1.1.10 Installation of a biogas CHP module at the sewage treatment plant - Lublin (PL)

Lublin is located at the northern end of the Lublin Upland, at the river Bystrzyca. It is the capital of the Lubelskie Voivideship and the biggest city in eastern Poland, with a population of nearly 350.000 people. The city covers an area of 147,5 km² and is divided into 27 districts. Due to its location and historical variety of cultures, Lublin is the meeting point of East and West - technologies implemented here diffuse to the east of Europe. It is also an economic center of the region and the biggest academic and scientific center East from the Vistula river.

Dynamic economic growth of the region results in increased energy consumption and negative impact on the local environment. Due to the decreasing number of natural resources and their increasing prices, as well as due to the progressive degradation of the natural environment, local authorities turn to RE and sustainable development. For many years already they have been engaging in many environmental initiatives. One of them is the project of **installation of a biogas CHP module at the sewage treatment plant "Hajdów"** managed by the Lublin's Municipal Water Supply and Sewerage Company.

"Hajdów" sewage treatment plant operates since 1992 and is located in the eastern part of the city. Currently it is **one of the biggest plants of this type in Poland**. Its total area comes to 62,6 ha, including 22,4 ha of fields used to store digested sludge. The receiver of the purified household and industrial sewage from the Lublin's agglomeration (including Lublin, Świdnik, Wólka and Konopnica) is Bystrzyca, which is the second biggest tributary of the Wieprz river.

Lublin's Municipal Water Supply and Sewerage Company is undertaking many efforts to reduce negative environmental impact of the „Hajdów" sewage treatment plant. For several years it has been conducting modernisation works aiming at improving the quality of purified sewage, especially in the field of the content of biogenic compounds. The **level of reduction of basic pollution indicators comes to approx. 96,2%**.

Technical aspects

The company is also implementing a project which is a subject of this assessment, i.e. a project of installation of a biogas CHP module at the plant. The project includes:

- purchase, installation and launch of **two new biogas-fueled power generating sets** with the capacity of **834 kW** each and with heat recovery modules,
- adaptation of the building of the current energy plant to the needs of the new sets (including adaptation of the accompanying installations - electrical, water, sewerage and ventilation system, measuring and control equipment, etc.),
- installation of renewable energy metering and billing unit.

The project is consistent with national, regional and local policies and strategic documents and contributes to the achievement of their objectives. Actions undertaken by the Lublin's

Municipal Water Supply and Sewerage Company support implementation of sustainable development vision described in following regional strategies and programmes:

- Development Strategy of the Lubelskie Voivodeship for the years 2006-2020,
- Programme for the Development of the Energy Sector in the Lubelskie Voivodeship,
- Regional Programme for the Development of Alternative Energy Sources in the Lubelskie Voivodeship,
- Regional Operational Programme for the Lubelskie Voivodeship for the years 2007-2013,
- Development Strategy of the City of Lublin for the years 2008-2015,
- Development Strategy of the Lublin's Municipal Water Supply and Sewerage Company for the years 2012-2020.

The main aim of the described action is to use the RE potential of the plant and thus contribute to the sustainable development of the city and the region. Other qualitative and quantitative aims include:

- reduction of operating costs of the plant,
- reduction of the consumption of conventional fuels,
- protection of the environment from the negative impacts of energy production processes,
- rational use of locally available renewable energy sources.

Figure 11 Lublin's sewage treatment plant

Environmental aspects

Environmental assessment proved that the action itself and the technical solutions used will have a positive impact on the environment. Biogas, which is a by-product of the purification of

sewage at the plant, has significant calorific value and may be used as an energy carrier. After finalization of the investment the amount of produced and used biogas will increase, which will result in decreasing the demand for conventional fuels. Modernisation of the plant will also result in decreasing the overall demand for technological heat.

Each amount of energy produced by the generator will contribute to decreasing the consumption of basic, conventional energy sources. Therefore, the main environmental effect of using biogas for producing "clean" energy is reduction of CO_2 emissions responsible for the - so called - "greenhouse effect" and accompanying climate changes. It was estimated that the project will result in the reduction of primary energy consumption amounting to **48.038 GJ/year** and the reduction of CO_2 emissions amounting to **10.835 Mg/year**.

Analysed project, aiming at increasing the use of renewable energy sources, is consistent with the main lines of actions specified in Agenda 21 - a set of recommendations and guidelines concerning actions that should be undertaken in the XXIst century to ensure long-lasting and sustainable development. The project will also contribute to the achievement of the aims of the Sixth Community Environment Action Programme.

Socio-economic aspects

Biogas-fuelled CHP unit installed at the „Hajdów" sewage treatment plant will be used for simultaneous, economical production of electricity and heat, which - according to the law in force - can be considered as renewable energy. The electricity produced will be used to cover the plant's own demand, while the heat will be used to heat the digestion chambers sand to supply the buildings with warm usable water and heating.

As a result of producing the fuel „on the spot" and of its high availability, installation of biogas CHP modules at sewage treatment plants is one of the most economic ways of utilization of biogas. Instead of being unproductively burned in the flares, the biogas produced in the process of anaerobic digestion will be used to produce electricity and heat, which will also results in the reduction of operation costs of the "Hajdów" sewage treatment plant and of the whole Lublin's Municipal Water Supply and Sewerage Company.

Financial aspects

Total estimated cost of the project implementation comes to **7.412.841,00 PLN** (approx. 1.853.210 €), including the cost of the construction and assembly works and the supply of the power generating sets which come to **5.890.200,00 PLN** (approx. 1.472.550 €). Remaining costs include the costs of the development of the feasibility study and the project documentation, promotion and the development and maintaining of the project website.

The project is financed from two sources:

- own funds of the Lublin's Municipal Water Supply and Sewerage Company (municipal unit);

- co-financing from the European Regional Development Fund (distributed via the Regional Operational Programme for the Lubelskie Voivodeship for 2007-2013, priority axis VI "Environmentally friendly energy"); the co-financing value comes to **2.621.250,00 PLN** (approx. 655.300 €).

Organisational aspects

The project is being implemented by the Lublin's Municipal Water Supply and Sewerage Company, which is a municipal unit and which guarantees securing human and financial resources necessary to successfully complete the task. All persons involved in the project have significant and many years' experience in implementation of similar initiatives.

The contractor will be selected in an open tender prepared and executed on the basis of the national law (Act on Public Procurement Law from the 27th of January 2004, amended on the 8th of November 2013) and the tendering procedures being in force in the company.

Implementation of the project started in May 2012 and it is planned that it will be finalized by December 2014. By now the investor managed to obtain all necessary administrative decisions, as well as to finalize the project documentation. In March 2014 there will be announced an open tender for the delivery and installation of the two biogas-fueled power generating sets at the "Hajdów" plant. It is planned that the contractor will be finally selected by the end of April 2014.

Additional support for the municipality of Lublin was an opportunity to participate in the Green Twinning project and an opportunity to exchange experience and best practices with other municipalities involved in the project, as well as to participate in the training seminars organized within its duration.

Table 10 below summaries the results of the technical, financial, socio-economical and organisational analysis of the action entitled "Installation of a biogas CHP module at the sewage treatment plant in Lublin"

Table 9 Summary of the findings of the assessment study of the action „Installation of a biogas CHP module at the sewage treatment plant in Lublin"

Technical/ Environmental assessment	**Title**	Installation of a biogas CHP module at the sewage treatment plant in Lublin
	Technology employed	2 power generating sets with the capacity of 834 kW each
	Technical specifications	**Engine:** Type: J 316 GS-C25, configuration: V 70º, no of cylinders: 16, bore: 135 mm, stroke: 170 mm, piston displacement: 38,93 l, mean effective pressure: 17,70 bar, specific consumption of engine: 2,43 kWh/kWh, specific lube oil consumption: 0,3 g/kWh, weight of the engine: 4000 kg, filling capacity of lube oil: 300 l. **CHP unit:** Electrical output: 834 kW, thermal output: 920 kW, electrical efficiency: 39,9%, thermal

		efficiency: 44%, Total efficiency: 83,9%, heat to be dissipated (LT-Circuit): 42 kW, emission values: NOx < 500 mg/Nm3 (5% 02). **Alternator:** Manufacturer: STAMFORD, type: PE 734 B2, apparent power: 1 305 kVA, efficiency at cos Ψ = 1,0: 96,9%, efficiency at cos Ψ = 0,8: 95,8%, active power at cos Ψ = 1,0: 834 kW, active power at cos Ψ = 0,8: 825 kW, frequency: 50 Hz, voltage: 400 V, protection class: IP 23,insulation class: H, speed: 1 500 rpm, mass: 2 710 kg. **Additional information:** Exhaust gas mass flow rate (wet): 4 500 kg/h, exhaust gas volume (wet): 3 500 Nm^3/h, exhaust gas temperature at full load: 458ºC, combustion air mass flow rate: 4 127 kg/h, combustion air volume: 3 192 Nm^3/h, return temperature: 70ºC, forward temperature: 90ºC, hot water flow rate: 39,5 m^3/h.
	Energy savings	48.038 GJ/year
	CO_2 savings	10.835 Mg/year
Financial assessment	**Financing scheme**	• Own funds of the Lublin's Municipal Water Supply and Sewerage Company (municipal unit) • Co-financing from the European Regional Development Fund (distributed via the Regional Operational Programme for the Lubelskie Voivodeship for 2007 -2013)
	Project cost	7 412 841,00 PLN (approx.1 853 210 €)
	Co-financing from the ERDF	2 621 250,00 PLN (approx. 655 300 €)
Organisational assessment	**Time schedule**	31.05.2012 - 28.11.2014
	Body responsible for the implementation of the action	Lublin's Municipal Water Supply and Sewerage Company (municipal unit)