Preparation of a pilot biogas CHP plant integrated with a wood-chip fired DHP system

Institute for Renewable Energy Ltd, Poland

Summary

The project focused on the preparation phase for a pilot investment in Koczala, Northern Poland, relating to an agricultural biogas CHP plant integrated with a converted wood-chip fired municipal district heating system. As a result of the project an integrated feasibility study has been prepared an a private-public partnership (PPP) has been established to accomplish the investment. Due to the model character of the project in Poland as regards production and utilisation of agricultural biogas the project focused on BAT obtainable from various European countries. The project was implemented in 2000-2002. Financial closure for the biogas investment which may require 34% or more grant is currently in progress.

Key words: agricultural biogas, CHP, wood-chip district heating, fuel switch, public-private partnership

End-user area		Target Audience		Technical	
	New buildings		Citizens		Energy efficiency
	Refurbishment of buildings		Households		Heating
	Transport and mobility		Property owners		Cooling
	Financial instruments		Schools and universities		Appliances
■	Industry		Decision makers		Lighting
	Legal initiatives (municipal regulations, directives, etc)		Local and regional authorities	■	CHP
■	Planning issues		Transport companies	■	District Heating
	Sustainable communities		Utilities		Solar energy
	User behaviour		ESCOs	■	Biomass
	Education		Architects and engineers		Wind
	Other		Financial institutions		Geothermal
		■	Other		Hydro power
				■	Other (biogas)

Context

In Poland, there are over a thousand larger animal farms that have more than 500 livestock units. Traditionally, disposal of animal manure is applied mainly through direct use as fertilizers sometimes posing serious threat on the local environment and causing contamination of underground waters and devastation of life in adjacent aquatic ecosystems. Direct application of the manure leads to the saturation of land with manure nutrients, possibly resulting in adverse effects on the growth of crops and grasses. Other environmental hazards, like nitrate leaching and odour/methane also take place.

An alternative, environmentally acceptable disposal routes with potential financial benefits refer to anaerobic digestion of animal manure and biogas-to energy schemes, which generate revenue from the production of electricity and/or heat and well-neutralised high-quality organic fertiliser. However, until now, there have been up to 15 applications of rural biogas projects in Poland. However, most of them used very simple non-commercialised technologies and focused mainly on the production of fertilisers and heat recovery.

It has been recognised that in order to start up more serious development of the agricultural biogas sector in Poland it may be necessary to prepare and develop a modern pilot biogas CHP plant with a transfer of experience and already well proven technologies to Poland.

Such a project focusing on a preparation of a pilot biogas CHP plant has been prepared by EC BREC Institute for Renewable Energy Ltd together with Danish companies NIRAS, Bioenergisystem and the Southern Denmark University. Financial support for the project has been received from the Danish Energy Agency.

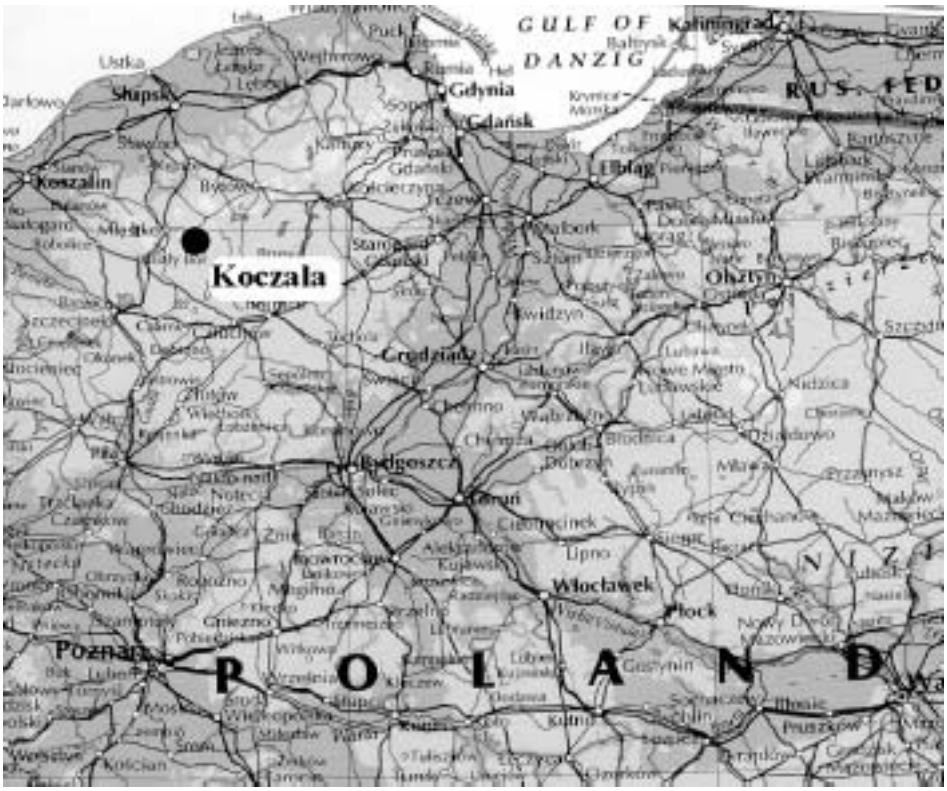
Objectives

National RES Strategy adopted by Poland in 2001 specifies generation of clean energy from agricultural biogas plants as an important priority. If the targets for RES are to be achieved cumulative capacity for agricultural biogas plants (heat+electricity) should grow in the year 2000 – 2010 by additional 30-40 MW.

Process

Prior to the project first detailed identification for possible locations for a demonstration project and investigations into financing possibilities both abroad and within Poland have been carried out. Detailed data was collected from 5 prospective locations; mainly due to outstanding interest in biogas of local partners, appropriate waste characteristics and very good financial condition, the commune of Koczala, northern Poland (130 km west of Gdansk) was selected for a more detailed feasibility study (see picture on next page).

The project concept that has been developed in the discussions between the local authorities and the local pig farming company Poldanor S.A. together with Danish and Polish experts included:
Technical plan for a biogas generation plant with pipelines for pumping manure from the farms and a pipeline to pump biogas to the biogas CHP plant (1 km south east of the town)
Biogas CHP plant (location at the existing boiler house of the local DHP plant in the western part of the town)
Modernisation of the boilerhouse itself with a switch from coal to wood chips
Refurbishment of the municipal district heating network (to improve energy efficiency)



Location for the pilot 1 MWth + 800 kWel agricultural biogas CHP plant in Koczala

As such, the integrated approach was to utilise animal manure and locally available organic waste from food processing industry on a continual basis, thus, recommending biogas CHP plant to provide base load for the municipal district heating system, while a new wood-chip boiler cover the winter demand on the top of energy supplied from biogas. Additionally a back up system of oil/(bio)gas boiler has been planned and an accumulation tank to increase efficiency of the overall system was designed.

Apart from full integrated feasibility studies and re-designing of all the elements of the energy system in Koczala further work included preparation of applications for various administrative approvals including connection of the biogas CHP plant to the grid, environmental impact assessment, application for grants and soft loans to national and international funding institutions, etc.

An important feature is that the project has been prepared a pilot also from organisational point of view as one of the first project in renewable energy in Poland arranged as public-private-partnership (PPP). In the course of the project, a local new joint company owned 51% by Commune of Koczala and 49% by Poldanor S.A. who will operate and construct the Biogas Plant, reconstruct the Heating Plant (including the CHP-unit and a new Wood Chip Boiler) as well as construct a new District Heating Network with new consumer connection installations.
In mid-2002 negotiations and application for grants and finance from different institutions have been underway.

Financial resources and partners

The total investment is around 14 million PLN (3.6 million Euro) with the payback period of 10 years. The precondition for the analysis was a constant low final price for the local consumers of centralised heat and sensibility analyses shows a significant sensibility for changes in the electricity sale price.

Results

The recommended technical solution for the biogas production plant included pumping of over 30,000 tonnes of pig manure from the two Poldanor farms situated less that 4.5 km from the Plant. Additionally 1500 tonnes of husk and energy crops will be delivered from the Poldanor owned feed mill in Koczala and the local set aside land.

Biogas at 65% methane content will be produced at two digesters 780 m^3 each (retention time 13 days in average, thermophilic conditions around 52 ^oC) and a sequence of after-digestion chambers with lower methanisation temperatures. Process heat for the primary digesters will be provide by an automatic 300 kW wood-chip boiler.

Biogas CHP plant will be receiving 346 m^3 of biogas per hour that will be combusted in a Jenbacher CHP unit 836 kWel and 1,010 kW heat (from cooling exhaust gases and the engine)
All electricity will be sold to the grid and the heat will be supplied to the municipal district heating system.

The old 5,5 MW coal-fired system will be replaced with an automatic 800 kW wood chip boiler with a daily storage system integrated with the building of the existing boilerhouse. Reserve/peak load boiler: with 3,15 MW capacity for biogas/light fuel oil and a 100 m^3 heat accumulator tank will secure the overall district heating system in the town.

A project for the reconstruction of the municipal district heating distribution network had been prepared by a local Polish company Gaszystem and was after minor amendment was integrated with the other components of the new energy system planned for Koczala .

The new energy system in the town of Koczala is designed to generate:
4,850 MWh/year of electricity (to be sold to the grid)
4,830 MWh/year of heat production (from the CHP unit and the wood-chip boiler at DHP plant)
130 MWh/year of heat production (gas boiler)

When eventually turned into operation, the new integrated biogas CHP/wood-chip DHP system in Koczala will allow direct reduction of emissions as compared to the previous DHP system based on coal. The CO_2 emission will be reduced with 99½% (6800 t/a), the emission of SO_2 will be reduced with 96% (53000 kg/a) and the NO_x emission will be reduced with around 51% (9900 kg/a).

Additionally, by treating manure in the biogas plant, production of methane will take place in a closed system and be utilised in the CHP unit. Hereby the emission of CH_4 to the atmosphere will be reduced. As the methane production is optimised in the biogas plant, it is estimated that the emission will be reduced by 30% of the total production in the biogas plant (the methane outlet in the present situation), which is almost 4800 tonnes of CO2 equivalent annually

Direct net creation of job will be minor (2 people) as the biogas production plant, biogas CHP, the wood-chip boilerhouse will be almost fully automatic and the existing staff of the old coal-fired DHP

plant will be trained to work at the biogas production plant. However, from a general social point of view the project is expected to stimulate local economy where currently, apart from the pig farms and a local saw mill there no other businesses.

From economic point of view, it can be concluded that implementing the overall integrated biogas/biomass project in Koczala is feasible and with a grant of around 34% and complementary soft loans. Implementing the project will be a showcase for the animal-producing sector in Poland, and the project will be in accordance with the national policy of development of renewable energy in Poland.

Lessons learned and repeatability

The key success to the project was a very open and active involvement of the local authorities of the Commune of Koczala and the management board of POLDANOR company – the owner of the pig farms in the area. It should be mentioned that the Danish director of Poldanor company has already been a shareholder of a similar biogas plant in Denmark, which may have been crucial for reaching the strategic decision of the company to invest own capital into the project in Koczala.

Recently established company Koczala Biogas Ltd will not only built, own and operate biogas production plant and a biogas CHP plant but will also refurbish the local district heating sector (changing pipes, valves and some heat exchangers of the distribution network, fuel switch from coal to wood chips at the local boilerhouse). The new company is 51% owned by the local authorities and 49% by the local company POLDANOR (pig farms).

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