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Regional Networks for the development of a Sustainable Market for Bioenergy in Europe

Case study: Reconstruction of district heating system in Slavicin, Czech Republic

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Acknowledgements

This report has been produced as part of the project BioRegions. The logos of the partners cooperating in this project are shown below and more information about them and the project is available on www.bioregions.eu

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Title of the project

Reconstruction of district heating system in Slavicin

Objectives of the project

- Reduction of greenhouse gas emissions
- Improvement of energy efficiency
- Decrease the dependence on fossil fuels
- Support of local employment
- Achievement an acceptable price of heat for inhabitants

District heating systems (DHS), mainly utilising brown coal or natural gas, play an important role in the area of households heating in the Czech Republic. Scheme of DHS enables effective use of waste heat from industry or power production and, furthermore, heat production in one controlled source is connected with lower emission rate and higher fuel exploitation (energy efficiency). These systems are facing up to several problems (age of equipments, high heat losses by heat distribution, rising fuel prices) which generate tendency to disconnect from DHS (decentralization) and threaten the existence of the DHS. This project aims to increase DHS efficiency in the town of Slavicin by implementing several measures: reconstruction of the system (heat plant, pipelines), partially replacing of natural gas by biomass and installation of a cogeneration unit (combined heat and power - CHP). Implementation of this project fulfils objectives of the BioRegions project.

Project Timeline

Preparation of the project including application submission was done in 2010. Implementation of the project (reconstruction of the DHS network, modernisation of heat exchanger stations, installation and putting in operation of new remote control and monitoring system, installation of biomass boiler) was carried out in 2011. The official starting up of reconstructed boiler plant K3 Male Pole (and the whole new DHS network) proceeded on 13th December 2011.

Description of local conditions

Project Operator:

BTH Slavicin s.r.o., a utility company established in 1996 and 100% owned by Slavicin municipality, operates 24 boiler-rooms and 4 independent DHS. Totally 37 apartment houses (922 flats with 2 261 occupants) and 12 public buildings are connected to the DHS networks included in this project.

Site selection:

The town of Slavicin (6 800 inhabitants) is a centre of the Czech target region of the BioRegions project, which aims to get at least 1/3 of heating and electricity needs from local biomass sources. There were operated three DHS networks (2 in Vlara locality and 1 in Male Pole residential area) without interconnection based on older natural gas boiler plants (“K1”, “K3” –

located in Male Pole residential area producing 2/3 of the heat in Slavicin DHS networks, “K4”). These boiler plants supplied heat and hot water via out-of-date 4-pipes distribution system (2 pipes for heating, 2 pipes for hot water supply and circulation directly from boiler plant). High heat losses caused by old boilers and unsatisfactory heat-pipelines together with growing maintenance and fuel costs led into the pressure on heat price for citizens, which could eventuate in their disconnecting from DHS and destabilisation of the whole scheme of heat supply in Slavicin. Consequently, move to the individual heating would lead to fierce decrease of air quality in winter season, considering local geographical and climate conditions.
A project of DHS boiler plant reconstruction in Brumov-Bylnice, realized in collaboration between Brumov-Bylnice municipality and the Energy agency of the Zlin region (EAZK), was an inspiration for Slavicin municipality how to solve issue described above. Considering EAZK’s long-time collaboration with local municipalities and their involving in BioRegions project, it was chosen a variant described below consisting of DHS reconstruction and its shift to utilising biomass (wood chips) from local producers.

Technology analysis

Heat supply system based on separated DHS networks was unsustainable for following reasons:

- Growing maintenance costs of old boilers (a part of equipments was beyond its service life)
- High heat losses in production and distribution (hot water preparation directly in boiler plant and its distribution parallel to heat distribution –> 4-pipes system)
- Ineffective use of installed heat outputs (larger sources in separated DHS networks)
- Complications with electricity supply for boiler’s technology during blackouts.
- Growing price of imported fuel –> efflux of capital from target region.

Fuel Supply:

1. Biomass – wood chips

Boiler plant K3 was utilising biomass boiler (1.6 MW), therefore, technology for biomass handling (wood chips storage and batching) was already installed at the plant. There are two significant sawmills providing wood chips in the region and, furthermore, a local biomass market facilitating contracting with smaller local biomass producer (e.g. waste biomass from road site and public green areas maintaining) is going to start in the frame of the BioRegions project.

2. Natural Gas

Standalone boiler rooms operated by BTH Slavicin, s.r.o., without connection to a new united DHS network, are going to use only natural gas. Natural gas will be used as a supplemental fuel in K3 boiler plant (to cover on-peak heat consumption and to serve as main fuel during low heat demand in summer). This fossil fuel will be also used for combined heat and power production in new CHP unit (higher fuel efficiency).

Implementation of the project

Growing operational costs and technical problems occurring by DHS operation persuaded Slavicin municipality to search, with assistance from EAZK, for available DHS reconstruction options:

1) *Reconstruction of "K1" boiler plant (Vlára residential area)*
   + possibility to proceed step-by-step according to actual situation (optimal size of new-installed natural gas condensing boilers, eventual installation of smaller CHP units)
   - deal not with heat losses by distribution
2) *Reconstruction of current DHS network (pipelines) in Vlára residential area*
   + reduction of distribution heat losses, more effective utilisation of installed sources (heat outputs)
   - High capital intensity solution requiring reconstructions of heat exchanger stations in blocks of flats
3) *Installation of new biomass boiler in K3 boiler plant*
   + utilisation of local biomass, CO2 emission reduction, heat price stabilisation
   - Selection of biomass boiler with suitable heat output (considering estimated heat consumption in DHS network, biomass handling)
4) *Installation of a CHP unit*
   + combined heat and power production (another source of income)
   - selection of suitable CHP unit – need to correlate amount of produced heat with heat production of installed boilers

A comprehensive variant – consisted of unifying (interconnection) DHS network, its renovation linked with installation of biomass boiler and CHP unit in K3 boiler plant – was chosen after consultation with EAZK. It is convenient, from technology and financial reasons, to implement all suggested measures within one big project.

<table>
<tr><th colspan="2">Schemes of original (not connected) DHS networks in Slavicin</th></tr>
<tr><th>K3 – 33 connections</th><th>K1 – 12 connections</th></tr>
<tr><td> 
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</td></tr>
<tr><td colspan="2">K4 - small grid with 4 connections</td></tr>
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System design:

The comprehensive variant - consisted of DHS networks reconstruction in Vlára and their connection to reconstructed K3 boiler plant in Male Pole residential area – was chosen after consideration of benefits and costs of particular variants:

- K3 boiler plant will be equipped with one new biomass boiler (1 MW) and a CHP unit (226 kW_H; 175 kW_E), heat exchanger stations replacement with new monitoring and control system (DHS will produce 15 112.6 MWh/y, assumed natural gas consumption is 9 954.82 MWh/y, heat supply from biomass is 10 148 MWh/y, increase of electricity supply 601,44 MWh)
- Unified interconnected DHS network has better response to changes in heat demand (increasing number of customers x reduction of heat consumption by building refurbishment) and stabilises heat price for customers due to utilisation of cheaper local fuel (woodchips) in central boiler plant K3
- replacement of outworn 4-pipes distribution system (original K1 boiler plant) by modern 2-pipes one including reconstruction of heat exchanger stations in blocks of flats (decentralisation of hot water preparation) lowering heat losses of the whole DHS
- implementation of all measures should be done by a single application
- the project suppose implementation of following measures:
  - new interconnection between boiler plants K3 and K1 (K4) i.e. unifying former separated networks into one big DHS including new connection of public buildings (kindergarten and elementary schools) originally heated by standalone natural gas boiler rooms
  - new 2-pipes heat distribution system in Vlára locality
  - to give out of central hot water preparation and its preparation in 16 new reconstructed heat exchanger stations
  - new scheme for remote monitoring and control of the whole DHS
  - total distance of new pipelines is 1 388 m

Energy saving achieved by reduction of heat losses from distribution and reconstruction of heat exchanger stations will be logically lowered by heat losses from new interconnection between K3 boiler plant and Vlára locality (distance 700 m).

Technology providers:

- Boiler producer: BIOPAL Technologie www.biopal.cz

Czech company producing biomass boilers, with many references, e.g. Reconstruction of heat plant in Brumov-Bylnice and good quality products.

- Exchange stations supplier: SYSTHERM www.systherm.com

Supplier of the whole district heating network (pipelines, exchange stations).

Financing of the project:

Investment costs of the project were initially estimated about 1.5 million EUR, but the project operator had own funds of 60 000 EUR. There were considered two options to cover investment costs based on a bank loan and a financial support (grant). Financial evaluation of those options

(with/without subsidy) is given below in this document. Firstly, a bank loan was assessed to cover most of the investment costs. Requirements for the bank loan under described conditions, resulted from short financial market survey, were unacceptable for the project operator (ratio of own funds/total investment costs were too low and some banks rejected to provide loan, remaining banks required high guarantees). Regarding capital intensity of this project and financial options of the project operator, EAZK evaluated available grants options:

- *Operational Programme for Cross-border Cooperation Slovakia-Czech Republic 2007-2013*
  In the frame of this Operational Programme, a project called "Development of energy use of biomass and sun in border region" was focused on reconstruction of the DHS boiler plant in Brumov-Bylnice in 2009. This Operational Programme is attractive due to higher percentage support for cross-border environmental projects in social handicapped border region. It was not possible to get support from this Operational Programme regarding the larger scale of DHS reconstruction and requirements of planned calls for proposals of this Operational Programme.

- *Operational Programme Environment (OPE)*
  The Operational Programme's main goal is to protect and improve environmental quality as a base for sustainable development. Between 2007 and 2013, this programme will offer almost 5 billion EUR from the Cohesion Fund and the European Regional Development Fund for projects falling into one of seven supported areas (priority axes). The aim of the DHS reconstruction project response priority axes 2 and 3.

  - *Priority axe 2: The Improvement of Air Quality and Reduction of Emissions*
    In the frame of subarea of interest 2.1.2. - Decrease of contribution to pollution load by cut-down of emissions from energy systems including DHS, it is possible to raise subsidy for expansion of DHS network (connection of new customers to the network) and for reconstruction of central heat source up to 5 MW of heat output. The project of DHS reconstruction in Slavicin did not meet one criterion of this subarea - replacement maximally 50 % of installed heat output by a renewable energy source (RES).

  - *Priority axe 3: The Sustainable Use of Energy Sources*
    This axis supports projects focused on sustainable energy use (especially RES) and promotion of energy conservation. In terms of **subarea of interest 3.1.1. - Building-up and reconstruction of heat sources utilising RES**, it is possible to raise subsidy for building-up and reconstruction of boiler plant including heat distribution network, customers connections and heat exchanger stations. Call for proposals within this subarea of interest was announced during project preparation therefore the project was adapted to technical parameters of this subarea and application for support from OPE was submitted under name „Teplofikace sídliště Vlára z OZE K3, Slavičín". The application was successful and the project was implemented with support from OPE (502 450 EUR).

An energy audit of DHS reconstruction in Slavicin was worked out under OPE's requirements together with project technical documentation. This audit describes initial conditions of DHS networks, variants of reconstruction and evaluates the options from technical (energy and

emissions savings) and economical point of view. The audit confirmed chosen comprehensive variant (unifying/interconnection of DHS network, its renovation linked with installation of biomass boiler and CHP unit in K3 boiler plant) as optimal solution of the issue.
The application for support from OPE was submitted and accepted in 2010. **Reduction of energy consumption and CO_2 emissions are the main evaluation parameters** and other parameters are based on their declared amount. For example, acceptable investment costs (base for calculation of grant amount) are divided by saved CO_2 emissions and the outcome is an important factor for comparing proposed project. Other financial parameters (proposed bank loan, project lifetime) are less important in this programme.
Consequently, a public commission was organized to get a bank loan for co-financing of the project. There were proposals of three banks considering accepted subsidy, conditions of chosen offer are compiled in following table. Technology providers were selected in public commissions at the end of 2010. Complex realisation of the project was done during summer of 2011 and a test operation of new biomass boiler and remote monitoring/control system was proceeding in autumn 2011.

Financial evaluation of the project

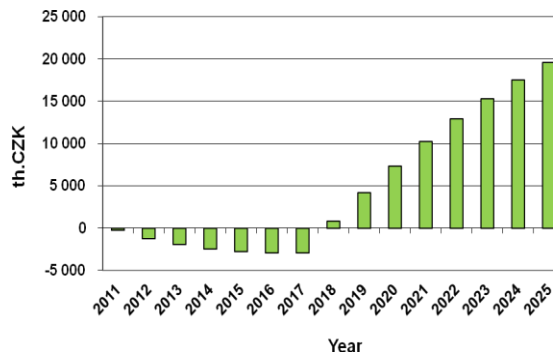
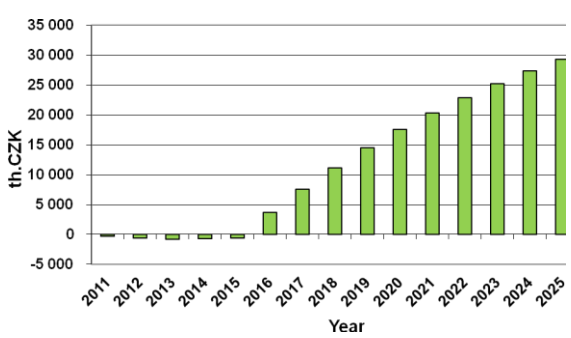
The following table presents the costs, benefits and main assumptions used as input to the financial model built within the BioRegions project in order to evaluate the financial viability of this case study. Firstly, the capital and annual operation and maintenance costs after the project implementation are presented, whereas the incomes consist by avoided costs for energy as a comparison between before and after the implementation of the project and incomes from heat and energy saves.

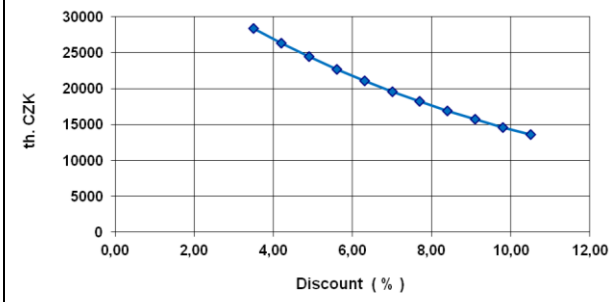
			Without subsidy		With subsidy		
	Currency		CZK	EUR	CZK	EUR	25 CZK/EUR
Capital costs	Investment costs		35 889.00	1 435.56	35 889.00	1 435.56	thousand (currency)
	Assumed subsidy	Amount	0.00	0.00	12 561.15	502.45	thousand (currency)
		Ratio	0.00		35.00		%
	Loan	Amount	34 453.44	1 378.14	21 892.29	875.69	thousand (currency)
		Interest	6.00		6.00		%
		Payback time	6		4		years
	Own funds		1 435.56	57.42	1 435.56	57.42	thousand (currency)
Operation & maintenance costs	Annual personnel costs		1 000.00	40.00	1 000.00	40.00	thousand (currency)
	Annual maintenance costs		1 500.00	60.00	1 500.00	60.00	thousand (currency)
	Other annual costs		3 950.00	158.00	3 950.00	158.00	thousand (currency)
	Emission charges*		10.00	0.40	10.00	0.40	thousand (currency)
	Wood chips	Price	0.50	0.02	0.50	0.02	currency/kWh
		Annual costs	5 074.05	202.96	5 074.05	202.96	thousand (currency)
	Natural gas	Price	1.50	0.06	1.50	0.06	currency/kWh
		Annual costs	14 932.23	597.29	14 932.23	597.29	thousand (currency)

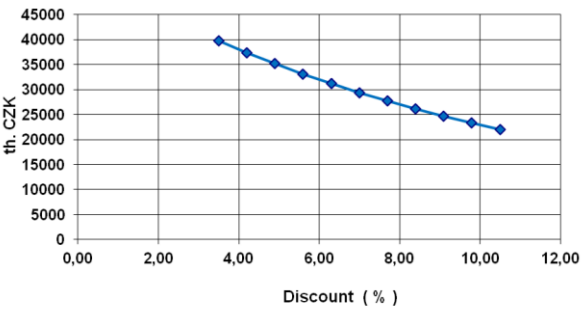
	Other fuel	Price	-	-	-	-	currency/kWh
		Annual costs	-	-	-	-	thousand (currency)
Incomes	Annual heat sale		32 643.32	1 305.73	32 643.32	1 305.73	thousand (currency)
	Annual electricity sale		1 094.62	43.78	1 094.62	43.78	thousand (currency)
	Other (annual) income		0.00	0.00	0.00	0.00	thousand (currency)
	Annual energy cost savings		3 133.25	125.33	3 133.25	125.33	thousand (currency)
Evaluation criteria	Net present value	NPV	19 579.46	783.18	29 371.92	1 174.88	thousand (currency)
	Internal rate of return	IRR	39.90		88.10		%
	Simple Payback Period	SPB	7		5		years
	Discounted Payback Period	DPB	7		5		years
	Year of implementation		2011				-
	Lifetime (evaluation)		15				years
	Discount		7.00				%
	Potential energy savings		163 663.00				kWh/y
	Potential CO_2 savings		706.89				t/y
* Emission charges are implemented for middle and large air-pollution sources (energy companies, DHS operators, chemical companies, ...) in the Czech Republic. Ecological taxes are included in the fuel prices.							

Financial evaluation of the project (CZK)

The cumulative discounted cash flow is shown in the first two graph of following table where it is clearly depicted that the project's benefits exceed costs after the 7th year of implementation without OPE's subsidy and after the 5th year of implementation with the subsidy. In the last two graphs a sensitivity analysis is conducted in order to decrease uncertainty and check the robustness of the results against the factor that can have the highest impact which is the assumed discount rate.

Without subsidy	With subsidy
Cumulative discounted cash flow	
	
Sensitivity analysis (NPV)	





Conclusions

Implementation of the DHS reconstruction project is in compliance with approved Biomass action plan designed within the BioRegions project for target region consists of two towns (Brumov-Bylnice and Slavicin) and eleven neighbouring villages. The reconstruction of the DHS network results in energy efficiency increasing and decreases dependence on imported fossils fuels. Raising utilisation of local biomass (wood chips – waste biomass from sawmills and forestry) strengthens economical and social stability of border region because financial resources stay in the region as well as jobs linked to biofuel supply. Consequently, utilisation of local biomass increases energy self sufficiency and stabilises the customers heat prices on acceptable level. The contracts with main biomass producers are made for five years whereas new created local biomass market decreases the dependence on dominant biofuel suppliers into the future. Moreover, building-up local biomass source (boiler) cut-down emissions and costs linked with fuel transport (local biomass producer – local consumer).

Initially, there were several different problems linked with DHS networks operation in Slavicin. Comprehensive approach helped to find realistic solution of all mentioned problems, but the investment costs were too high for the project operator. However, there was a possibility to get support from OPE and EAZK prepared and submitted (in cooperation with the project operator) an application which was successful. Ensured financial support from OPE did not cover all investment costs but it helped to increase possibility of getting bank loan under more acceptable conditions. Another lesson learned from the project is effective fuel utilisation. Cheaper local biomass became the main fuel for new united DHS network (fuel price stabilisation) and most of the remained (more expensive) natural gas consumption was transferred into combined heat and power generation, which provides important and stable income from electricity sale.