Development of a Cogeneration Plant at the Osijek Clinical Hospital in Croatia

Project Title : Feasibility Study for a Cogeneration Plant at Osijek Clinical Hospital
Leader: Clinical Hospital Osijek (Osijek, Croatia)
Partner: Parsons Energy & Chemicals Group (Pennsylvania,USA)
Associate: Enerkon, d.o.o., (Zagreb, Croatia)
Location: Osijek, Croatia
Project Duration: April 2001 – April 2002
EcoLinks Project Investment: Total Project Investment: $83,354; EcoLinks Grant Support: $48,554; Project Team Cost Share Contribution: $34,810.

Best Practice: Transferable Solution

This EcoLinks project successfully demonstrated a methodology for determining the feasibility of using a small-scale, combined heat and power (CHP) plant at a medical facility in Croatia. This project is an example of a market-based solution for improving energy efficiency, reducing greenhouse gases emissions, and improving energy supply efficiency. After implementing several low-cost and no-cost energy saving measures, the feasibility of installing a cogeneration plant at the Clinical Hospital in Osijek, Croatia was explored to further reduce utility costs and enhance the security of the supply of heat and electricity. This integrated approach and feasibility study methodology are transferable to other similar facilities that seek to gain environmental benefits, improve utility cost efficiency, and achieve independence from the municipal utility network.

Project Summary

Clinical Hospital Osijek is an integrated health care facility with significant energy demand. Hospital's complex spreads on an area of approximately 7.5 hectares and includes over thirty separate buildings. In 1999, the Hospital consumed 96,943 gigajoules (GJ) of heat and 6,105 thousand kilowatthours (KWh) of electricity that cost $417,000. In order to reduce energy costs, the Hospital first identified and implemented several low-cost and no-cost energy saving measures including: 1) optimizing the peak power demand by operating high-load heat consumers during off-peak hours; 2) optimizing the reactive power compensation system; 3) improving the insulation in the existing steam and heating

pipes; 4) installing a recovery unit in the air-conditioning system; and 5) installing a central electricity and heat monitoring and control system. Despite these improvements, the Hospital still needed to increase the efficiency of their energy supply by reducing their dependence on municipal energy services. The Hospital currently relies on the city district heating system and power grid for heat and electricity respectively. A natural gas distribution pipeline –part of the city's gas supply system– is located near the Hospital. The possibility of installing a combined heat and electric power system to further improve energy cost savings and secure an efficient supply of energy needed to be explored.

With the support of an EcoLinks Challenge Grant, Project Leader Osijek Clinical Hospital, Project Partner Parsons Energy & Chemicals Group from the United States and Project Associate Enerkon from Croatia collaborated to assess the feasibility of installing a natural gas-fired cogeneration plant (i.e., combined heat and electric power system) in order to improve energy efficiency and improve energy savings. The project's work plan included 1) developing an energy management plan considering heat and power consumption and additional internal savings; 2) selecting the most favorable options for establishing a combined heat and power supply system at the Hospital; 3) determining the CHP plant parameters; and 4) preparing basic design and tender documents for the plant.

The project accomplished several tasks towards improving energy efficiency at Osijek Clinical Hospital. The feasibility of introducing a cogeneration system to cover the demand for electricity and heat at Osijek Clinical Hospital was assessed. An optimal solution for installing a CHP plant was identified. The technical information (e.g., technical design and tender documents for delivery of equipment and services) for installing a CHP plant was prepared. Seven companies have expressed an interest in financing the CHP plant installation phase developed by this project through a concession agreement with the Hospital. With installation of the plant, this project is ultimately expected to result in a savings of up to $285,000/year, reduce CO_2 emissions by 4,236 t/year, and decrease SO_2 emissions by 152 t/year.

Project Activities

The project was initiated with a conceptual plan for managing energy. A feasibility study on using a combined heat and energy facility at the Hospital was then conducted. The final stage of the project involved selecting the most appropriate alternative, prepared a feasibility study for that and tender documents for procurement and installation of a cogeneration plant.

1. Prepared an energy management plan concept, and developed and implemented an energy measuring plan.

Action: An on-site visit to the Osijek Clinical Hospital was conducted to review the existing power equipment and the Hospital's energy supply. An Energy Management Plan was developed. After reviewing existing energy management efforts, an Energy Measuring Plan was developed in accordance with the Energy Management Plan. Based on the results of the energy consumption measurements, the parameters for selecting the appropriate cogeneration plant were determined.

Product(s): 1) Energy Management Plan 2) Energy Measuring Plan 3) Parameters for a cogeneration plant

2. Assessed the feasibility of installing a CHP plant.

Action: A feasibility study was conducted. Analyses of the Hospital's present energy (heat and electricity) demand, future energy demand growth, and options for covering the extended demand were conducted. Alternatives were developed, including financial considerations for introducing cogeneration were generated. Economic and financial analyses and the selection of an optimal

solution were generated, including the investment outlays covered by a bank loan under the following conditions: loan interest rate of 7.5%, loan tenor of 6 years, and a grace period of 2 years.

The most appropriate alternative was selected and consisted of the following:

- The installation of one 1,047 kWh natural gas-fired engine CHP plant.
- The installation of a 2,500 kWh boiler for using exhaust gas heat and additional heat exchangers for using exhaust heat from the gas engine's oil and water cooling systems.
- A description and detailed specification of the technical equipment for the selected CHP plant's installation and operation.
- Based on electricity rates in Croatia which consist of peak prices during the day and lower tariffs at night, an optimal working regime for the plant was determined as follows: 1) operate engine 14 hours per day during the high-tariff period to produce electricity and heat; 2) use power grid generated electricity for the remaining 10 hours (during the low-tariff period).

Product(s): Feasibility Study Report including an overview of Hospital heat and electricity consumption and demand projections, cogeneration alternatives, and the selected alternative including CHP plant basic design and financial analyses.

3. Prepared tender documents for CHP plant installation.

Action: Detailed tender documentation was prepared based on recognized international standards for equipment delivery and services related to the installation of a CHP plant in the Hospital..

Product(s): Tender documentation necessary for the installation of a CHP plant at the Hospital.

Project Benefits

This project generated several benefits. During the initiation of the project, the Hospital staff became more acquainted with energy saving efforts at the Hospital and the introduction of a CHP plant as an alternative for improving energy efficiency. With implementation of the energy scheme to install a cogeneration plant at the Hospital, greenhouse gas emissions and energy costs would be reduced.

Capacity Building

As a result of this project, the technical staff at the Hospital understands the advantages of cogeneration and is now prepared to support the operation of a CHP plant at the hospital. Due to the data generated by the Feasibility Study, the staff has access to information about energy consumption at the Hospital that can be updated and utilized for multiple purposes to further improve energy efficiency.

Environmental Benefits

Implementation of the alternative generated and selected through this project's Feasibility Study would reduce energy consumption and greenhouse gas emissions. The installation of a CHP plant will result in reduction of CO_2 emissions by 4,236 t/year and SO_2 emissions by 152 t/year.

Economic Benefits

The installation of the identified CHP plant in the Hospital will result in an annual savings of $285,000 in energy costs.

For the selected alternative, considering the CHP plant's capacity and working regime, the following economic indicators have been calculated: Total investment outlays - $1.03 million; Simple pay-back period – 3.6 years; IRR – 21.2%; NPV – $1.3 million.

Lessons Learned

- A continuous and relatively consistent daily and annual demand for electricity and heat are main factors to be considered prior to undertaking activities related to introducing cogeneration.

- For CHP feasibility assessment, the most important factors to be considered are: (1) the ratio of fuel versus electricity and heat prices; and (2) the possibility of selling surplus electrical and/or thermal energy.

- Under the current ratio of electricity, heat and natural gas prices in the region[1], natural gas-based cogeneration can be a feasible energy supply alternative even without selling surplus electrical and/or heat energy to another consumer.

- It is important to analyze the possibility of using the total waste heat generated by a CHP plant (waste heat from exhaust gasses as well as plant's oil and water cooling systems) as an energy source.

- The selection of the CHP plant type to be used – gas turbine or gas engine – is determined by a number of factors including: main energy type needed (heat or electricity) which depends upon the average and peak heat and electricity demands, current prices, the availability of alternative sources, the conditions for connecting to the power grid, and the plant's investment and operational costs.

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