Reducing Greenhouse Gas Emissions through Alternative Energy

Project Title: Reducing Greenhouse Gases by Introducing Renewable Energy Sources
Leader: Municipality of Kyustendil (Kyusstendil, Bulgaria)
Partner: Holzer Energy Management (Maryland, USA)
Location: Kyustendil County, Bulgaria
Project Duration: February 2001 – October 2001
EcoLinks Project Investment: Total Project Investment: $ 56,800; EcoLinks Grant Support: $ 42,712; Project Team Cost Share Contribution: $14,088.

Best Practice: Transferable Solution

This project is a Best Practice because it established a highly transferable methodology for improving energy conservation and using geothermal energy. There is a large potential for implementing similar geothermal energy projects throughout Bulgaria, especially at the municipal level. The energy audit methodology and the method and technical tools for using geothermal energy are highly transferable.

Project Summary

Kyustendil is located at the foot of the Ossogovo Mountains in southwestern Bulgaria. The area has a rich history with archeological findings dating back to the Neolithic age. Currently, it is best known for its abundance of cherry and apple orchards and hot springs. Kyustendil is one of the most famous balneological resorts of Bulgaria. The potential for a thriving tourist industry is promising. Despite these attractive features, however, the area has a high unemployment rate (16.5% in 1998) is challenged to improve energy conservation and reduce greenhouse gas emissions. High levels of carbon dioxide (CO_2) are released into the air from burning coal and

light oil for heating purposes. Emissions from fuel combustion are especially dense during the winter months when the demand for heat is highest. While undustrial growth may help to alleviate the unemployment rate, efforts to improve energy efficiency and reduce pollution were needed.

With the support of an EcoLinks Challenge Grant, the Municipality of Kyustendil teamed up with Holzer Energy Management Company, a US consulting firm, to develop a local energy and business plan for reducing air pollution including greenhouse gas emissions through energy conservation and by introducing geothermal energy in two main municipal buildings. The two main municipal administration buildings in the city of Kyustendil are heated by central heating systems that use light oil. The buildings consume 210 tons of light oil per year and in turn produce 651 tons of CO_2. Identifying and implementing energy conservation measures would help to reduce the amount of energy consumed by each building. Exploring an alternative energy resource, such as geothermal energy, could help to reduce greenhouse gas emissions. Located near the two buildings is a natural spring made up of geothermal water with a flow rate of 33 liters per second and a temperature of 75°C. The spring is used largely for balneological purposes after the water naturally cools in pools. Much of the heat from the spring, which is a potential energy source, is subsequently lost to the atmosphere.

With implementation of the plan generated as part of this project, energy consumption can be reduced by 165 tons of light oil fuel per year, CO_2 emissions would be reduced by 651 tons annually, and cost savings would be generated from energy conservation as well as from using an alternative energy resource.

Project Activities

The project activities were geared toward producing a plan to improve energy conservation and use geothermal energy.

1. Conducted energy audit and identified energy conservation measures.

Action: A detailed energy audit of two administrative buildings owned by the Municipality of Kyustendil, HIGIA Company and the Town Hall, was conducted to identify energy saving measures for reducing heat consumption.

The audit included:

- Analysis of the current situation including building structure and envelope, energy generation and distribution, environmental control systems, energy consumers and occupants, and climate conditions
- Development of a necessary data base for modeling and simulating an energy transfer process
- Development of models for actual energy consumption
- Determination of baseline energy consumption
- Simulation of the energy transfer processes and determination of the energy savings potential
- Technical and economic evaluation of energy saving measures

The audit included multiple data sources including interview data from building staff and managers, on-site observations and evaluations, and available records.

Energy conservation measures were developed and included:

- Plate heat exchanger substation
- Night setback temperature control in substation
- Installation of Thermostatic Radiator Valves (TRVs)
- Window weatherization
- Heat installation of the roof
- Continuing to replace burned out lights with more efficient lights

Product(s): 1) Energy audit 2) Energy saving measures.

2. Evaluated geothermal energy resources as an alternative to existing oil burning heating systems.

Action: The activities to build a framework for utilizing geothermal energy consisted of the following steps:

1) The parameters of existing geothermal water were evaluated.
2) A preliminary design for retrofitting the heat installations in the two municipal buildings was prepared.
3) Suitable systems were developed.
4) The dimensions of the indirect sub-stations and geothermal heating pipeline systems for the two municipal buildings were established.
5) Suitable technical components and units were selected.
6) An analysis of the cost and technical and economic aspects of the systems was conducted.
7) A technical report was prepared and distributed to workshop participants and municipal staff involved in the project.

Product(s): 1) Technical report on geothermal energy utilization 2) Presentation of technical report to project participants and municipal staff members.

3. Developed an energy and business plan for implementing and monitoring selected measures

Action: Based on the energy audit and the findings on geothermal energy utilization, an energy and business plan was developed. It provided information on the replacing liquid fuel with geothermal water as an alternative energy source for generating heat in the two municipally owned buildings.
The plan detailed the requirements for replacing the existing oil-fired boilers with substations in order to house the heat exchangers and pumps. Equipment suppliers were identified and price quotations were obtained.
The plan further included economic considerations such as the payback periods for implementing the energy measures in each building.

Product(s): Energy and business plan.

4. Disseminated project results

Action: A one-day seminar was organized at the Municipality of Kyustendil. Participants included representatives of the Municipality of Kyustendil, administrators, potential investors, and representatives from local organizations. The purpose of the seminar was to share the project findings as well as to expand the implementation capacity of the project.

The project results were disseminated through traditional media sources and the internet. An article about the project results was published in the BSREC (Black Sea Regional Energy Center) Newsletter which is distributed to more than 300 members. Case studies of the project results were developed and published on the web (http://www.bsrec.bg).

Product(s): 1) One-day seminar on project results; 2) Media productions about the project; 3) Internet site on project results including case studies (www.bsrec.bg). An article on the project published in the BSREC.

Project Benefits

This project facilitated the institutional and technical requirements to introduce alternative energy sources, namely geothermal energy, in the region. By providing heat using geothermal water, several environmental and economic benefits were generated including CO_2 emissions reductions and cost savings.

Capacity Building Benefits

This project provided capacity building benefits. It established and demonstrated a methodology for conducting an energy audit and exploring alternative fuel resources. It strengthened regional expertise in the use of geothermal energy. Case studies of the project were developed for further dissemination of practical information on energy auditing and geothermal energy use throughout Bulgaria.

The one-day seminar organized by the Municipality of Kyustendil as part of this project included representatives of the Municipality, administrators, potential investors, and representatives from local organizations. The seminar convened key actors addressing energy issues in the region, and conveyed the framework for implementing an energy savings program.

Environmental Benefits

This project contributed to reducing air pollution and alleviating trends in global warming by reducing CO_2 emissions in the Kyustendil region of Bulgaria. With application of the project methodology in other parts of Bulgaria, CO_2 emissions can be reduced even further. The methodology provides a way for reducing energy consumption and the reliance on non-renewable energy resources. By removing the oil-fired boilers in the two municipal buildings in Kyustendil, greenhouse gas production was reduced. With implementation of the energy saving measures created

by this project, heating fuel consumption will be reduced by 165 tons per year. Carbon dioxide emissions are reduced in total by 512 tons per year. The conversion of the heating system from light oil to geothermal water alone will result in an annual savings of 103,343 liters of oil per year and an annual reduction in CO_2 emissions by 321 tons.

Economic Benefits

Several economic benefits can be generated by implementing the proposals developed by this project. The amount of fuel used to heat the two municipal buildings can be reduced by 165 tons per year. The reduction in fuel oil consumption generates a savings of $66,000 each year. With installation of the modern heat-exchange units for using heat from geothermal water, maintenance costs for providing heat are reduced by $2,500 per year. Low-temperature water (i.e., water that is less than 50°C) that is not used by the municipalities can be used by other consumers.

Table 1. outlines a financial analysis of the three different options of energy conservation measures.

Energy Conservation Measure	**Investment**	**Geothermal Efficiency** (Percentage decrease in heating peak load)	**Payback Period**
Plate heat exchanger substation; Night setback temperature control in the substation; Installation of TRV	$78,968	0.00	2.08 years
Windows weatherization; Plate heat exchanger substation; Night setback temperature control; Installation of TRV	$79,971	16.75	2.11 years
Windows weatherization; Heat insulation of roof; Plate heat exchanger substation; Night setback temperature control; Installation of TRV	$88,901	23.57	2.34 years

All the measures have a payback period of less than 2.5 years. The decrease in the heating peak load varies from 0% to 23.57%. These figures refer to the efficient use of geothermal water. For example, the last option listed would require using 23.57% less geothermal water than the first option.

Lessons Learned

The following lessons were learned during this project:

- The two municipal buildings used in this project were constructed in the 19th century and have unique architecture and heating systems. Team experts were challenged to project the benefits that could be generated in this project.
- The existing regulatory framework facilitates securing financial support for further implementation of the project.
- For other cities interested in implementing similar projects, developing an overall program for using geothermal energy is beneficial.
- Early planning, especially with regard to the identification and allocation of responsibilities is important.
- It is important to consider seasonal effects and to use monitoring instruments accordingly.

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