Case study on Biogas project in Třeboň, Czech Republic

Annex A.2 to Part 1 of the Study on the competitiveness of the renewable energy sector

ENER/C2/2016-501

28 June 2019

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Abstract

The European Commission aims to analyse the competitiveness of the European heating and cooling industry. Four case studies of successful and competitive deployment of heating and cooling solutions at a city level from selected organizations support this analysis. The case studies aim to illustrate how competitive renewable energy technologies such as solar-thermal, biomass, biogas and heat pump are in the context of different local factors across Europe, and what the impacts are from their deployment are on the local communities.

The case study is based on the desk search, field visit, interview with project owners and interview with the Czech Ministry for Industry and Trade.

This case study presents a biogas plant in Třeboň, Czech Republic.

1 Introduction

The oldest large-scale agricultural biogas plant in Central Europe was built in 1974 in Třeboň. In 1950´the new government initiated nationalisation of the Czech market. By the 1960´s, all small pig farms were nationalised and most of them were closed. Instead, the large-scale farms were introduced. One of the large pig farms (with about 25,000 pigs) was built near Třeboň. The farm generated large quantities of pig manure, which at that time was stored on the nearby fields. In order to mitigate the smell and to utilise the manure, it was decided to build a biogas plant and a wastewater treatment plant nearby the farm. The centrate water from the biogas plant and municipal waste water were treated together. The electricity produced from the biogas plant was used to power the wastewater plant, while heating was used to heat the stables. The plant was in function every day for 36 years, until 2011, when the pig´s farm was closed.

In 2009, the new biogas plant was built next to the old one. By that time the political situation in Czech Republic changed. The market was liberalised. Czech Republic joined the EU and new agricultural policy was introduced. Both size and the amount of animal farms decreased. That led to the excess of animal feed. In order to utilise this newly available feed in an efficient way, the new biogas plant was built. While the old plant was designed to process mainly the pig manure, the new plant utilises primarily maize silage from local farmers and grass silage from the nearby floodplains.

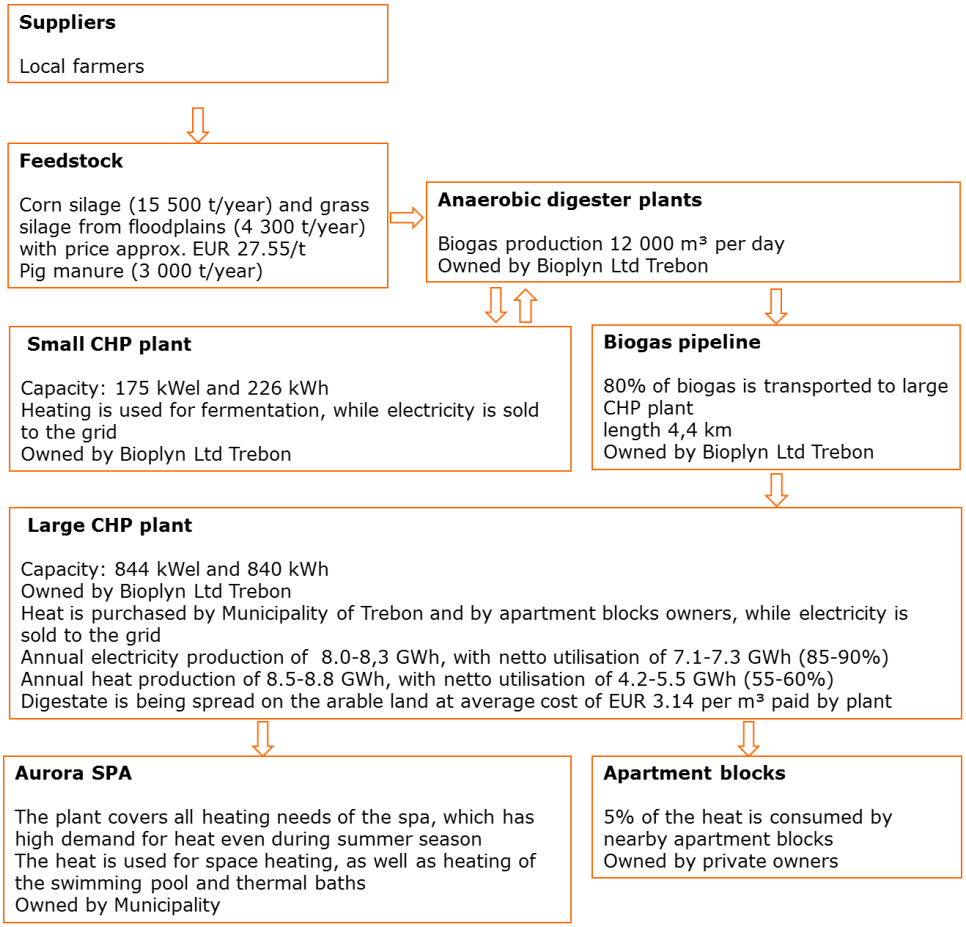
Figure 1 Biogas Plant, Třeboň

Source: Bioplyn Třeboň, Ltd

The project comprises a biogas plant with a biogas production capacity of 12 000 m³/day, silos for 15 000 tons of silage, digestate storage tanks, 4,4 km long biogas

pipeline and two CHP units with a total installed capacity of 1019 kW_{el} and 1076 kWt_h (see Figure 1-2 for the project overview). The project is unique for its high utilisation of biogas heat. The total utilisation of biogas heat is about 55-60%, which is significantly higher than the value commonly attributed to the similar biogas plants[1].

Figure 2 Project overview



The small CHP unit (with capacity of 175 kWel and 226 kWth) was built next to the biogas plant to cover plant´s energy needs. Most of the biogas (cca 80%) is transported by the biogas pipeline to the large CHP (with capacity of capacity of 844 kWel and 840 kWth) unit that is located 4,4 km away, in the near proximity of heat consumers (municipal Spa Aurora and apartment blocks). The project is also a front runner when it comes to the deployment of the biogas pipeline. It was the first project to entail the biogas pipeline in Czech Republic. As there were no governing legal requirements and standards for such installation at that time, the project triggered the needed policy development.

The project was realised in May – November 2009. The total investment cost was EUR 4.5 million. The project obtained both investment support and operational support.

[1] Renewable Energy in Czech Republic 2017, Ministry of Industry and Trade: https://www.mpo.cz/assets/cz/energetika/statistika/obnovitelne-zdroje-energie/2018/12/Obnovitelne-zdroje-energie-v-roce-2017-new.pdf

The overview of the key technical characteristics of the projects is illustrated in the table below.

Table 1 Key technical characteristics

Location	Třeboň, Czech Republic
Capacity of large CHP plant	844 kWel and 840 kWth
Capacity of small CHP plant	175 kWel and 226 kWth
Biogas production	12 000 m³ per day
Biogas production- heat	8.5-8.8 GWh per year
Utilization of biogas heat	55-60%
Biogas production - electricity	8.0-8,3 GWh per year
Utilization of biogas electricity	85-90%
Heat buffer storage (two water tanks)	size 2 x 100 m^3
CO2 Saving	9 424 tCO2/year (electricity 8424 tCO2/year and heat 1000 tCO2/year)
Expected lifetime of the project	20 years
Installation/Commissioning	2009
Operation temperature of fermentation	42°C
Total investment costs	EUR 4.5 m
Feedstock	Maize silage, grass silage, pig manure
Investment support	25% from the European regional development fund, Operational Programme Enterprise and Innovation[2], EKO-ENERGIE
Operation support	Feed-in tariff for electricity, fixed scheme, guaranteed for 20 years
Payback time (at current level of support)	15-16 years

2 Technology

The plant comprises of two fermenters, post-fermenter, two digestate storage tanks, cogeneration unit, dosing machine for solid substrates, tank for liquid substrates, technology for biogas upgrading, burner for the excess gas and two storages for silage (as illustrated in **Error! Reference source not found.**). Both fermenters and the post-fermenter are reinforced concrete cylindrical tanks equipped with polystyrene insulation coated with aluminum trapezoidal sheet. The tanks are covered with a self-supporting air-clad with an integrated gas jar. The content of the tanks is heated by warm water from the cogeneration unit (circulating via polyethylene pipes located on the inner walls of the tanks). Fermenters and post-fermenter are equipped by security features such as anti-vacuum and overpressure protection devices, windows for visual fermentation monitoring, overflowing sensors, etc.

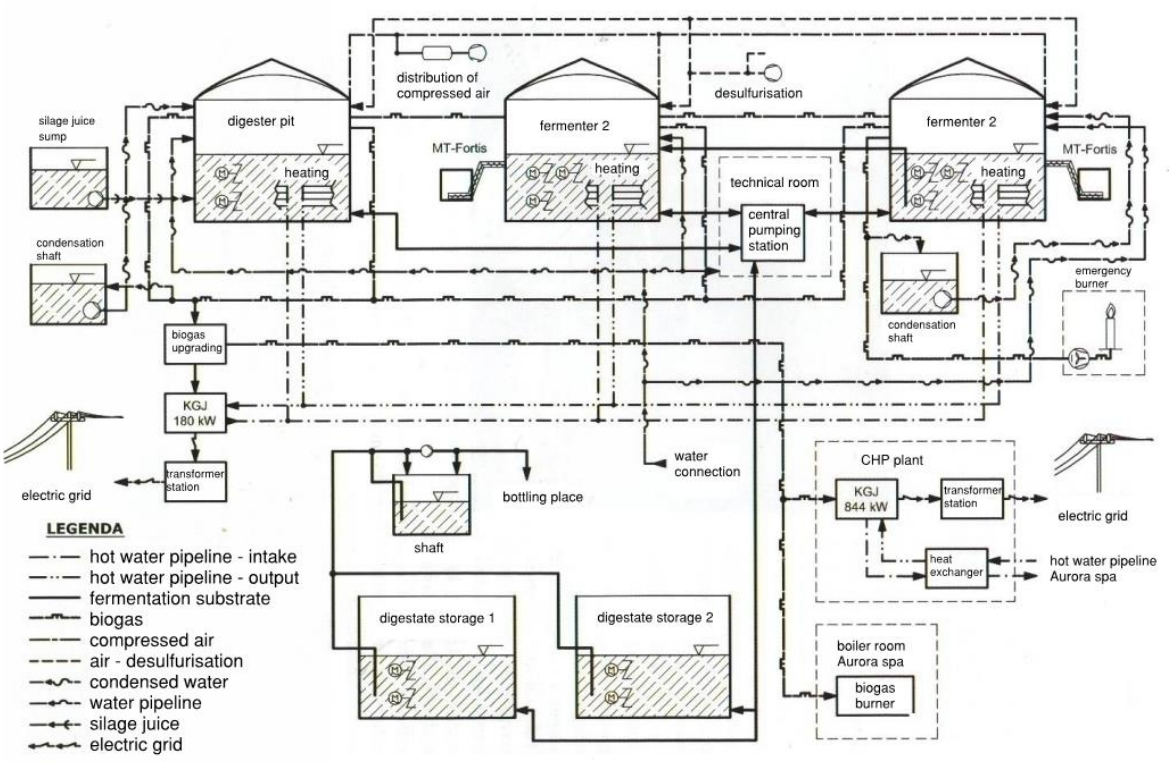
Table 2 Technical specifications

Parameters	Unit	Fermenter 1	Fermenter 2	Post-fermenter
Hight	m	6	6	6
Diameter	m	21	21	23

[2] http://biogasaction.eu/wp-content/uploads/2018/01/BiogasAction_D2.4_Biogas_Plant_Třeboň.pdf

Total volume	m3	2076	2076	2493
Reaction volume	m3	1800	1800	2285

Figure 3 Technology



Source: Bioplyn Třeboň, Ltd

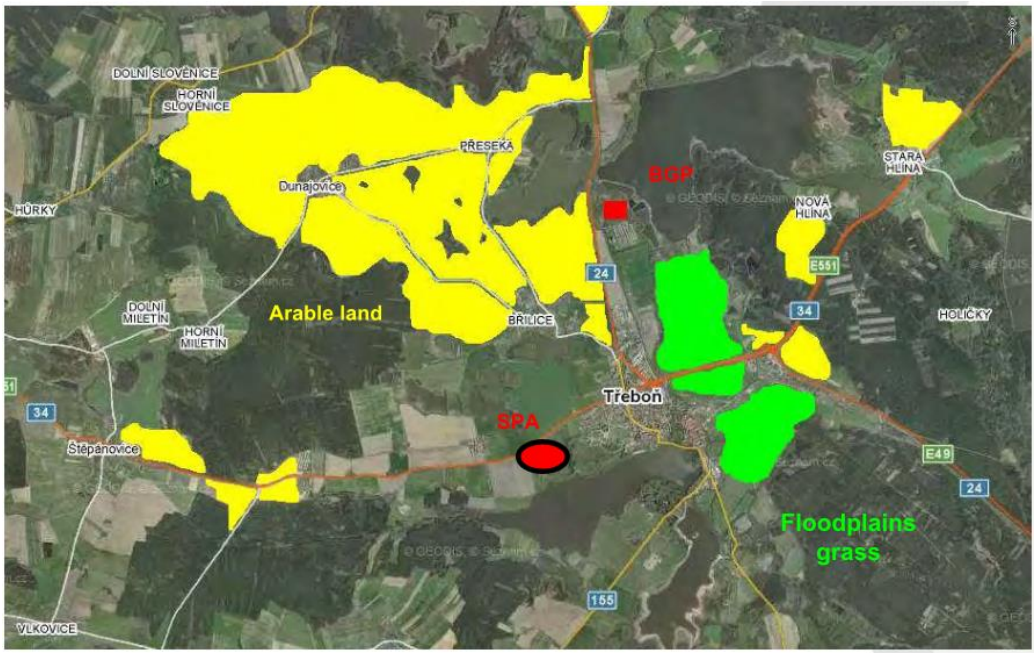
3 Value chain

The project owner is Bioplyn Třeboň, Ltd formed by natural persons including local farmers (such as the owner of the areal, the owner of the arable land, the owner of the pig farm). This ownership relation has proven very important for ensuring for both security of feedstock supply and digestate outbound.

The biogas (anaerobic digesters) plant is located on agricultural brownfields from the historic city of Třeboň. More specifically, the plant is located arable land, where plant silage is produced and floodplains grass, where produced (see

). The main feedstock used for biogas production is plant (maize, triticale, etc.) silage from nearby arable land (approx. 15 000 t/year) and also grass silage (4 300 t/year) from nearby floodplains. These are supplied by local agricultural company, at price of approx. EUR 30 per ton.

Figure 4 Project location



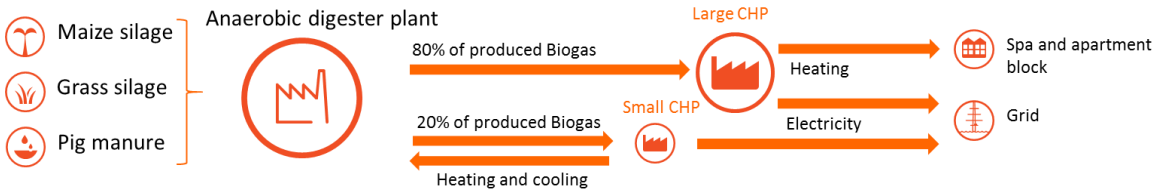
Source: Bioplyn Třeboň, Ltd

80% of produced biogas is transported by the biogas pipeline to the large CHP unit, where biogas is used for electricity and heat production. In order to optimise the heating supply, the large CHP unit is located nearby the main consumers of the biogas heat (Aurora spa and the apartment blocks), in the spa area[3].

The large CHP unit has capacity of 844 kWel and 840 kWth. Electricity is sold to the grid. Heat is sold to the Aurora spa (95%) and the remaining 5% is sold to the nearby apartment blocks. The spa is owned by municipality of Třeboň, while apartments are owned by private owners. The spa uses heat for space heating and heating of swimming pool and thermal baths. The apartment block uses heat mainly for space heating. Annual heat production is around 8.5-8.8 GWh, with netto utilisation of approx. 4.2-5.5 GWh (55-60%).

Figure 5 Project´s value chain overview

[3] As such, it has to comply with stricter noise standards. Currently, the noise is kept at 36 dB.



Distribution of heat required adequate infrastructure and therefore also it entailed additional investment costs. Given that the heat could be only supplied to the consumers, which are well connected to the CHP plant, the security of demand played important role for the project owners. Hence the contract has been signed between the heat supplier and the heat consumers before the project implementation. The contract has been designed to provide a "win-win" solution for both. The biogas plant receives remuneration for otherwise wasted heat, while heat consumers profit from the cheaper heating. The price of the biogas heat is set on annual bases to be approx. 10-20% below the heat from natural gas market price.

The electricity is sold on the electricity market. Currently, it is sold to E.ON Energie, a.s. Ceske Budejovice for EUR 29,19/kWh. Annual electricity production is 8.0-8,3 GWh, with netto utilisation of 7.1-7.3 GWh, which represents approximately one quarter of electricity needs of Třeboň municipality. The rest of electricity is utilised by the biogas plant.

Digestate is being spread on the nearby arable land at average cost of EUR 3.2 /m³ for transportation, paid by the plant.

The remaining 20% of biogas is used by a small CHP unit. Most of the heat that is produced by the small unit is transferred back to the biogas plant, where it is used for fermentation. Most of the electricity produced by the small CHP unit is sold to the grid.

The project was implemented by MT Energie and Stavcent a.s. Jindrichuv Hradec. These two companies designed the plant, gathered components from various producers and installed the technology.

Technology was supplied by the EU suppliers:

- large CHP unit was supplied by Jenbacher (AT)
- small CHP unit was supplied by TEDOM (CZ)
- biogas transport unit was supplied by Siloxa (DE)

Additionally, various SMEs supplied components needed for the project development.

Two types of components have been used for project implementation:

- Construction components, including mainly concrete, insulation, membranes and armatures
- Technological components, including pipes, conduit, eletronics, electrics, steel, iron and armatures

Project´s value chain is illustrated in the table below.

Table 3 Project´s value chain

Inbound logistics	Operations	Outbound logistics	Sales activities	Service provided
Delivery and installation of components produced in Europe necessary for the construction work to begin.	Producing renewable heating and cooling and electricity from biogas. Feedstock includes pig manure supplied by local pig´s farm, plant	Distribution of biogas by biogas pipeline to the large CHP unit. Production of both heating and electricity.	Heating: the contract signed with the main consumer before the project implementation Electricity: sold	The final service is both heating (space heating, heating of the swimming pool and thermal baths) and

Raw materials like steel and iron have been used during the manufacturing.	biomass from local arable land and grass silage from nearby floodplains.	Supplying the local spa and apartment block by heat (using water pipelines).	on the electricity market	electricity production.

4 Local factors

The nature of the project has been influenced by various factors, such as:

- EU and Czech policy frameworks promoting deployment of renewable energy
- Public acceptance of biogas and demand for biogas heating and cooling
- Availability and proximity of the feedstock

In 2009, the European Commission adopted Renewable Energy Directive setting up a binding target of 20% final energy consumption from renewable sources by 2020. To contribute to the achievement of this overall target, the Czech Republic committed to achieve their national RES targets of 13%[4]. The new legal framework that entailed provisions enabling more RES deployment, initiated the energy market shift.

Since the adoption of the Renewable Energy Directive, the share of renewable energy in Czech Republic grew by 76% (2017) and the country is currently well on track to meet their 2020 target. Heating and cooling sector plays the key role (70,5%) for achieving the target (namely biomass)[5]. Biogas is the second most utilized renewable energy source in the country. It contributes to the 13,5% on total RES consumption. According to the report recently published by Czech Ministry of Trade and Industry, the total biogas consumption in Czech Republic increased 7,5 times between 2008 and 2017[6]. Currently, the total amount of biogas plants in Czech Republic is 423 (in comparison to only 6 plants installed in 2002).

In Czech Republic, renewable energy is supported mainly through a guaranteed feed-in tariff (as it was done in case of Třeboň´s biogas plant) or in a form of a green bonus paid on top of the market price. In 2017, the total support of biogas projects was EUR 315 mil[7].

Biogas Plant Třeboň obtained both investment support (25% of the total investment costs from the European regional development fund, Operational Programme Enterprise and Innovation, EKO-ENERGIE) and it also receives operational support for electricity production (feed-in tariff). The feed-in tariff is set for 20 years. With current energy prices, the operational support has been very important for the project sustainability. On the other hand, investment support did not prove to have a significant impact on the project. Technology developers and project installers, knowing about the investment support that the project received, artificially increased the price of the project. Additionally, the investment support imposes obligation for the project promoters to follow strict deadlines. This however gives a lot of power to project installers, as it is very complicated to change these during the process and still comply with the given deadlines.

[4] Act No. 165/2012 Coll., on supported energy sources (implemented the Directives 2001/77/EC and 2009/28/EC on the renewable energy promotion)

[5] The European Union Member States Main Energy and Climate Indicators, JRC visual tool:https://visualise.jrc.ec.europa.eu/t/NREAPs/views/Countryprofiles/Story1?:embed=y&:showShareOptions=true&:display_count=no&:showVizHome=no

[6] Renewable Energy Sources in 2017, Czech Ministry of Industry and Trade, October 2018:https://www.mpo.cz/assets/cz/energetika/statistika/obnovitelne-zdroje-energie/2018/10/Obnovitelne-zdroje-energie-v-roce-2017.pdf

[7] This amount has been paid only to biogas plants built before 2014, as then the support for all the new projects was stopped (the support became too expensive for the government).

Initially the feed-in tariffs were applicable only to electricity produced from biogas. This had significant impact on the design of the plants and the utilization of biogas heating and cooling was rather small. Despite of this, the Biogas Plant Třeboň project owners found a way to increase plant´s utilization of biogas heat. They managed to secure customers for biogas heat before the implementation of the project. Given the long history of biogas in Třeboň, both local citizens and Třeboň´s municipality were well familiar with the technology and they were more willing to use it. Another key factor that played role when attracting consumers of the biogas heat was price. The price of biogas heat is set annually, to be about 10-20% below the market price of natural gas. While customers profit from the favorable price, the biogas plants utilizes heat that would be otherwise wasted. As of 2016, the government introduced the operational support for useful heat from small scale heat production plants with installed capacity up to 500kW and using biogas[8]. However, this newly introduced support mechanism did not translate into the new biogas installations yet.

Next to the policy framework and secured demand for the biogas heat, availability of feedstock also played a key role when opting for biogas plant. As an alternative, the project promoters considered other technologies, such as biomass. However, all the energy crops grown in the region were already sold out to other biomass producers. PV installations on the rooftops were also considered. However, these were not permitted, as Třeboň is a UNESCO protected area. In addition, project promoters wanted to produce both heat and electricity and therefore large heat pump unit was not considered to be a suitable option. The large quantities of excess animal feed and good relations with the existing suppliers led to the decision to build a biogas plant instead.

5 Impacts

The project contributes to the achievement of the renewable energy targets. In 2017, biogas generated 13,5% (25,45 PJ) of the renewable energy in Czech Republic[9]. 18% (4,6 PJ) of the total biogas production was biogas heat. The Biogas Plant Třeboň contributes to 7200 MWh of renewable electricity and 500 MWh of renewable heat production a year. This has also significant impact on security of supply and reduction of fossil fuels imports.

In addition:

- The project supports greenhouse gas reduction and improvement of air quality. CO_2 savings are estimated to be 9,424 tons a year
- Five full time workers and on average 5 temporary workers (6 months) were employed by the project
- Maintenance of the plant is done by local SMEs, contributing to the stable and secure project portfolio for these SMEs for a longer time period
- Project involved various EU companies (AT, DE, CZ), increasing internal trade between EU Member States
- For its uniqueness, the project is often used as showcase example by various Universities and scientific communities, both local and international.

[8] Act No. 131/2015 Coll., amending Act No.458/2000 Coll. (the Energy Act) also included an amendment to Act No. 165/2015 Coll.

[9] Renewable Energy in Czech Republic 2017, Ministry of Industry and Trade: https://www.mpo.cz/assets/cz/energetika/statistika/obnovitelne-zdroje-energie/2018/12/Obnovitelne-zdroje-energie-v-roce-2017-new.pdf

The project was awarded the Czech Energy and Ecologic Project 2009 prize. The Ministry of Industry and Trade selected the project for its intelligent conversion of biomass to biogas, without any negative impacts and for its ability to mitigate fossil fuels imports.

Table 4 Impacts from the biogas plant on Europe's 2020 targets

Energy from renewables	7200 MWh_{el}/year 500 MWh_{th} /year
CO_2 reductions	9, 424 tons/year
Employment	On average 5 temporary workers (during construction period of 6 months) 5 full time employees (operation, revision, suppliers etc.)

6 Summary

The project shows that the local conditions and public awareness play significant role when opting for deployment of biogas technology. Given the local conditions, such as design of support schemes, available feedstock, steady heating needs and location (UNESCO protected area), biogas technology is the most suitable solution. The project demonstrates that continuation of operating support for biogas is important, while perhaps investment support could be reconsidered given that biogas heat production is confronted with high capital requirements and strong competition from lower priced natural gas.

This comprehensive project also exhibits a good cooperation across various sectors (energy, agriculture, health, environment and waste) and market players (private investors, local authorities and individuals) across the EU. Furthermore, the components were produced in Europe and the installation/delivery of the biogas plant was done by the EU companies, as such the project contributed to the EU industrial competitiveness.

CASE STUDY

Biogas in Trebon, Czech Republic (A2)

Source: Bioplyn Třeboň, Ltd (2019)

Biogas in Trebon, Czech Republic

Overview and value chain analysis

Key information

- 1st biogas pipeline in the Czech Republic: 4.4 km
- Biogas plant (12 000 m³/day), silos, digestate storage tanks, biogas pipeline, 2 CHP units
- Commissioning year: 2009
- Investment costs: EUR 4.5 million
- Yearly biogas production (heat): 8.5-8.8 GWh

Value chain

Inbound logistics	Operations	Outbound logistics	Sales activities	Service provided
Delivery and installation of components produced in Europe	Producing renewable heating and cooling and electricity from biogas	Production of both heating and electricity. Supplying the local spa and apartment block by heat	Heating: the contract signed with the main consumer before the project implementation.	The final service is both heating (space heating, heating of the swimming pool and thermal baths) and electricity.

Biogas in Trebon, Czech Republic

Factors and impacts

Enablers

- Investment support (25% of the total investment costs from the Operational Programme Enterprise and Innovation, EKO-ENERGIE under ERDF)
- Local acceptance and involvement – land owners, feedstock suppliers and consumers
- Guaranteed income flow through pre-project purchase agreement with heat consumers

Other factors

- Feed-in tariffs for electricity, but not for heat distribution
- The plant replaced (and expanded) an existing biogas facility
- Construction involved companies from Austria, Germany and Czech Republic

Impacts

- CO_2 emissions saving are estimated at 9424 tons per year
- Contributes to security of supply
- Contributes to improved air quality
- Contributes to the national RE target