

MINI HYDRO POWER

HANNOVER (Germany)

Among the renewable energy sources, hydropower is the one that is used the most. In some European countries, it covers more than 30% of the national electricity needs. New, big hydropower stations will – because of the damming up of rivers and the related environmental laws – only very rarely be constructed. But there is a big potential for the mini-hydropower below 1MW. It can be very cheaply (re-) activated on those places where there are still the old exploitation rights and where old installations can be reactivated or at least the dams do exist. In Hannover as well, where two sites on the river Leine within the city limits are being developed

GENERAL ASPECTS

Hannover, the State capital of Lower Saxony [Niedersachsen], has 514,00 inhabitants within the city itself, and about 1.1 millions in the metropolitan area. Lying on both banks of the river Leine, it is near the North German plain, the Weser hills, and the Harz Mountains. The city is dominated by its automobile and chemical industry, and is famous as the site of the world's largest industrial trade fair.

Climatic data:

Degree days (17 °C):	4,000
Annual mean temperature:	9.8 °C



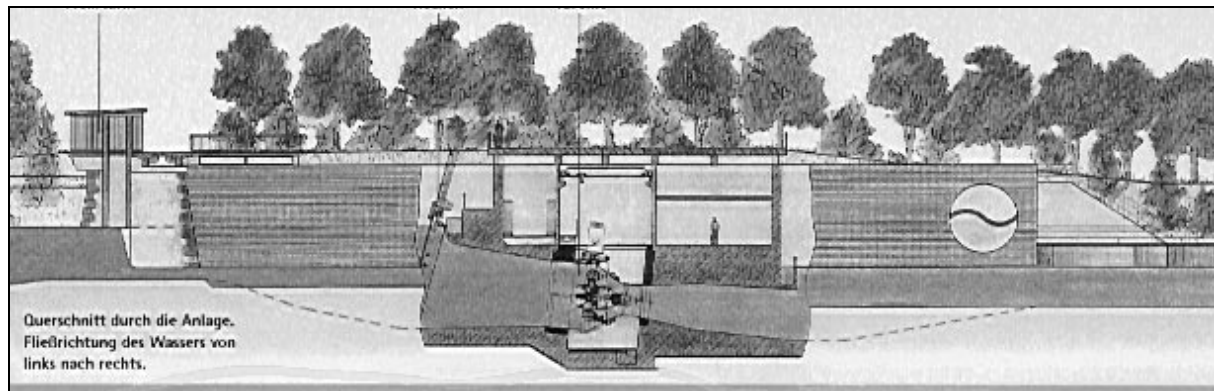
CONTEXT

The City and the Stadtwerke Hannover AG, one of Germany's largest municipal utilities, reconsidered their energy policy and corporate objectives in the late Eighties, jointly in part, and reformulated them as the "Hannover Energy Concept" and the municipal utility's "Concept 2000". In 1992, the city council approved the energy concept for the City of Hannover, with a commitment to reduce carbon-dioxide emissions by 25% (over 1990) by the year 2005, and not to use electricity from nuclear power in the city limits any more. Renewable sources of energy were assigned an important role in this.

This year, Hannover is the host of the World's Fair, at which about 300,000 visitors a day on average are expected. The Expo 2000 motto "Humankind – Nature – Technology" is the occasion for the City and the utility to demonstrate an energy future in accordance with Agenda 21 with several ambitious exhibits. One of the municipal utility's five exhibits is the Herrenhausen hydroelectric station. For six months, visitors from all over the world will have an opportunity to inspect the hydroelectric plant, which went on line in 1999.

EXPERIENCE OF HANNOVER

There were once one or more water mills at least fourteen sites on the present territory of the City of Hannover. According to a feasibility study from 1991, the use of water power for energy is still conceivable at only three sites within the city limits. One of these is the "Schneller Graben", where a hydroelectric plant was commissioned by the municipal utility in 1921. In 1983-84, it was thoroughly modernized, and converted to automatic operation. Its two open-flume Francis turbines, with a total capacity of 630 kW, supply about 3.3 GWh annually to the grid. At present, only half the annual mean cumulative flow available is utilized.



As part of the Expo project "The City as a Garden", the City of Hannover and Stadtwerke Hannover decided to build a second, new hydroelectric station with a fish ladder. The Herrenhausen hydroelectric station was intended to be an example of how, even in a countryside conservation and recreation area, a technical structure can be implemented with only minimal impact on nature. The construction of a fish ladder by the City will permit the various species of fish that exist or could exist in the Leine to climb up and thus pass the weir, for the first time since it was erected.

Implementation

In 1995, planning of the authorization process began, and the environmental compatibility study was started. Special attention was paid in planning to minimizing the impact on the biotope around the power station. Four site variants were investigated and evaluated; building the turbines into the existing weir proved to be the best solution ecologically. The



area studied covered 24 hectares.

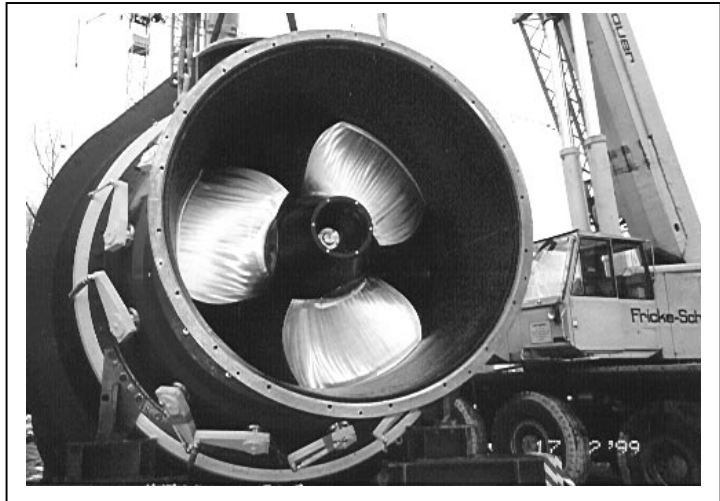
The authorization procedure lasted a good year long, and all recognized conservation societies and representatives of public interests participated. Since environmental compensation measures had been included in the planning from the start, no major objections were raised to the project. The costs of the environmental compatibility study, including the

compensation and replacement measures, amounted to about 100,000 Eur. In the immediate vicinity of the hydroelectric plant, trees and shrubs of hardwood bottomland woods were planted in an area of 600 m² as compensation and replacement measures. In addition, bottomland willow woods and typical bottomland shrubbery were established over an area of 2,400 m² by initial planting of willow bushes.

Excavation for the foundation began in at the beginning of 1998, and the concrete work started in June. In February, 1999, the turbines were installed, and trials began in September. On 5 Oct. 1999, the power station was formally inaugurated, after 18 months' building.

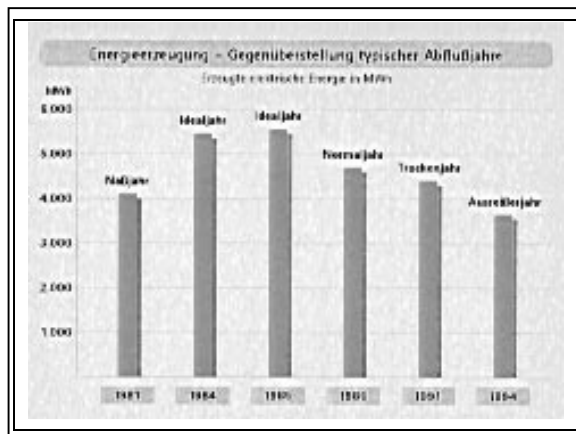
Plant engineering concept

The total water flow available ranges from 16 m³/s at low water to 250 m³ at high water. The mean tail flow is 50 m³/s, and the height of fall is then 2.10 m. The surplus water flows over the weir, as previously, or over the spillway in the case of high water.



The two Kaplan turbines are designed so that they can each use at most 25 m³/s. They have an output of 470 kW and a maximum efficiency of 92%. The utilization factor of the complete plant is 86%. The plant is out of operation because of high water (height of fall too small) for about thirty days a year.

A computer program for power-station simulation was used in the planning phase. The program calculated the respective turbine efficiency and corresponding output from the respective flow conditions (height of fall and tail flow) day by day for the period from 1980 to 1995. According to this, the annual electricity yield will average 4.8 million kWh, which is about 0.14% of the total electricity demand of the city of Hannover.



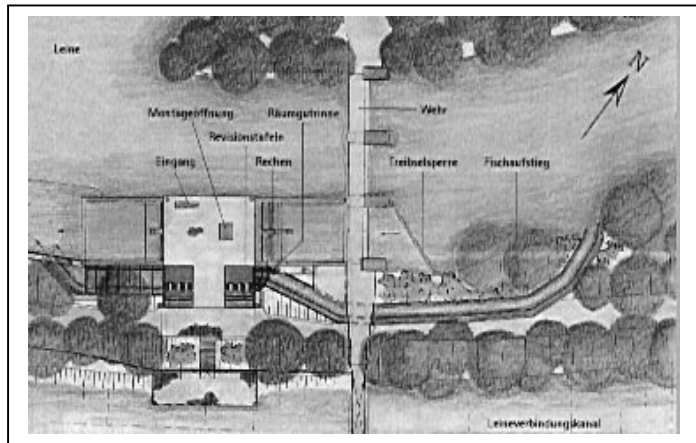
Hannover, with 400,000 Eur coming from Expo GmbH as an investment subsidy in the "City as a Garden" Expo project. Another 900,000 euro are coming from ProKlima, the local climate-protection fund. In addition, the State of Lower Saxony has granted a low-interest loan for 50% of the investment.

The electricity generated by water power is sold by the municipal utility directly and via Naturstrom AG to residents who wish to have electricity from renewable sources of energy. The surcharge per kilowatt-hour is just under 0.02 Eur.

EVALUATION AND PERSPECTIVES

Besides the hydroelectric plant on the Schneller Graben, Hannover now owns a second power station, and thus is utilizing about 50% of the city's technically feasible potential. The Herrenhausen hydroelectric plant may be considered a very successful example of the environmentally compatible erection of a hydroelectric plant at an existing barrage weir. 1,850 households can be supplied with electricity from the Herrenhausen hydroelectric station in future. The electricity production cost, including all subsidies, is 0.077 Eur per kWh, and the amortization period is twenty years. The figures for pollution avoided and resources spared are as follows:

- Reduction of annual emissions of pollutants by:
 - carbon dioxide: 3,500 t
 - sulphur dioxide: 1.600 kg
 - nitrogen oxides: 2.200 kg
 - dust: 80 kg
 - carbon monoxide: 400 kg
- Savings of:
 - 750 tons of coal and 600,000 Nm³ gas annually



The remaining potential for utilization of water power in Hannover is divided between enlargement of the power station on the Schneller Graben, and the former location "Döhrener Wolle". For the power plant on the Schneller Graben, an expansion with an additional capacity of about 735 kW would be possible from the engineering and legal points of view. However, the utility is not pursuing such an expansion at present, for business reasons. In the "Döhrener Wolle" area, there was already a water mill in the fifteenth century, and utilization continued until the Sixties. Since 1990, the City has been working to reactivate the plant, aiming at a capacity of about 900 kW when completed; annual generation has been computed to be 3.9 GWh, and the electricity production cost calculated at 0.06 Eur (not taking any subsidies into account). However, difficulties with the adjacent owners and with the operating company handling the project have caused the project to be postponed indefinitely.

FOR FURTHER INFORMATION

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