Increased Hydroelectric Power Generation through Use of the ASK Weir

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The Freusburger Mill in Kirchen an der Sieg, formerly used for milling grain by water power, ceased operation in 1978. Since then, it has been used for generating hydroelectric power. An ASK-Weir was installed in 1992 and has significantly increased its efficiency.

In view of the continuously rising costs for conventional power generation, the operation of small hydroelectric plants is becoming more and more attractive. While the use of hydroelectric power stations in the Scandinavian countries and alpine regions has always had considerable advantages due to geographic conditions, they are now becoming increasingly widespread in Germany too. One significant problem in the efficient operation of small hydroelectric power plants is maintaining a stable water level in the inflow channel to the turbine chamber. The power-generating units can only operate within an economic range if the point of maximum turbine efficiency is consistently assured.

The History of the Freusburger Mill

The operation of a mill is first mentioned in Kirchen church register in the year 1660, although the existence of the building is documented for the first time in 1437. According to other reports, grain was being milled on the slopes of the Freusburg hill well before the Thirty Years War.

Freusburger Mill Hydroelectric Plant

Turbine type:	Francis twin turbine
Year of construction:	1925
Water flow:	3,500 l/sec.
Fall height:	4.00 m.
Turbine capacity:	106 kW

The natural descent of the river Sieg favoured the use of water power for milling grain. It is not known exactly when the mill was built on its present site. The reason probably lay in improvements in the exploitation of water power. Until 1845, the Freusburger mill was a so-called "Bannmühle", i.e. the milling of grain in the Freusburger mill was compulsory for all local farmers. According to surviving documents, three separate milling operations were carried out in the old mill, which was rather unusual for the time. In 1888 its daily capacity was increased to 10 tons by the installation of a roller mill. After the Second World War, it was again modernised to produce 60 tons per day. The milling of grain ceased in 1978.

Special Requirements

In the central uplands of Germany, hydroelectric power plants generally have relatively long upper channels through which water is channelled to the turbine from a barrage weir in the river.

In plants with long upper channels, the full exploitation of the maximum top water level was not previously possible in the interests of operational reliability. Any problems in operation (failure of mains energising current, clogging of inflow grate etc.) would have caused the upper channel to overflow. In addition, when such emergencies occur, it is also essential that the electrically powered bypass guards actually open before the upper channel overflows.

However, it often happens that the bypass guards fail in critical situations, e.g. because the motor safety switch has triggered, a fuse has blown, a V-belt has burnt through or the guard screen is frozen into place.

Besides the amount of water available and the efficiency of the turbine, the power generated by a hydroelectric plant is dependent on the fall height achievable. The relation is expressed by the following equation:

Mechanical power achieved = water volume per unit of time x fall height x turbine efficiency

Every additional centimetre of fall height means more power. This is particularly the case in low-pressure plants with little fall height such as Kaplan and propeller turbines which are generally used in central-upland locations.

In view of the above circumstances, the fall height is not fully utilised since the maximum top water level is reduced by a "fear factor" to allow for unforeseen problems and keep a certain storage capacity available in the upper channel. Thus, maximum power is sacrificed to operational safety.

Solution of Problem by a Float-Controlled Gate Guard

Through the use of a float-controlled gate guard, it is possible to fix the maximum top

water level in the upper channel, thereby achieving maximum power generation, and ensure operational safety in case of emergency.

Should the turbine, for whatever reason, close suddenly at maximum water flow and maximum level in the upper channel, the gate guard is forced open and the water can flow into the bypass. This takes place without additional electrical monitoring devices, control and power cables, or external power supply.

A float-controlled gate guard of this type has been in operation at the Freusburger Mill power plant since 1992. During this time, it has more than fulfilled the expectations of the operators.

Since the installation of the float-controlled gate guard in the upper channel, water power as a resource has been used much more effectively than in the time before. This is demonstrated by the monthly credits from the local electricity supplier. In addition, the power generated in this way helps to reduce the consumption of raw materials such as coal or uranium which would otherwise be necessary, as well as reducing environmental pollution.

Conclusion
Although the proportion of hydro-electricity is still very small in relation to Germany's total power supply, the float-controlled gate guard can play an important part in improving the efficiency of smaller power-generation plants with long upper and lower channels in countries with upland topographies. It may even allow inefficient or disused power plants to be put back into production.

An increase in annual production of between 20 % and 40 % is a very realistic possibility. The addition of a float-controlled gate guard to existing generating facilities is also an economical proposition since the investment is soon repaid. Of equal importance is the fact that tapping this additional potential is active environmental protection.

Red curve: power generation without ASK Weir
Blue curve: power generation with ASK Weir
(Results interpolated for entire period considered)