Cogeneration, heat recovery and frequency controllers at the Leuze Spa City of Stuttgart, Germany

Summary

Facilities with an all-year need for heat and electricity like public baths are a perfect application for cogeneration. The Leuze Spa, Western Europe's largest mineral spring, replaced its old steam-based district heating system with a combined heat and power plant featuring 3 x 112 kW_{el} and a condensing boiler. Several heat recovery units are used to derive heat from wastewater. Several frequency controllers along with an improved lighting system help to save some 170,000 kWh of electricity per year.

End-user area
- New buildings
- ■ Refurbishment of buildings
- Transport and mobility
- ■ Financial instruments
- Industry
- Legal initiatives (regulations, directives, etc)
- Planning issues
- Sustainable communities
- User behaviour
- Education
- Other

Target Audience
- ■ Citizens
- Households
- Property owners
- Schools and universities
- Decision makers
- Local and regional authorities
- Transport companies
- Utilities
- ESCOs
- Architects and engineers
- Financial institutions
- Other

Technical
- ■ Energy efficiency
- ■ Heating
- Cooling
- Appliances
- ■ Lighting
- ■ CHP
- District Heating
- Solar energy
- Biomass
- Wind
- Geothermal
- Hydro power
- Other

Context

Facilities with an all-year need for heat and electricity like public baths are a perfect application for cogeneration. The Leuze Spa, Western Europe's largest mineral spring, replaced its old steam-based district heating system with a combined heat and power plant featuring 3 x 112 kW_{el} and a condensing boiler.

Objectives

The objective of all activities of the municipal energy management in Stuttgart is to reduce the energy consumption of public buildings and thus reducing energy costs, emission of pollutants and greenhouse gas emissions. In this project we achieve this target by a variety of measures adapted to the local boundary conditions. They are long operating hours, high consumption of electricity and heat and very limited space for installations. Since the last refurbishment was in the early eighties, new technologies could be applied.

Process

Technical description of the project:

The **cogeneration plant** consists of 3 modules each with 112 kW electrical power and 196 kW thermal power. They are gas fired and have an electrical efficiency of 34 % and an overall efficiency of 93 %. This does not include the additional condensing unit used for preheating of hot water. When we designed the plant in 2000, we expected the plant to produce 1,910 MWh electricity and 3,350 MWh of heat per year. In 2003 the plant produced 2,407 MWh electricity and 4,970 MWh heat. This proves that the co-generation plant works very reliable.

Several pools in the Spa offer mineral water with 34°C. At a change of water of 65 m³ per hour that have to be heated from 20°C it is important to minimise the thermal load. Thus, two additional **heat recovery units** with 377 kW each were installed.

Instead of reducing the flow fed by a 10 kW pump with a throttle valve; a frequency controller regulates the power of the pump. Now we need only 7.2 kW to feed 160 m³/h.

Installation of the CHP

Heat recovery unit

At the start of the project there were doubts from the colleagues in the Spa concerning reliability, noise and the space needed for the CHP plant. In a number of meetings with the designer and the operator of the Spa these problems were solved. A big advantage during the negotiations was the fact that the CHP was financed by Intracting without any money from the Spa.

In the heat recovery project the operator of the Spa was afraid that the water would lose its therapeutic effect. We had to prove, that the water doesn't loose its contents of dissolved Carbon Dioxide. Fortunately, the measurements showed that the effect produced by the heat recovery is negligible.

The frequency controller didn't cause any problems they are meanwhile a standard component in many applications.

During the implementation a difficulty was that the heating system had to be replaced while the Spa was open. This means that there had to be heat available at any time. Various systems had to be transplanted to different places in the Spa to gain the necessary space for the boiler and the co-generation plant. Very often it is difficult to integrate a condensing boiler in an existing heating system since its temperature level is too high. In this case we avoid the problem by using the condensing unit to preheat the domestic hot water.

The heat recovery units have to be cleaned thoroughly in rather short intervals. For that, the system has to be opened. This requires sufficient space and special tools.

Financial resources and partners

The plant was financed using Stuttgart's Internal Contracting model.

Frequency controller in the Leuze Spa

Results

The total cost of the co-generation plant was 501,000 €, the annual savings are 83,400 €. The cost for the heat recovery units were 189,000 €. They save 2,800 MWh per year worth 119,000 €. Here we achieve a payback time of less than 2 years.

The frequency controller caused an investment of 3,500 € and saves 14,5 MWh of electricity and costs of 1,400 € per year. The investment was paid by the Spa.

In total CO_2 -savings of 767 t per year are achieved

Since the boundary conditions in the location are very favourable for investments in energy efficiency, all our targets could be reached.

Lessons learned and repeatability

The examples prove that highly efficient technologies achieve both a very good return on investment and substantial ecological advantages. The prerequisite are long operating hours every day and an all-year need for thermal energy. With the experience from the project we were able to introduce cogeneration plants in various other applications like smaller public pools or a hospital.

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