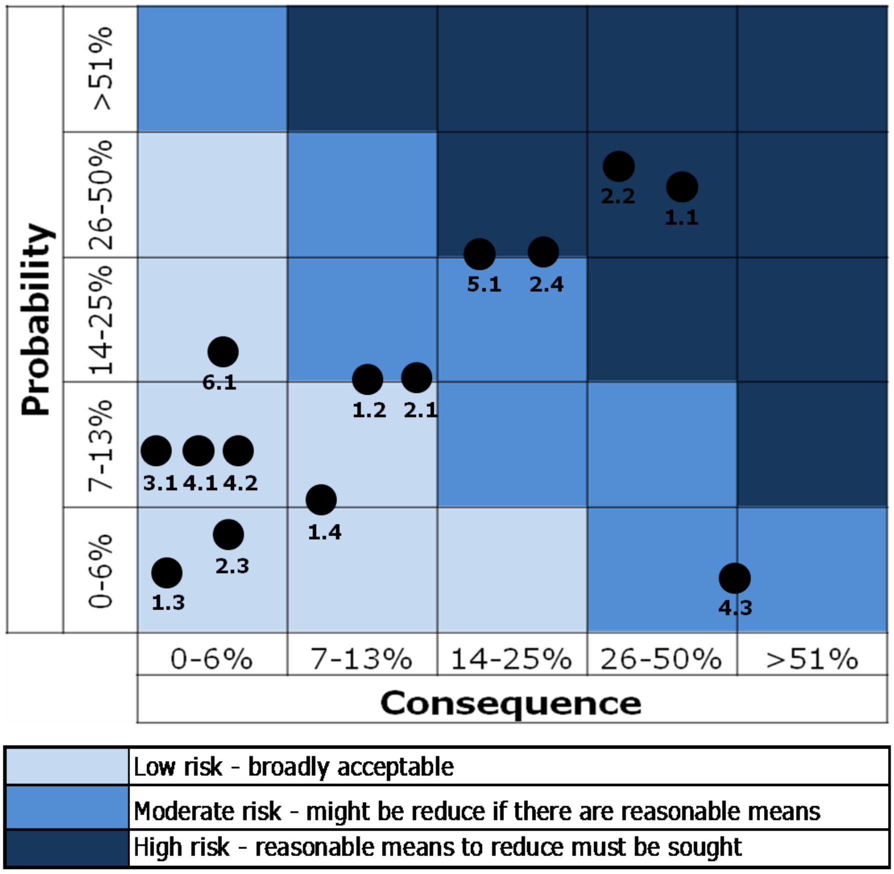
Source: IDN

1.3.1 Qualitative risk assessment (risk mapping)

Qualitative risk assessment serves to provide better picture for company management, when decide where to focus their attention in their risk mitigation strategy. It is concerned with discovering of the probability of a risk event occurring and the impact the, risk will have if it does occur.

We grouped together individual risk in 3 main risks categories (low, moderate and high) based on our expert opinion, depicted by drawing below:

Scheme 1 Qualitative risk assessment



Source: IDN

Based on our point of view we consider as substantial to the company investment realization 4 following risks:

STRONG REGULATION (1.1)
The DH sector in Slovakia is not subsidized but strongly regulated. Intensive heat sector regulation in Slovakia done by RONI significantly affects (and will affect) future business of the company Trebišovská energetická, s.r.o.. <u>The regulator regulates not only the eligible cost structure, but it states maximum unit price for selling heat, regardless the type of the customer (individual – industrial)</u>.
We describe regulation of DH sector in Slovakia more in details in the next chapter (2.3 Existing barriers for development).

CUSTOMER DEMAND (2.2)
With the continuing climate changes it seems, that the weather in Slovakia will get warmer each year, so there is high probability that the customers demand for heat supply will gradually decrease. This will happen not only due to the warmer weather, but also due to the already implemented energy efficiency measures, such as building insulation.
/Heating in Slovakia begins when the outdoor average daily air temperature in the heating period falls during two consecutive days below 13°C and according to the predictions of the weather the increase of the average daily air temperature is not expected. Heating period usually begins on September 1 and ends on 31 May of the following calendar year. The period of the heating season is determined by decree of the Ministry of Economy nr. 152 (§ 1. Heat supply). However, even after the end of the official heating season, there may be cold weather and the formal requirements of individual residential buildings and other customers have required to restart heating./

COMPETITION (and NEW TECHNOLOGIES) (2.4)
The DH price regulation in Slovakia sets one single heat sales price for the DH company and its customers. This means that one maximum price is set for all customers of a single heat supplier. Thus, the same price is paid by residents and industrial customers. <u>Large industrial customers, due to economy of scale, require a certain price advantage similar to those that can be applied for example by the electricity or natural gas consumption</u>. And since heat suppliers cannot charge them a different price than other customers, they consider individual heat supply based for example on natural gas more economic.
While, based on the recent amendment to the Act on thermal energy it is not so easy for current clients to disconnect from the DH network (certain requirements must be met), the new potential clients may face hard decision, when opting for DH or other alternative heating form (individual boiler houses, heat pumps, solar thermal energy, etc.).

Based on the information from the client, the company Trebišovská energetická, s.r.o. has not yet experienced a case, when customer disconnected from its DH system, but the probability of this scenario to happen may significantly increase in the future.

We cannot also omit the speed of technical development in the world. The serious indirect competition for the company will present new or more advantageous forms of heat production.

PERFORMANCE AND SERVICE FACTOR (5.1)
The company Trebišovská energetická, s.r.o. part in the project SINBIO consists of building of two 4 MW boilers using wood chips and straw as fuel. The heating from biomass will be new experience for the company and its employees. While there are many installation with wood chips boilers across Slovakia, the straw boiler operation will be first of its kind in the Slovakia. Because of missing experience there is therefore high risk of inappropriate boiler operation and/or its maintenance, what can result in higher operation costs and possible boiler downtime. The same applies also to the inappropriate feedstock storage.

1.3.1 Sensitivity analysis on critical quantitative parameters

Main purpose of the sensitivity analysis is to provide valuable insight how would key financial indicators develop, if the project would not run as expected.

We analyzed the change of key financial indicators in 2 potential scenarios when the expected revenues and operating costs over 15 year period would be cutted off by 25% or increased by 25% (not taking into account any potential changes in the fix costs).

The changes in operating costs were done across the board, since we were missing detailed, structured data to be able to calculate it more precisely.

The results of our analysis are depicted by tables below:

Table 5 75% of projected annual operating revenues/costs

Not disclosed

Source: IDN

Table 6 125% of projected annual operating revenues/costs

Not disclosed

Source: IDN

Based on our findings, if the expected project annual revenues and operating costs would decrease only by 1%, the situation may already create problems with co-financing bank (since DSCR ratio will be below limit of 1,2). When not taking in to account the bank rules, then not even 25% decrease of annual revenues and operating costs would jeopardize the project, since it will still create positive cash flow.

Critical situation (under condition that co-financing rules od DSCR II. ratio >1,2 are not taken in to account) would present for the company annual decrease in operating costs and revenues by more than 33%, when it will jeopardize the viability of the project, since it net cash flow would be getting negative. The scenario depicts table below:

Table 7 67% of projected annual operating revenues/costs

Not disclosed

Source: IDN

1.3.2 Risk Mitigation strategy

Based on our findings we recommend to the company management to take following risk mitigation measures:

Be engaged pro-actively in new (de)regulation policy development

We strongly advise company management to team up with other district heating companies in Slovakia and other relevant stakeholders who would like to create more stable and favorable conditions on district heating market. They should create "common voice", develop strategy how to approach the regulator (and other relevant players - Gov Office, Ministries, etc.) and together also develop a clear proposal how should conditions be changed, and what benefit it will bring to all parties (with public interested first in mind).

Develop and run simulations – play with different scenarios

We consider as very helpful to create a financial model (can be in Excel) and run simulation to discover how the main economic parameters would change (Revenue, Costs, Profit, Netto cash flow), if for example the main industrial client will disconnect, or more residential buildings will disconnect, but also how it will affect company numbers when it gain new customers or the regulator will introduce even less favorable conditions (or the combination of above). We see such scenario playing as very useful way to strengthen ability to properly react on future changes on the market and/or develop and implement company future strategy.

Realize marketing activities to attract new prospects

Company should be active in attracting new clients. First step should cover identifying who are current (and future) potential customers and the second step designing (and implementing) strategy (PR activities) to attract them (we will dive deep into the topics in the following 2. chapter).

Plan development of new (pro-customer oriented) services

Despite the strong regulation the company may already start to design new pricing model for different level of clients or for different seasons during the year or different payment options), so it will be prepared ahead, when the regulation conditions get more favorable. Very inspiring example of flexible pricing presents company Fortum, which operates in Nordic and Baltic countries (http://www.fortum.com/en/products-and-services/district-heating/pages/default.aspx).

Besides flexible pricing we see also as very promising development of other new services for district heating customers – such as district cooling, which may be, due to the weather changes, "on the rise" in the future.

Get in touch with professionals from other DH companies with the same boiler technology

We also consider as very important to engage professionals from other DH companies in Slovakia or abroad, who operate biomass – wood chips and straw boilers. The company management and workers should get assistance (besides training from boiler producer) and learn from the experiences on how to operate properly and maintain the new biomass boiler plant.

1.4 Key findings and recommendation for company management

Based on the cash flow analysis of the retained data the investment of company Trebišovská energetická, s.r.o. will present successful project from the point of view of stable cash flow for its shareholders over projected period (the cumulative cash flow netto should reach more than 5 mil. EUR).

From our opinion we consider the cash flow projection as a conservative version and there is opportunity also to reach higher numbers. But as we learned the investment project is significantly affected by following risks that should be taken into account:

- strong regulation of DH market,
- lower customer demand,
- intensive competition,
- missing previous experience with performance and service of biomass boiler house.

Critical point, when the project will require additional financial sources to be "poured in" (not considering co-financing bank rules) will happen when expected annual revenues and operating costs will be decreased by more than 33%.

To ensure project sustainability and viability, or better said its development to reach even more promising numbers, we recommend company management in relation to the main project risks:

- to be engaged pro-actively in new (de)regulation policy development,
- to run financial simulations – play with different scenarios,
- to realize marketing (PR) activities to attract new prospects (and conduct analysis of new current/future potential clients).
- to plan development of new (pro-customer oriented) services,
- to get in touch with professionals from other DH companies with the same technology operations.

In the following chapter we will look more in details what business opportunities can company Trebišovská energetická, s.r.o. utilize to fully realize its economic potential.

2. Analysis of future business directions for company Trebišovská energetická, s.r.o.

2.1 Local stakeholders

Trebišov is a Slovak town situated in the area of Eastern - Slovak plain with 23 thousand inhabitants (whole Trebišov district has around 103 thousand inhabitants).

District of Trebišov historically dominated in the area of agricultural and food production. In 90´s of last century after political and society changes the industrial structure has changed as well.

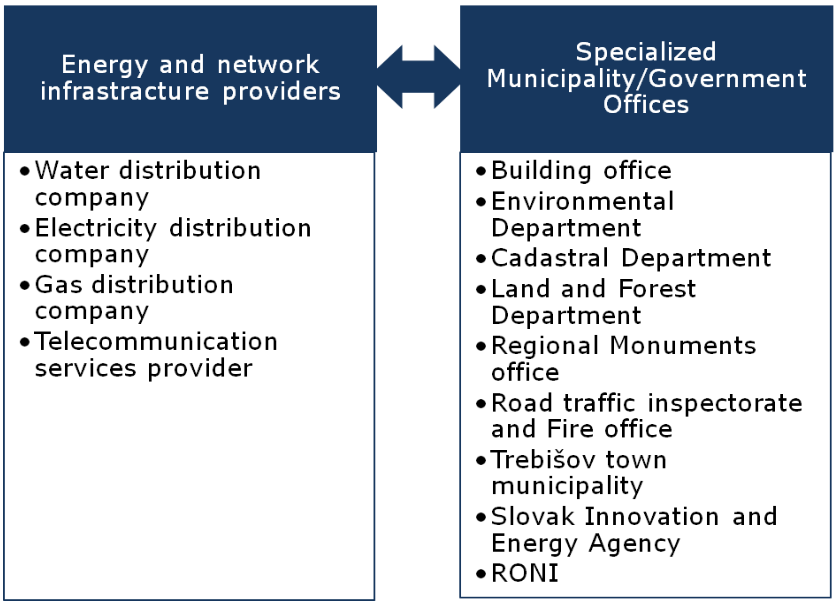
Bearing sector became the processing industry focused mainly on metal processing. Food production in the town is significantly represented by production and processing of chocolate and candies. In recent decades also building industry has developed in the town.

City of Trebišov has developed infrastructure with public administration, available specialized health services and network of health services providers, elementary and secondary technical schools, high school, sport areas - ice hockey stadium, sport hall, football stadium, in-door out-door swimming pool. Whole district of Trebišov has also significant potential in the area of tourism development especially in the wine area - Tokay wine route.

In terms of the company Trebišovská energetická, s.r.o. it is operating in “active” town with developed infrastructure and potential for further development.

The main stakeholders who may influence the company operation presents scheme below:

Scheme 2 Stakeholders of Trebišovská energetická, s.r.o.



Source: Trebišovská energetická, s.r.o.

Because company operates in network industry sector its operation is influenced by many players on local, regional and national level. Mainly during energy project designing phase each of them has right to reject proposed investment or ask for its modification (which may trigger added investment costs). Then on regular basis the company needs to undertake inspection and attestation of its energy facilities (for example every 3 years there is attestation of its boilers done by Slovak Innovation and Energy Agency - SIEA).

2.2 Current customers base of company

In 2014 the company earnings presented around 1,5 mil. EUR.

Graph 2 Heat consumption of clients of Trebišovská energetická, s.r.o. in 2014 (in kWh)

Not disclosed

Source: Trebišovská energetická, s.r.o.

Based on kWh consumed the biggest proportion on provided services has space heating.

Graph 3 Share on heat consumption of individual customer groups of Trebišovská energetická, s.r.o. in 2014

Not Disclosed

Source: Trebišovská energetická, s.r.o.

In terms of different customer groups, both space heating and DHW is provided mainly to housing co-operatives and public sector (municipality or state owned/controlled organization). The company has only 1 client from private sector. As we had learned from client and based on our own analysis **there is huge potential for the company to connect new customers to its network – mainly from private sector, who are running their businesses in the town Trebišov and are situated closely to the DH pipelines.**

In subchapter 2.4 we present new potential customer base of the Trebišovská energetická, s.r.o..

2.3 Existing barriers for development

In this sub-chapter we present 3 main identified barriers for further company development.

The top and the main barrier for development is already mentioned strong regulation of the company, as producer and distributor of heat (providing space heating and hot water supply).

Heat energy sector in Slovakia is a regulated industry. RONI is a national body which regulates also the heating industry. Price regulation applies to the production, distribution and supply of heat and is carried out by determining the method of calculating the maximum heat price (RONI Decree no. 222/2012 Coll., As amended, establishing a price regulation in the thermal energy and the Law no. 250 / 2012 Coll., as amended by regulation in Network Industries).

The underlying basis for the regulation of heat energy is currently valid for the regulatory period 2012 - 2016. One of the objectives and priorities for regulatory policy is to ensure the stability of the market environment for regulated entities. Therefore, the Council for the Regulation set the duration of the regulatory period for 5 years (2012-2016) so that the heating sector becomes a stable industry with a predictable and transparent regulatory environment. However, in current practice there are significant changes in terms of regulation during the regulatory period - by amending the legislation. To change the Authority access without prior assessment of the state, i.e., without analysis are not available, and thus cannot be reviewed. Their credibility is called into question. There is no guarantee for predictability of the proceedings of RONI.

On the heat market there has been roughly a stable number of heat suppliers over the last years. However, the DH sales have had a long-term declining trend, and it is expected that this trend will continue. For the past 10 years there has been a substantial reduction in DH generation and supply due to termination of heat consumption (mainly industrial customers in the cities where the DH systems are developed, due to the building of so-called residential heat sources, mostly based on natural gas), as well as the heat savings on heating and hot water by implementing measures on the production side (installing modern technical equipment for heating), as well as on the demand side (hydraulic adjustment, installation of the thermo regulatory valves, insulation of buildings). The decrease in heat sales is also affected by the behavior of end users (saving, sometimes at the expense of thermal comfort) due to increasing prices of heat.

As a result of the heat sales decline and the set-up of the current price regulation the share of fixed costs on the unit price of heat tends to increase, which encourages disconnection of customers from DH systems. In order the heat suppliers to maintain their competitiveness, they must find new heat customers. While this is not case in town Trebišov, the company Trebišovská energetická, s.r.o. expects that the situation in following years may start to shift.
Based on regulation the maximum heat price constitutes in general a so called two-part tariff which consists of its variable part (costs related to the actual fuel consumption together with consumption tax on mineral oils) and its fixed part together with adequate rate of profit set by the regulator. The price approved for the individual heat producer/distributor is apart from some exceptions common for all consumers within the relating municipality or certain parts of its area.

Variable component of the heat price is calculated in €/kWh and covers the costs on fuel, energy and technological material. It represents approximately 60 – 70% of the total heat price depending on a kind of fuel for heat production. It is determined by planned heat consumption as well. Fixed component of the heat price is set in €/kW and corresponds to the whole regulatory input power which reflects the real heat consumption in the year t-2. It may cover only eligible costs on heat production and distribution (e.g. costs on amortization, repairs and maintenance, costs on various legal obligations connected to heat production, insurance, audit, services, personal costs and adequate rate of profit) and represents in average around 30% of the total heat price.

From the economic efficiency point of view the heat price covers just certain, regulated rate of heat losses. Finally the VAT of 20% shall be added to variable and fixed part of the tariff.

The second important barrier for the company development which relates partly to strong regulation is available funding ("cash"). The company was bought 2 years before by new private investor, who has announced gradual rebuilding of the DH system and its switch to renewable sources. New company management has introduced also more effective financial management, but years of "stagnant" company control by Trebišov town municipality in the past left the company in weak financial condition.

The third significant barrier for further development of the company is more intensive politics in its area. Because company operation belongs to network industries and it plays important role in people daily life, it presents also means for different political intentions. And because any new planned technological investment efforts of the company requires plenty of permissions from different local/national authorities, they can be easily misused by different third party interests.

2.4 Assessment of potential connection of new customers to DH

As was mentioned earlier main company customers present state/public sector and house cooperatives. Based on studing of Trebišov town DH network distribution map and discussions with management we found out that connection of new, highly prospective customers in the town would bring company additional income of at least 350 000 Eur/year, while the connection costs would be minimal. That means additional approx. 20% of company current revenue.

Future prospective customer would come mainly from service sector (store buildings and offices owned by local businesses).

New customers would require additional approx. 1,8 MW of heat. This additional demand can be covered partly by newly built biomass boilers and existing "central" gas boiler in the town, or by one of technical solution depicted in next chapter (after conducting feasibility study and cash flow analysis).

Table below presents detailed overview of new potential customers of company Trebišovská energetická, s.r.o.

Table 8 Overview of Prospective Clients of Trebišovská energetická, s.r.o.

Not disclosed

Source: IDN

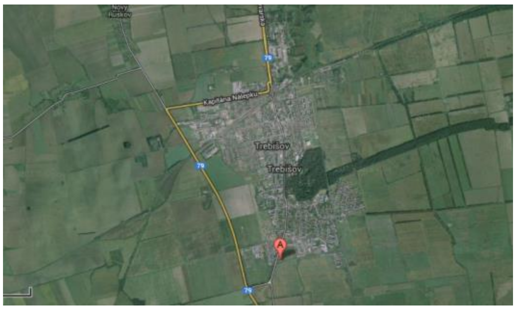
3. Analysis of new technical solutions for integration with newly built energy facility in Trebišov

3.1 Current solution

In project SINBIO the company Trebišovská energetická, s.r.o. is reconstructing its central DH system in Eastern Slovakia town Trebišov. The initial, previous DH system was based on natural gas heating. With the SINBIO project the company will build new modern renewable district heating from biomass. The project consists of 2 core activities:

1. Building of new biomass boiler house

Building of heating plant on the area o 727 m^2 (plant will consists of 1x 4MW wooden chips boiler; 1x 4 MW straw boiler and 1 other boiler). Besides heating plant will be part of the complex building also ready-to-use straw stock on the area of 734 m^2 and technical outbuilding on the area of 313 m^2. For storage of wooden chips will be built open space storehouse on the area of 4771,1 m^2, the straw biomass will be stored in the covered storehouse on the area of 2956 m^2. Wooden chips will be transported from the storehouse to the so called daily chips stock by the spoon loader and then with the help of hydraulic feeder will be transported directly to the boiler. The straw will be transported to ready-to-use straw stock by the forks loader. Ash created during the burning process will be removed by automatic conveyors into the large capacity containers.



<u>There will be also free area of 19 436 m^2 which will be dedicated to the further development of energy facility.</u>

2. Building of interconnection of new boiler house to existing pipeline system in 2 phases:

1. Interconnection of the new central energy source to the current heat distribution system - building of the hot water pipes from the new biomass boiler plant to the currently operating central gas boiler plant, 2. Centralisation of the new heat distribution system (interconnection with local gas boiler plants). Technical parameters of the pipeline system interconnection are:

- temperature gradient (primary hot water) 95/55°C
- maximum operating pressure 1,0 MPa
- pre-insulated pipes dimensions DN 32 up to DN 300

Because new company premises offers huge potential for further enlargement we have analyzed potential technical options, which could be in the future install on the site and supplement new biomass boiler house operation.

3.2 Potential technical options for future development

While the client has already some ideas for future development of energy facility areal in Trebišov, such as to install 3rd biomass boiler or provide district cooling beside DH, we have tried to find also other opportunities, which could be very well integrated with the newly built biomass boiler house. We came up with 3 promising options described below.

3.2.1 Municipal/Agricultural Waste Processing Plant (BGS)

<u>First technology option presents more traditional technical solution, already well implemented in Slovakia.</u>

Different waste management technologies have the potential to reduce the amount of municipal solid waste disposed in landfills while also providing electricity or electricity and heat that reduces GHG emissions. The main benefits of these technologies are:

- reduction of methane emissions from landfills,
- reduction of GHG emissions,
- reduction of emissions from energy consumption,
- increase of storage of carbon in trees (carbon sequestration).

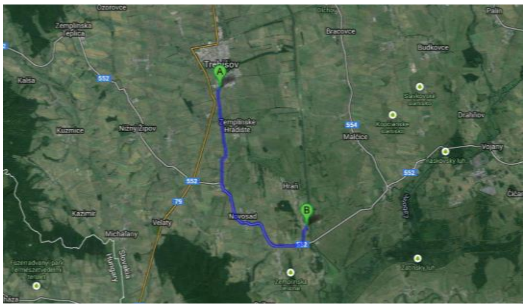
As was already said, the Trebišov town district dominates agricultural production, because of fertile lands. Based on our findings the waste from agricultural production is used as feed for cattle, as natural fertilizer or is left on the land to prevent weed growth but it is used also as feedstock for local BGSs. In Trebišov town district were built 2 BGSs with total 1,4 MW power output, and other 6 BGSs are located in the neighboring town districts Košice and Michalovce.

Regarding the town municipal waste, table below shows the structure of disposed municipal waste.

Table 9 Structure of municipal waste in town Trebišov (2012-2013)

Type of waste	Volume (t)		Waste treatment
	2012	2013	
WEEE	8,43	9,72	recycling or recovery
Motor oil	1,75	n/a	recycling or recovery
Oils and fats	2,56	n/a	recycling or recovery
Plastics	26,82	24,94	recycling or recovery
Paper	29,36	8,23	recycling or recovery
Glas	28,41	22,94	recycling or recovery
Soil and stones	48	4,8	landfill
Mixed construction waste	507	496	landfill
Mixed municipal waste	9 096	9 242	landfill

Source: Trebišov town municipality



Municipal waste is disposed by responsible association representing municipalities by landfilling. Currently is municipal waste stored in the landfill in village Sirník, 19 km from Trebišov.

In terms of Trebišov and our analysis we have consider anaerobic digestion as most effective and considerable approaches to manage town solid waste and build integrated energy facility on premises of company Trebišovská energetická, s.r.o..

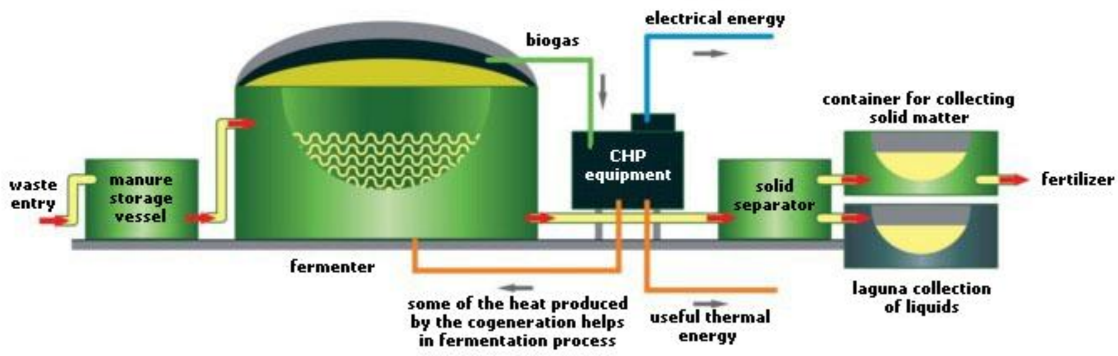
Anaerobic Digestion, as one of the main options for processing the biodegradable organic materials, consists of the degradation of organic material in the absence of oxygen and the presence of anaerobic microorganisms. It produces biogas as a source of renewable energy which contains mainly 60-70% methane 30-40 % carbon dioxide gas, tracer amount of nitrogen, oxygen, hydrogen and hydrogen sulfide as well as nutrients in the form of compost product as a fertilizer and soil conditioner. The biogas which is produced in anaerobic digestion process can be used directly as fuel or as electricity provider in a BGS. By recovering energy, the fossil fuel usage for providing energy can be avoided and so, there is a potential for GHG emissions avoidance.

Next table below presents our preliminary design assumptions for technical solution of BGS in Trebišov:

Table 10 Preliminary design assumptions for BGS project

<table>
<tr><th colspan="2">TECHNICAL PARAMETERS</th></tr>
<tr><td>BGS operation</td><td>8 000 hours/year</td></tr>
<tr><td>Waste consumption (organic municipal waste + agricultural waste)</td><td>30 000 t/year</td></tr>
<tr><td>Produced biogas</td><td>3 500 000 m3/year</td></tr>
<tr><td>Produced electricity</td><td>7 200 MWe/year</td></tr>
<tr><td>CHP unit output</td><td>1 MW –electricity/1,1 MW heat</td></tr>
<tr><th colspan="2">MAIN TECHNOLOGICAL COMPONENTS:</th></tr>
<tr><td colspan="2">Foundation of BGS should present two fermenters (each with sludge tank capacity around 2 700 m^3 and gasholder volume in rooftop of 1 000 m^3), decomposition storage tank (with sludge tank capacity of 3 600 m^3 and gasholder volume 1 200 m^3) and end storage tank (with sludge tank capacity of 6 000 m^3 and gasholder volume of 1 800 m^3).
For intake of fluid waste should serve underground concrete tank with the capacity of 100 m$^{3.}$ For intake of solid waste serves designed shredder with a capacity of 50 m^3, which can deposit at one time about 40 tons of waste. From the tanks the waste is transported by screw conveyors directly into the fermenters.
In the fermenters is waste decomposed by anaerobic digestion (without air and light access, by the temperature of 40 ^{0}C and periodical stirring). The result of digestion process is biogas (the main component are methane and CO_2) and the byproduct digestate.
The generated biogas is collected in the fermenters rooftop gasholders and is transported to the CHP unit. The installed CHP unit should provide power and heat output of 1 000 kW._Part of generated electricity can be consumed directly within the biomass boiler house; the part of the power is consumed by the BGS itself and the rest can be transmitted to the grid (depends on particular day/hour; production/free days). The heat can be consumed in the form of hot water and space heating.</td></tr>
</table>

Scheme 3 Main Components of BGS



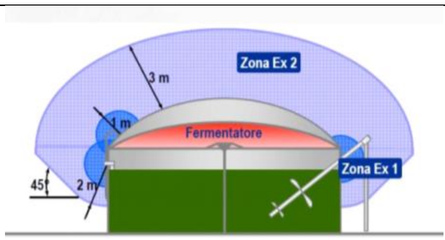
Source: *http://www.bteam-energy.ro/*

The electricity produced by the BGS will be transmitted mainly to the grid, around 300 kW may be consumed by boiler house operation and administration center of company. The heat produced by BGS will be transmitted to heat network to cover increased heat demand caused by newly connected consumers.

Following table presents risk associated with BGS project:

Table 11 BGS project associated risks

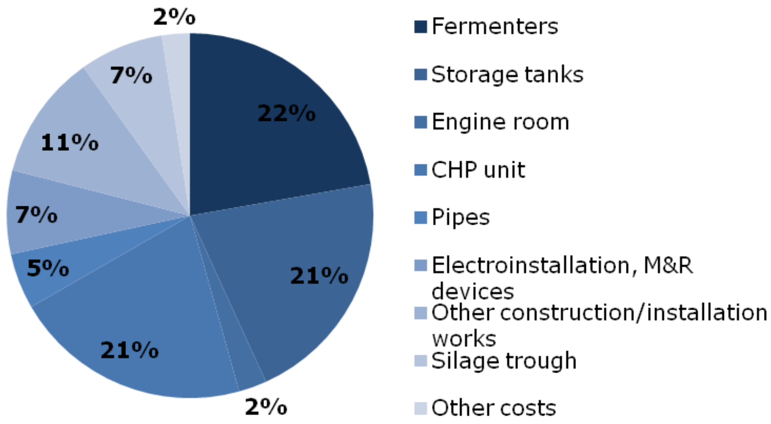
RISK	RISK DESCRIPTION	MITIGATION
Feedstock supply	A biogas-to-energy project is unlikely to succeed if the long-term fuel supply is unpredictable or the fuel quality is uncertain.	Ensuring long-term contract with a feedstock supplier A lending bank (if any) will typically require a feedstock supply agreement that extends two years beyond the loan repayment term.
BGS Technology	Not all generating technologies are designed, manufactured, and serviced equally. It is incumbent on the project owner to select prime movers, generators and ancillary equipment with an eye toward a track record of performance in similar applications. While initial installed cost per kilowatt-hour matters to project success, proven reliability	Asking prospective equipment suppliers to offer references and data on successful projects of similar size and type operating on similar fuel. The technology provider should have both the ability and willingness to provide a performance guarantee for a term that is agreeable to the lender (if any).
BGS operation	Improper maintenance or poor operating practices can lead to unplanned downtime that puts project financial results in jeopardy.	Project owners should expect an equipment supplier to have built a substantial product support

		infrastructure in-country. This can include remote monitoring and diagnostics, on demand technical support, fully qualified service technicians able to respond in less than 24 hours, and a local parts stocking and distribution network that ensures prompt delivery of genuine original-equipment replacements.
Explosion	 <u>Zone 1 (radius 1 m)</u> explosive atmosphere is likely to occur occasionally, in normal operation conditions. E.g. immediate vicinity of manholes into the gas storage tank or on the gas-retaining side of the fermentation tank, and in the vicinity of blow-off systems, pressure relief valves. <u>Zone 2 (radius 1-3 m)</u> explosive atmosphere is not likely to occur in normal operation conditions, but if it does occur, it will be for a short period only. e.g. manholes and the interior of the digester, in the vicinity of aeration and ventilation openings of gas storages	Introduction and following safety guidelines In general: • During filling and emptying, pay attention to pressure fluctuations and ensure good accessibility to the operating equipment. • Avoid ignition sources • Do not work on your own! (always at least 2 persons)

Source: IDN

<u>Estimated investment costs for building of 1 MW BGS in Trebišov present around 4 mil. EUR.</u> The investment costs structure depicts graph below:

Graph 3 Estimated Investment Cost of BGS project



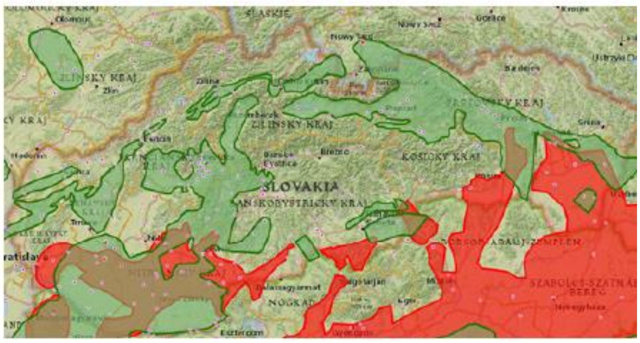
Source: IDN

3.2.2 Geothermal District Heating

Second proposed technical option has not been implemented in Slovakia yet, but there are couple of successful project in operation across the Europe (Germany, Denmark, France, Hungary).

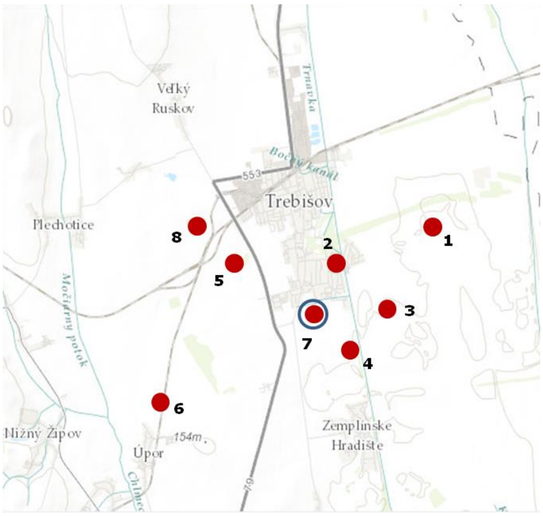
With a total population of more than 5 mil., the proportion of the Slovak population that can be reached with geothermal district heating (where geothermal heat at 2000m is 60 °C to 100°C) is around 50%. This area includes NUTS 3 regions such as Nitriansky kraj, Trnavský kraj, and Presovský kraj. Furthermore, the proportion of the country's population that can be reached with geoDHs with temperature above 100°C at 2000m is around 20%. This potential includes mostly NUTS 3 regions such as Nitriansky kraj and Kosický kraj.

Geothermal potential of the East-Slovakian Basin belongs to the highest potentials in the Central European region. The high potential is a result of the complex tectono-sedimentary structure of the area as different deep structure of neotectonic blocks, direction of main deep-seated fault zones and lineaments and spatial distribution of volcanic rocks.



The potential reservoir rocks in the surroundings of Trebišov are represented by the Neogene sandstone layers. The thickness of the sandstone layers varies, the thickest layer has some 20 m. Based on the experience form hydrocarbon prospection in similar areas, the mean volume of sandstone bodies is 30 000 m^3. Temperatures at 1 000, 2 000 and 3 000 m in the selected localities are depicted in table below:

Table 12 Existing wells in Trebišov town and their main parameters

BOREHOLE	DEPTH (M)	TEMPERATURE	MAP
1	1158,5-1673	64-93	
2	929-2116		
	1710-2120		
	2120-3000		
3	724-2023		
	2020-2710		
4	587-1055		
5	181-1635,5	57-75	
	1635-2515	75-102	
	2515-3040	102-123	
	3040-3163	123-127	
6	300-649	28,5-49	
	1495-1915	86-104	
	1950-2300	104-120	
	3145-3463	157-170	
	2300-2700	120-137	
7	720-1760	36-72	
	1760-3440	49-86	
	3440-3500	131-133	
8	1660-2220	72-131	

Source: Geothermal District Heating Trebisov (2007)

The new company biomass boiler house is directly situated in the area of one of existing geothermal wells in the Trebišov town (No. 7). Closed to new company site are placed also further 2 wells.

Next table below presents our preliminary design assumptions for technical solution in Trebišov:

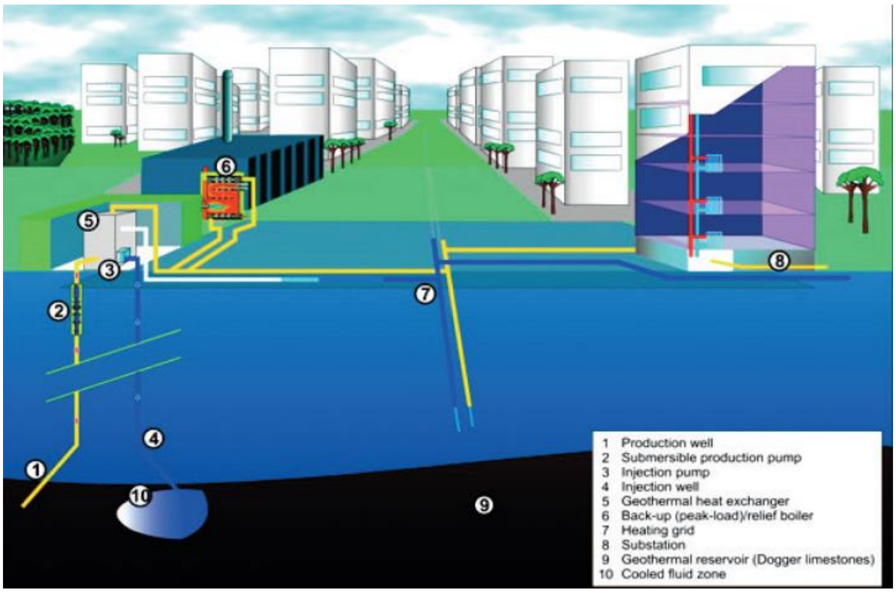
Table 13 Preliminary design assumptions for geothermal DH project

TYPE	ASSUMPTIONS
Geological/technical	Reservoir rocks: Tertiary sandstone
	Expected well depth (m): 2 500
	Well temperature. 110 °C
	Expected production capacity – water flow: 25 l/s (2200 m^3/day)
	1 production well, 1 reinjection (due to chemical content of the water)
MAIN TECHNOLOGICAL COMPONENTS:	

A geothermal district heating system comprises three major components, as shown in scheme below.
The first part is heat production which includes the geothermal production, conventionally fuelled peaking station, and wellhead heat exchanger (elements marked 1-2-3-4-5 on scheme).
The second part is the transmission/distribution system, which delivers the heated or cooled water to the consumers (element 7).

The third part includes central pumping stations and in-building equipment. Geothermal fluids may be pumped to a central pumping station/heat exchanger or to heat exchangers in each building. Thermal storage tanks may be used to meet variations in demand.

Scheme 4 Main Components of Geothermal DH



Source: Developing geothermal district heating in Europe (2014), European Geothermal Energy Council

Source: IDN

Geothermal project risk differs from risks associated with other projects mostly regarding to the subsurface facilities while ground level facilities and sales can be regarded in the same way as those applicable for any other project type. Below we present main geo-scientific risks of geothermal energy project in Trebišov:

Table 14 Geothermal energy project associated risks

PRE-DEVELOPMENT RISK	RISK DESCRIPTION	MITIGATION
Resource temperature (enthalpy)	Different types of geothermal projects require different resource temperature ranges, risk of falling out of needed range for DH system in Trebišov.	Geochemical surveying of site prior to project development or evaluation of data from existing nearby wells (it includes mapping of mineral alterations, chemical sampling, geo-thermometry calculations)
Resource permeability	Permeability greatly influences well yield and injectivity, which are key-factors in successful commercial geothermal development.	Geochemical surveying (see above) Geological surveying, such as geological mapping, fracture/fault mapping, lithological mapping and tectonics. Injection testing of well to determine effective permeability and whether prudent to increase near

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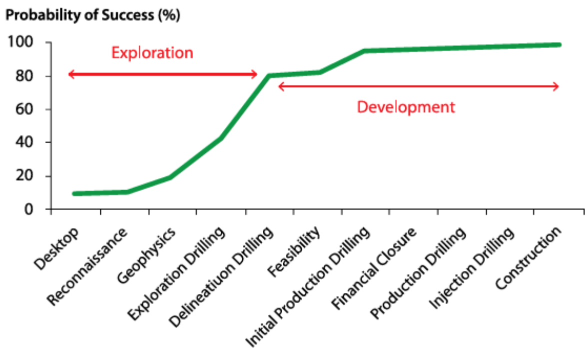
		borehole permeability – post drilling acidizing is one possible method to increase near well permeability, it reduces number of wells per a given energy output for facility.
Resource size	Risk of insufficient capacity and longevity of geothermal reservoir.	Geophysical surveying, such as resistivity soundings, seismic soundings, magnetic surveys and thermal flux surveys.
Chemical composition of geothermal fluid, both its gaseous and liquid phases	Risk of acidity of fluid both of deep magmatic origin and shallow near surface origin – corrosion and scaling potential.	Corrosion and scaling tests in the field prior to facility´s design phase. Important for deciding materials selection of fluid carrying components and/or the need to use of inhibitors.
Volcanic activities	Normally very low risk of volcanic activities in low enthalpy areas.	Surveillance of land and historical study of volcanic activities in the area provides valuable data relevant to deciding plant locations in the least vulnerable to such activities.
Earth tremor potential	Potential for earthquake – but low enthalpy areas are usually associated with low risk of earthquake.	Careful study of previous instances of earth tremors to determine earthquake strength, frequency and location. Land surveillance of seismically induced land disturbances etc..
Gas content in geothermal fluid	Reduces performance of ground-level and subsurface equipment, through scaling, corrosion and gas collection in pipelines, condensers and heat exchangers, and lead to atmospheric pollution.	Careful and continuous sampling of well fluid, its chemical analysis and study. Pre-calculation of corrosion and scaling potential. Important in selection of materials, and energy extraction processes for facility.
POST-DEVELOPMENT RISKS	**RISK DESCRIPTION**	**MITIGATION**
Reservoir changes associated with mass extraction	Excessive pressure drawdown, cool influx into well, and subsidence. Potential loss of surface thermal features, possible formation of steam cap above production zone of reservoir.	Continuous and careful reservoir monitoring and management.
Scaling in formation and	Typical TDS is expected to	Inhibitors, system

surface facilities	be 10-30 g/l, may however be as high as 130 g/l in low temperature sedimentary reservoirs.	pressurizing, doublet with heat exchanger.
Re-injection and other means of geothermal effluent disposal	Gaseous effluents may in some instances require special solutions before disposal, if contents are significant in quantity and chemical composition considered dangerous to environment.	Fluid tracer tests may be necessary to discover the likely fluid paths within the formations to decide well location and depth of re-injection strategy.
Changing gas content	Long-term fluid removal often leads to changes in gas content, either to increase or reduce it. This is highly local specific, depending upon geology and temperature of formations, and chemical properties of fluid.	Continuous and careful geothermal field monitoring and management.
Unreliability of transport (network system)	There is a risk that damaged water mains of existing network cause the water to cool down. This could lead to less use of geothermal water.	Inspection and renovation of mains simultaneously or before the geothermal construction.
Fluctuation of demand	Risk of high outside temperature and mild winters.	Creation of more sustainable demand - such as spa and factories.

Graph 4 Variation of risks at different phase of a geothermal project

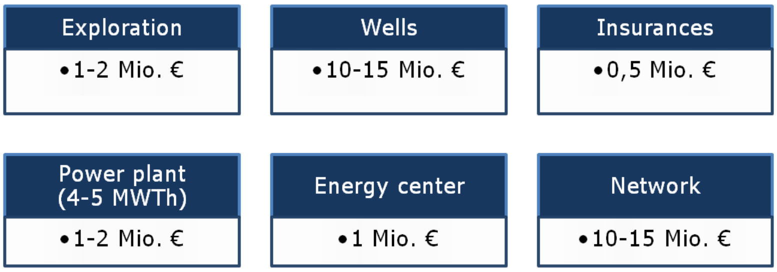


Source: Developing geothermal district heating in Europe (2014), European Geothermal Energy Council

Source: IDN

Because the investment costs for such project usually expect to exceed 10 mil. EUR, there has to be thorough consideration of potential financial sources, expected investment return period and wider benefits the project is expected to bring to the town and the stakeholders (typical project volume can reach €20 – 30 Mio. depending on project type - e.g. electricity, new district heating or CHP).

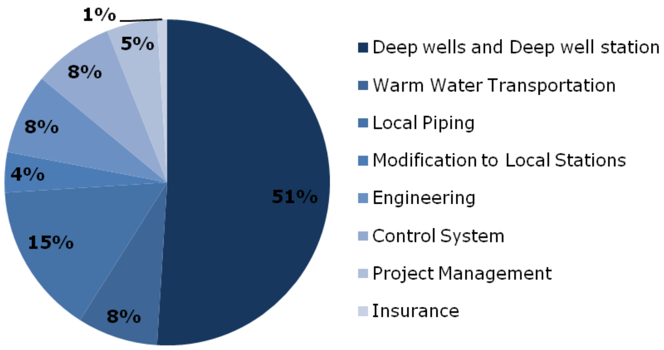
Scheme 5 Estimated Investment Cost for Geothermal DH Projects



Source: Developing geothermal district heating in Europe (2014), European Geothermal Energy Council

Below we present our estimation of investment costs structure of the geothermal energy district heating project in Trebišov.

Graph 5 Estimated Investment Costs Structure of Geothermal DH Project



Source: IDN

<u>The actual water flow and temperature from the well are highly influential parameters on the feasibility of the project (return of the investment).</u> The further research regarding the parameters is recommended in order to gain sufficient knowledge of the geological situation and therefore the feasibility of the project.

Because of current investment in biomass energy and high exploration costs we see the Geothermal DH project as more "system" solution to be implemented when there will be new significant additional high volume of heat demand in future.

3.2.3 Waste Water Treatment Plant

Our third proposed technological option presents very attractive solution of waste water treatment, which has not been implemented in Europe yet.

Waste water of town Trebišov is processed in waste water plant only 720 m from the new premises of company Trebišovská energetická, s.r.o.

Waste water plant focuses on treatment of municipal sewage and rainwater sewage from the town Trebišov. Because of the insufficient capacity of the plant, there was announced investment in its enlargement by the company operating the plant (The Trebišov town is also preparing its own project for rainwater capturing and use in the town - one of the solutions is building of rain gardens).

Waste water plant provides mechanical-biological treatment of waste water. Mechanical pretreatment is followed by fine bubble activation, nitrification and denitrification including mechanical sludge dewatering, removal of phosphorus and tertiary final purification of waste water. Produced sludge is then deposited in the sludge tanks.

Bellow we present new innovative technology which turns waste water into drinking water and electrical energy. This solution was developed by company Janicki Bioenergy with the aim to ensure potable water for people in developing countries of Africa. But the technology has much wider potential to be implemented for different purposes across the world.

We consider as great solution to co-locate proposed technology with existing waste water treatment plant to consume the solids that are left over after treatment. This provides the treatment plant with huge savings because they do not have to pay to dispose of or further treat the solids, and they may be supplied with electricity from the new technology to run the rest of the plant (or the produced electricity may be consumed by biomass boiler).

The table below shows parameters of one of available technical solutions, which we consider as prospective to be installed at client premises in Trebišov.

Table 15 Preliminary design assumptions for technical solution

TECHNICAL PARAMETERS	
Max sludge processed	92.3 m^3
Fuel	sludge, biomass (but also paper, plastics, etc.)
Max. fuel moisture	100%
Min. dry solids required per day (Not limited to fecal matter; can be any dry, combustible feedstock fed in as an auxiliary fuel source.)	10 – 12 t
Electricity output	150-250 kW (but can be scaled up to 5 MW)
Water produced	50,000 – 86,000 L/day
MAIN TECHNOLOGICAL COMPONENTS:	

The technology ("Omni processor") presents stationary combined heat and power plant that converts fecal sludge and other combustible waste streams into electricity, potable water, and ash. The heat from combustion within a fluidized sand bed is utilized to generate high pressure steam that is expanded in a reciprocating piston steam engine connected to a generator, producing electricity. The exhaust from this engine (process heat) is used to dry the incoming fecal sludge. The water that is evaporated out of the sludge is then treated to meet clean drinking water standards. The combustion gases are treated as necessary to meet local emission standards.

The water treatment system works by using a distillation process, followed by multi stage filtering in the vapor phase, condensing, multi stage filtration and aeration in the liquid phase, ozone injection, and light chlorination for storage.

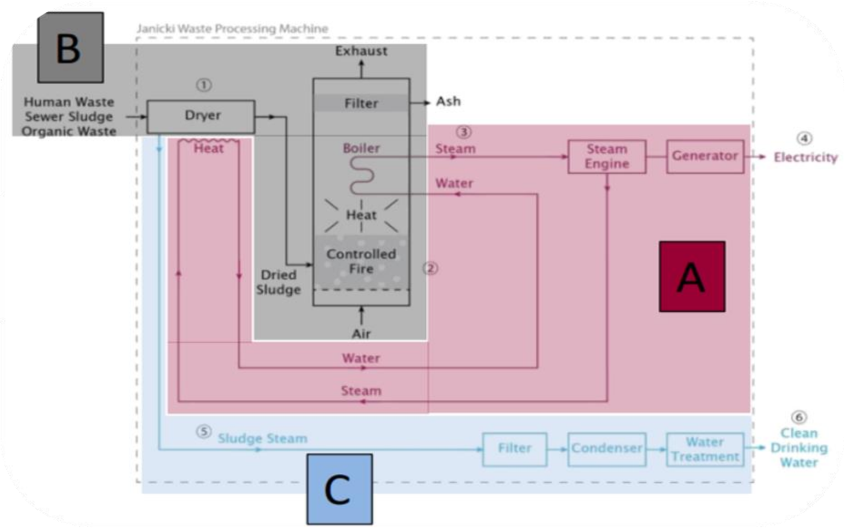
The machine is started using propane or butane. The machine becomes self-sustaining

within 30 min, and then the propane or butane feed will turn off automatically. We expect the OP to run 24 hours/day, 7days/week, and only get shut down occasionally for maintenance or if there is a fuel shortage. Therefore, the consumption of propane or butane should be minimal.
The exhaust of the Omni Processor meets all applicable EPA standards for emissions. The combination of a highly controlled burn in a fluidized sand bed and the downstream use of absorbents and a bag house are used to make this possible.

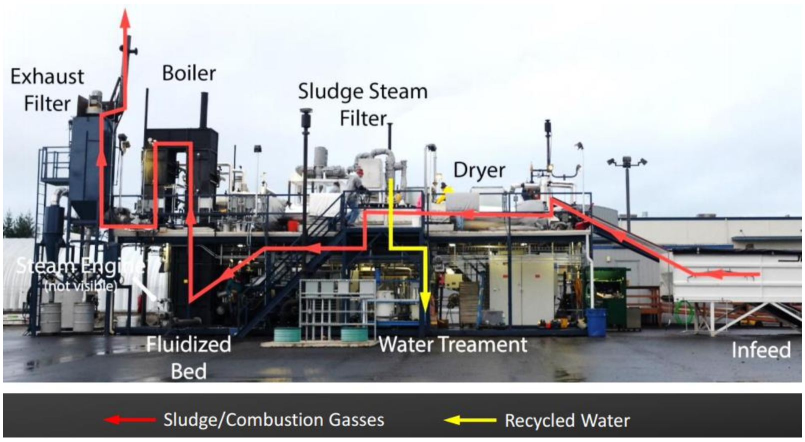
The Omni Processor has three infeed mechanism options. The first is a solid waste infeed mechanism that incorporates a grinder and conveyor for garbage and other solid waste streams. The second is by means of a pipe that pumps septic sludge from a tank. The third is an auger mechanism for inputting partially dewatered sludge and other similar "thickened sludge" waste streams.

The technology will be connected to the internet and remotely monitored and operated by a central command center. This will provide technical expertise to each unit without requiring technical expertise physically at each unit. Additionally, this will provide access to software upgrades for the customer continually increasing the performance of their unit.

Scheme 6 Main Components of Janicki Waste Water Treatment Plant



A – Steam power generation B – Solid fuel combustion C – Water treatment plant



Source: Janicki Bioenergy

Source: IDN

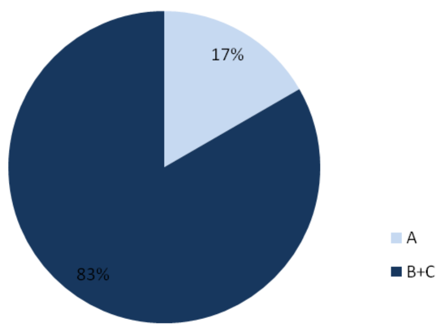
Table 16 Waste Water Treatment project associated risks

RISK	RISK DESCRIPTION	MITIGATION
Feedstock supply	A waste-to-energy project is unlikely to succeed if the long-term fuel supply is unpredictable.	Ensuring long-term contract with a feedstock supplier.
Omni Processor technology	The technology is new and not proved in long-term.	Asking for full guarantee for performance of the technology. A technical service package should be also provided for each unit which will cover parts and technical support for the life of the unit.
Omni Processor operation	Improper maintenance or poor operating practices can lead to unplanned downtime that puts project financial results in jeopardy.	Asking for 24hr remote assistance and support for the operation, spare parts, and software upgrades as necessary. Technology should be fully equipped with cameras and live data feed that allow supplier engineers to monitor and troubleshoot it remotely.
Water pollution	Potential contamination of water and/or using heavy metals or pharmaceuticals for treatment.	Assuring adequate physical security of the facility and installing water quality detection and monitoring systems.

Source: Janicki Bioenergy

The commercially available Omni Processor costs roughly 2-4 million USD depending on options. However, the company is developing a range of similar products that will cost between 300k-7M USD. These products will range not only in price but also in purpose and scale, from focusing primarily on solid waste processing and electricity production, to fecal sludge processing and water treatment to high volume water sterilization for agricultural or other purposes.
The scheme below shows basic investment cost structure of omni processor.

Graph 6 Estimated Investment Cost of Waste Water Treatment Projects



Source: Janicki Bioenergy

In the sub-chapter bellow we compare all 3 presented options and provide our recommendation.

3.3 Recommended technical solution for implementation

All of presented technical solutions have their significant benefits for environment (utilization of available local RES), but of course each option brings different scope of challenges for the investor.

Our final recommendation was based on 6 following criteria:

1. Project Investment Costs – capital required for project implementation
2. O&M Costs – costs related to technology operation and maintenance
3. Innovativeness of solution - project solution novelty
4. Project Associated Risks – factors that jeopardize the project success
5. Integration with local RES - exploitation of available local energy sources
6. Available Experiences – existing know-how of client and/or its stakeholders about the solution

The result of our analysis depicts scheme below:

Scheme 7 Comparison matrix of 3 proposed technical solutions

	BGS	Geothermal DH	Waste Water Treatment plant
Output	Electricity (1 MW) Heat (1,1 MW)	Heat (4 MW)	Electricity (250 kW) Water (70th. l/day)
Project Investment Costs	4 mil. €	> 10 mil. €	< 4 mil. €
O&M Costs	medium (7%)	low (< 5%)	medium (9%)
Innovativeness of Solution	low	medium	high
Project Associated Risks	moderate	high	moderate
Integration with Local RES	yes	yes	yes
Available Experience	yes	no	yes

Source: IDN

Based on our evaluation of all above mentioned criteria we consider the Waste Water Treatment plant as "the best choice" to implement in Trebišov in the near future.

While the solution is not based primarily on providing high volume energy output it strives to effectively treat organic waste and waste water and turn it into clean water to be used for agricultural purposes or even as drinking water.

Investments costs of the solution are in comparison with other proposed solutions lower despite the O&M costs are not minimal. But the expected profit and ROI can reach very promising numbers (of course beside positive impact on environment). The technology is designed to pay for itself within 2-4 years with some combination of revenue from tipping fees for fecal and solid waste, electricity production and water production.

As a new, innovative technological solution the associated risk of project implementation are not low, but the quality of technology and qualified support of producer should over time minimize the risks. The most risky from proposed solutions would be Geothermal DH project which requires high costs for drilling of the wells and for conducting of site analyses with a 20% failure rate.
Based on our discussion with the project promoter managers we have learned that the company staff has already implemented couple of project related to waste water treatment, so there is also available past experience with project of similar kind, which we consider as very important factor for eventual project success.

Last 7th important criteria, not mentioned in our analysis would present "Saved emissions", but because the chosen solution is not based only on renewable energy production we left it out from our basic evaluation.

Below we present the estimated value of saved CO2 emissions per year for all proposed solutions:

Project	**Saved CO2 emissions**
BGS	4 500 t/year
Geothermal DH	3 900 t/year
Waste Water Treatment Plant	520 t/year

Regardless of which of proposed (or other) technological options the client will choose to implement we consider that company Trebišovská energetická, s.r.o., thanks to its orientation to renewables and energy efficient solutions (and with the further strategic effort taken) could become one of Europe role model on the energy market and especially district heating sector.

4. DH in Norway

In Norway, the price of district heating is regulated by § 5.5 of the Norwegian Energy Act which establishes that the price of district heating may not exceed the price of electrical heating in the customer's supply area.

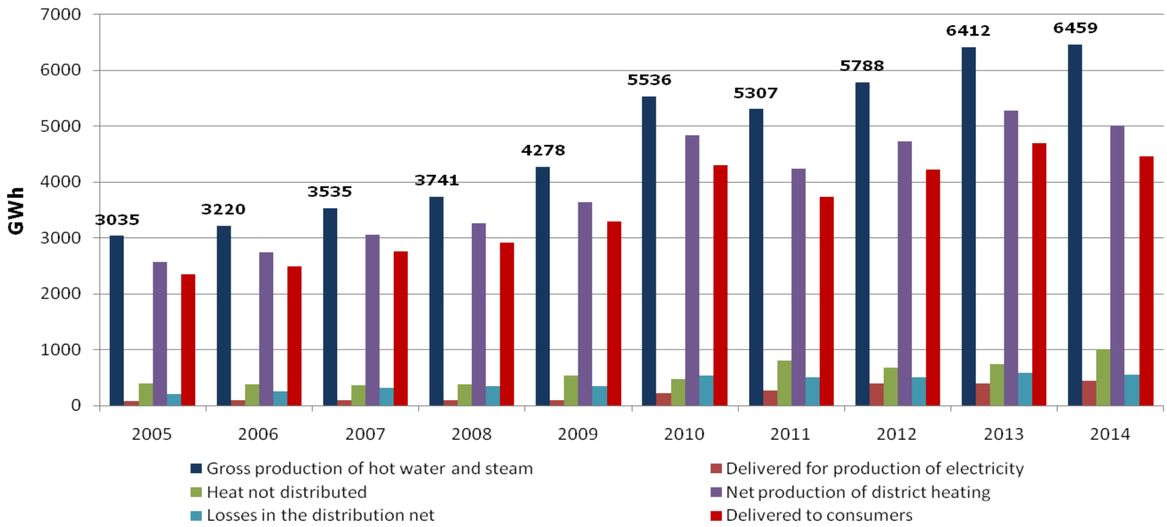
Norwegian district heating companies deliver energy services to a free market in competition with other energy sources. For operating district heating plants above 10 MW it is required to obtain a district heating concession. New buildings within the area licensed for district heating must install water based heating system.

In following sub-chapters we present main highlights about Norwegian district heating sector.

4.1 DH statistics in Norway

District heating consumption decreased by 5.1 % in 2014 compared to the year before and amounted to 4.5 TWh. Consumption of district cooling came to 169 GWh in 2014; an increase of 8.3 % from 2013.

Graph 7 Development of balance of DH in Norway

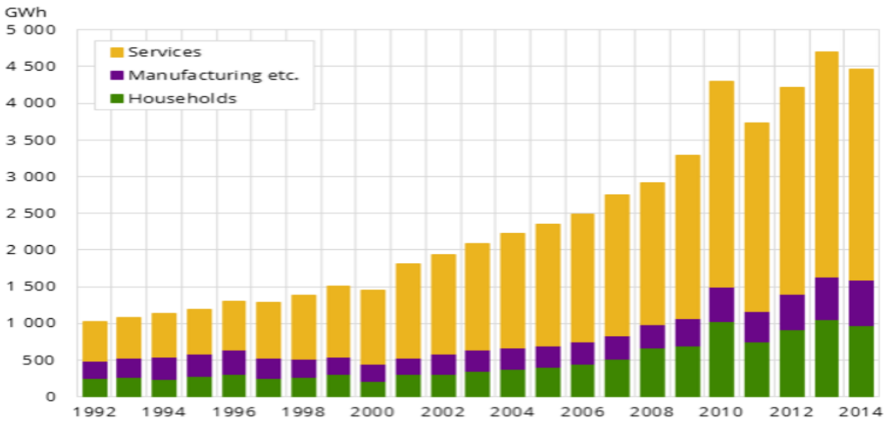


Source: http://www.ssb.no/

Lower consumption of district heating and higher consumption of district cooling can be seen in conjunction with the record high average temperature in 2014. The average temperature in 2014 was 2.2 degrees above normal, while in 2013 it was 1.0 degree above normal.

Service industries continued to account for the largest share of consumption in 2014 (65%), and their use of district heating accounted for about 2.9 TWh. 22 % of the total district heating consumption, or about 1 TWh, was delivered to households, while consumption in industry accounted for 13 %, or 616 GWh.

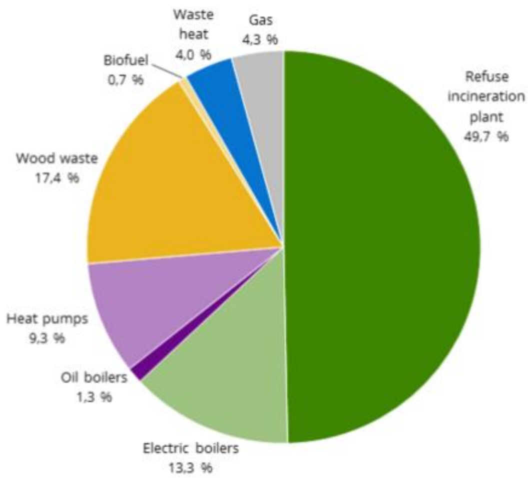
Graph 8 Development of consumption of DH by consumer group in Norway



Source: http://www.ssb.no/

In Norway most common in the production of district heating is waste. Waste incineration is the main energy source for district heating. In 2014, about 50 **%** of district heating, or 2.5 TWh was produced from waste. The second largest source of energy was waste wood facilities, with a share of around 17 **%**, which amounted to 873 GWh in 2014. The shares of district heating produced from electrical, gas and oil boilers as well as bio fuel and heat pumps decreased somewhat compared with 2013, while the share of waste heat remained unchanged.

Graph 9 Net production of DH by type of heat central

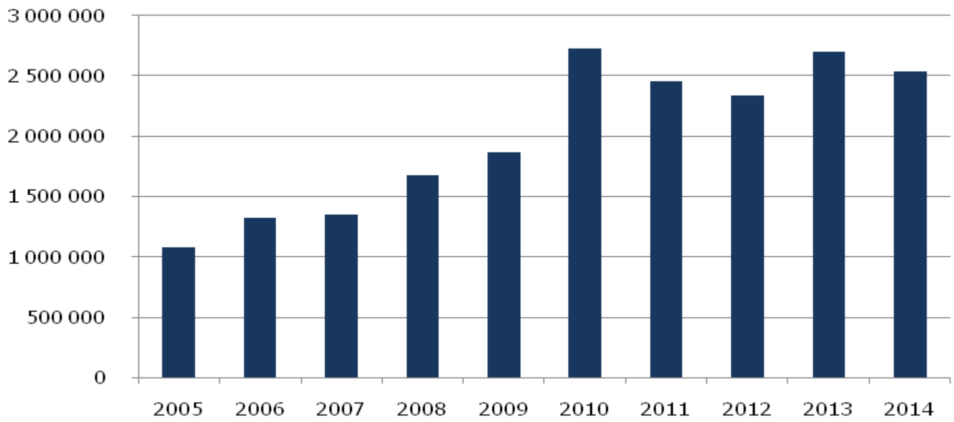


Source: http://www.ssb.no/

The average price for district heating decreased from 59.2 øre/kWh in 2013 to 58.5 øre/kWh in 2014. For households and the service sector, the average price was 59.6 and 61.1 øre/kWh respectively, while it was lower for industry – 33.7 øre/kWh. The price for cooling amounted to 85.4 øre/kWh in 2014, 3.9 øre/kWh lower than 2013.

Reduced district heating consumption and low price contributed to reduced sales revenues from district heating in 2014. The revenues from district heating decreased by 5.8 per cent compared to 2013 and amounted to NOK 2.5 billion. The revenues from district cooling were NOK 144 million; 3.4 per cent higher compared to the year before.

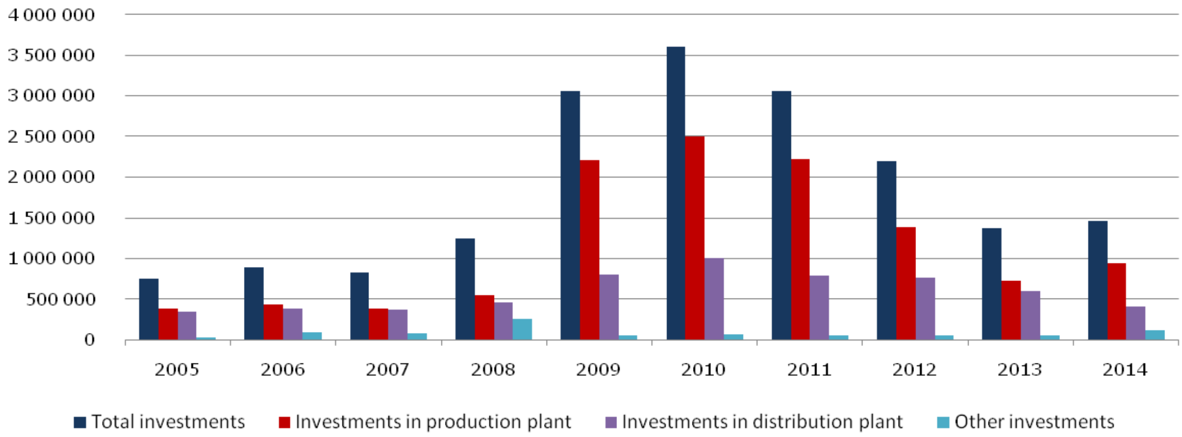
Graph 10 Development of sales income excluded tax (in 1 000 NOK)



Source: http://www.ssb.no/

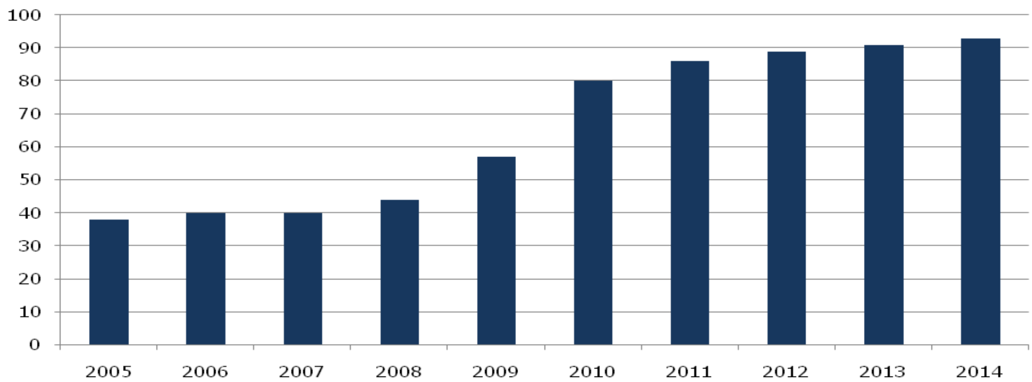
Total investments in district heating plants increased by 7.4 per cent and equalled around NOK 1.5 billion in 2014. Of this amount, NOK 945 million was invested in production plants and NOK 402 million in distribution facilities. Other investments amounted to about NOK 120 million.

Graph 11 Development investments in DH sector in Norway (in 1 000 NOK)



Source: http://www.ssb.no/

Graph 12 Development of DH companies in Norway



Source: http://www.ssb.no/

4.2 Key players in DH in Norway

Hafslund is Norway's largest district heating provider with 36 % of total production of district heating in Norway.

Hafslund produces and distributes district heating within the licence area for Oslo, and for Kolbotn centre and Mastemyr Business Park. The company also owns two waste-to-energy plants in Østfold that supply industrial steam and district heating, and generate electricity.

97 % of the energy used for heat production in 2013 came from renewable sources. District heating in Oslo reduces GHG emissions by an amount equivalent to the emissions of 100,000 cars a year.

Hafslund supplies environmentally friendly heat and hot water to large sections of Oslo's population through its district heating grid. In 2013 Hafslund produced 1.7 TWh (billions of kWh) of district heating, which equates to around 20% of Oslo's heating requirements, or the heating needs of around 170,000 residential units.

Hafslund prioritises the use of heat purchased from the City of Oslo Agency for Waste Management's waste-to-energy plants and then uses energy produced at its own heating centres. The company's own production involves the extraction of heat from the city's sewage and heat generation based on different renewable energy sources.

One of Hafslund's express aims is to phase out fossil energy sources used in district heating production. Specific situations and lengthy periods of cold weather can result in some use of fossil energy sources in order to maintain security of supply. In order to guarantee security of supply in even the coldest periods during the winter, the company also uses electric boilers, together with peak load sources such as LNG and oil boilers to produce district heating.

In 2013 around 800 residential developments, 3,200 detached and terraced houses, and 1,100 commercial buildings, including schools, public and municipal buildings were connected to Hafslund's district heating grid.

District heating is particularly suitable for residential and commercial buildings with water-borne heating systems located close to Oslo's existing district heating grid, whether these are older buildings with an oil furnace that is due to be phased out and replaced with a renewable energy source, or a new building in need of an energy source.

A district heating plant supplies hot water to buildings or urban areas to provide heating and hot tap water. District heating is produced in one place and used in another. Heat energy is distributed to customers through a sealed pipe circuit comprising insulated pipes that are buried in trenches, often together with other infrastructure. The heat energy is transported to consumers or business customers as hot water and tepid water is returned to be reheated.

The district heating system comprises two parallel pipes: one pipe containing heated water, which runs to the customer, and a return pipe which takes cooled water back to the heating centre. The cooled water is then reheated. The water that is transported is often extremely hot, and can be up to 120 °C, and under high pressure. The district heating pipes in Oslo have an average heat loss of around just 5 – 10 %.

When a building is connected to the district heating grid, a customer exchange is installed containing a heat exchanger where the energy is transferred from the district heating water to the building's water and heating system. The customers have a water based heating system with radiators, floor-heating or ventilation systems with a water-based heat battery. There is no direct contact between the district heating plant and the water the customers receive in their taps or radiators.

Customers, through caretakers or operating personnel, manage the heat in the building using thermostats, and consumption is recorded by energy meters in exactly the same way as standard electricity consumption.

Waste energy

In Oslo around 60 percent of district heating production comes from waste incineration, heat pumps that extract heat from sewage and biofuel plants. In other words; resources that would otherwise go to waste.

Waste energy is produced by incinerating residual waste, which is the waste that remains after standard recycling measures, and thus preserves a resource that would otherwise be lost. Sensible energy recycling significantly reduces not only GHG emissions, but also other environmental impacts associated with landfilling. The use of modern emission reduction technology in connection with incineration results in a very low level of emissions to air at Hafslund's plants.

Table 17 Hafslund heat production

Production and heat in Oslo and Akershus	1.7 TWh per annum
Production of industrial steam in Østfold	340 GWh per annum
Primary grid	300 km
Secondary grid	84 km
Number of heating centres	15
Number of heating boilers	61

Source: https://www.hafslund.no/

The company's production plants in Østfold

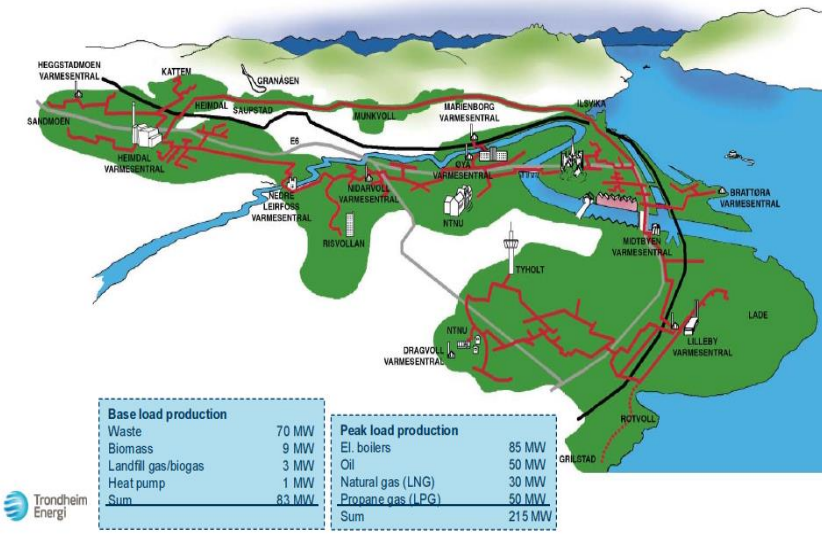
Bio-El Fredrikstad (Fredrikstad) is a modern multi-fuel facility with high environmental standards located on Øra in Fredrikstad. The installed capacity is 25 MW. Each year the plant recycles energy from around 45,000–60,000 tonnes of waste-based fuel. Annual capacity is delivery of energy of 160 GWh in the form of district heating, industrial steam along with some production of electricity.

Sarpsborg Avfallsenergi (Sarpsborg) is a cutting-edge waste-to-energy recycling plant. The facility primarily converts household waste to energy to environmentally friendly industrial steam, which is then delivered to industrial businesses in Borregaard. The installed capacity is 33 MW. The plant has the capacity to receive around 80,000 tonnes of waste, primarily in the form of household waste, which is then used to produce and deliver around 230 GWh of industrial steam each year.

Second large DH operator in the country is Statkraft Varme The company is part of the Statkraft group, and has been active within energy recovery and district heating since 1982. The company currently has more than 130 employees in Norway and Sweden.

The company has licenses for the development and operation of district heating in Trondheim and Klæbu, Harstad, Ås, Narvik, Stjørdal, Namsos, Levanger, Moss, Nannestad, Bogerud, Haugerud and Sandefjord in Norway. Statkraft Varme's annual production is in excess of 1 TWh.

Scheme 8 Statkraft Varme heat production in Trondheim



Source: Trondheim Energi Fjernvarme AS

Statkraft Varme covers more than 30 % of Trondheim's heating needs through district heating. The company supplies heating to 8 000 homes and 650 business and public buildings in Trondheim and Klæbu.