CASE STUDY: Tervola Small-scale CHP Bio Energy Plant

SECTOR: Energy
COUNTRY: Finland

BACKGROUND

The district heating for a small Northern Finnish municipality of Tervola with 4000 inhabitants was previously produced by an oil power plant, which was coming to the end of its life-cycle at the turn of the millennium. The local sawmill produces a lot of logging and sawing waste. Another local company called Entimos Ltd developed an energy efficient, small scale, combined heat and power (CHP) plant *(figure 1)* exploiting wood fuel in co-operation with VTT Energy and the University of Oulu. The municipality of Tervola wanted to support these locally interesting opportunities regarded as both economically and environmentally sustainable. The first Entimos power plant was completed in 2001.

Figure 1. Entimos power plant in Tervola, Northern Finland

At the same time, the EU has made a commitment to the Kyoto protocol in order to reduce the greenhouse gas emissions. The net emission will remain zero with bioenergy, as it is when wood is used as fuel. Therefore it is natural to increase its share in energy production.

Up to now there technology which enables the use of bioenergy for heat and power production in a small unit with high efficiency has not been available. Small power plant units are suitable for small communities, which allows decentralized energy production. This is economical, because the renewable biofuels are decentralized: biomass is created almost everywhere where the sun is shining. Decentralized energy production is feasible also in terms of safety, as well as maintenance and supply security. On a societal level, it is important that economical benefits from the decentralized energy production remain within the local community.

DESCRIPTION

The core innovation of the new power plant is the technology of double gassing of the fuel. Two already known ways of producing and collecting fire gases - so called upstream - and forward current gassing – have been combined to the same plant. Two different gases are derived from the fuel combustion in this way, and the cleaner one can be used as a fuel in the combustion engine driving the electric generator *(figure 2)*. The heat loss generated in the power production is used also for district heating.

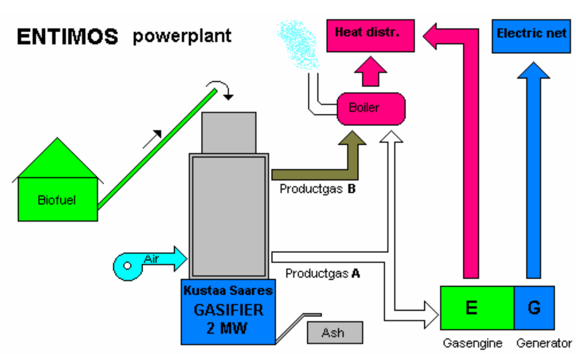

Figure 2. The principles of the Entimos power plant.

The efficiency of this kind of power plant is high: depending on the fuel, the efficiency is 80-85%. The proportion of electricity of the produced energy is even 30-40%. The most appropriate size of the power plant is 2-3 MW, but the units can be combined to make a power plant of even 10-15 MW. Other technologies are normally more economical in higher efficiency classes.

A power plant based on double gassing technology has many technical advantages. The power plant is unoccupied, which lowers the operating costs. The gassing temperature is high (1 000-1 200 ºC) causing low level of emissions. The quality requirements of the fuel are not high: the humidity of the fuel is not a problem and the chip size doesn't matter. The adjustment range of capacity is wide (20-100%), the power plant can be used with only a fifth of it's maximum capacity.

In Tervola, the excess wood from the logging (sprigs, stubs, wood unsuitable for sawing etc.) and the sawing waste, bark and sawdust accrued by the operation of the sawmill are used as fuel of the power plant. In principal, all renewable biomasses are suitable as fuel, like the pressed leftovers of palm oil and corn, which is unsuitable as food. Also assorted, firing municipal waste or peat can be burned in the power plant.

EVALUATION

The municipality of Tervola chose the type of power plant clearly on economical basis. The total cost of the power plant was about 1,2 M Euro, of which the share of the building was over 0,3 M Euro. The state gave an investment grant to the municipality, which was 27% of the total investment sum.

The estimated repayment period with current incomes is 7-8 years, with the investment grant by the state 5-6 years. The life period of the power plant is at least 30 years.

The power plant produces approximately 90% of the district heating energy and approximately 10% of the electricity used by the municipality. Because of the advanced burning technology, particulate emissions are under control. There is also demand for tar from the gas boiler *(figure 3)*. Ashes can be used for forest fertilisation.

Figure 3. The boiler

DRIVERS

In addition to the local needs and opportunities, building of the Tervola power plant was desirable because of environmental policy reasons. The goal of EU is to double the share of renewable energy sources from the level of 6% in 1995 to 12% in 2010. From this increment, 80% would come from bioenergy, the use of which would threefold. The National Technology Programme for Wood Energy in Finland aims at fivefolding the use of woodchips for energy production during the period from 1998 to 2003.

LESSONS LEARNT

Emissions of carbon dioxide can be reduced, the share of renewable energy sources can be increased and the energy production can be decentralised with the help of this type of modern technology.

APPLICATION

A power plant like Entimos is feasible when a small community is situated in a forested area, where trees are cut and made use of – as the situation often is in the Northern countries. In addition to heat production, also electric power can be produced about three times more compared with the earlier technologies.

Another application is an individual power plant, which produces power and heat, for example sawmills and greenhousesexploiting the biomass left over from their normal processes. In co-operation with the municipality and the production plant, it is possible to find overall economical solutions depending on the amount of electricity and heat, that the both parties need.

The third possibility is to use this kind of power plant for incineration. The possibilities for that depend on how the waste is sorted and collected. Anyhow, attention has to be paid to the control of emissions from the power plant.

TRANSFERABILITY

The technology is completely transferable to any other country. The usefulness of the solution depends on the available fuel. Useful biomasses and community waste can be found in every country.

IMPACT ON SUSTAINABILITY AREAS

Ecology		Economy		Social aspects	
Are emissions to air, water and soil within the restrictions set locally and internationally? Are the emissions decreasing?	CO_2 ↑ others ↗	Is the cost/effectiveness and/or cost/benefits of the system reasonable compared to other systems? Compared to other needs in the city and to political goals?	↗	Has the planning and decision-making for the infrasystem been done in a democratic and participative way?	→
Is the use of natural resources reasonable compared to other comparable systems? Is the use decreasing? (e.g. fossil fuels, water, phosphorus potassium)	↑	Are the citizens willing to pay for the services offered? Are the services affordable to all citizens?		Are the function and the consequences of the system transparent to and accepted by the citizens? Is the system promoting a responsible behaviour by the Citizens?	↗
Is the system allowing a reasonable bio-diversity with regard to the kind of area studied? Is the bio-diversity increasing?	→	Is the organisation(s) that finance, maintain and operates the system effective?	↗	Is the system safe to use for the citizens? (hazards, health, well-being)	→
Is the system more or less sustainable than a conventional system regarding ecology?	↗	Is the system more or less sustainable than a conventional system regarding economy?	↗	Is the system more or less sustainable than a conventional system regarding social aspects?	→

Environmental: High
Social: Medium
Economical: High
Institutional: Medium

PROJECT CONTACT

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