



# Preparation and Realization of HPP Žilina

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## **I. Introduction**

Considerations of prominent specialists in the world rarely agree in the opinion that a human potential and affluence of energy at a reasonable price are and will be a decisive factor for further development of mankind. Availability and a price of energy will determine its future standard of living. Thus every society pays maximum attention to a problem of supply with fuels and energies. A decision on energetic strategy of a state is a decision on an economic stability. Availability of resources, their economic advantageousness while not exceeding ecological barriers must be provided. A goal is to determine economic rules and conditions for management with energies, to affect distribution of resources in order to increase their economic and ecological efficiency within a legal framework for a market economy. A goal is required to introduce programs which affect distribution of revenues to the subjects of power economy directed by a state whereas the electric energy price is determined by a state.

The government of the Slovak Republic in its policy statement declared, among others, to deal with an increase in utilization of hydro power being renewed permanently, to speed up construction of HPP Žilina. The Constitution of the Slovak Republic in its section 4 states the following: mineral wealth, underground water, natural medicinal sources and water flows are in the ownership of the Slovak Republic. Respecting the Act No.119/96 of the National Council of the Slovak Republic on licensing attendance and prepared acts on power management (on licenses), the water management structures with power utilization beneficial to the public are in the ownership of a state or a town during the whole time of their construction and operation. A national wealth becomes a wealth only if it is used. To support utilization, when approving the power concept, a goal was set, especially for agricultural and economy departments, in the point B/5 of a Resolution of the government of the Slovak Republic No.562/93 to solve completely preparation, construction and operation of water management projects with a power utilization from the point of legislation so that an increase in utilization of hydraulic power became entrepreneurially interesting even at the mentioned conditions. No substantial progress has been reached in solving this very demanding task (participated by the company limited by shares).

It is a fact that a power potential of water management projects does not meet the requirements of power engineering in ensuring electricity consumption even if it is fully used. With about 20% share in production, it covers the needs for regulating capacity and regulating operation for the electric system of the Slovak Republic to a substantial extent, especially after connection to an electric system of the Western Europe UCPTE. A technical design of a water power project Žilina with a dispatching control from a dispatching centre of SE a.s - Vodné elektrárne o.z. in Trenčín, it enables its participation in regulating needs of the electric system. Thus it is required to consider the objectivity of a myth that only nuclear power plants are a solution to all needs of an electric system, that resources are required to finance the heating sector and that it is necessary to wait some time with a development of utilization of a hydropower potential.

The offers from abroad in a phase of preparation of a hydro power project Žilina presented its delivery date within four years without participation of domestic organizations in its realization. At that time, due to an effect of fully new conditions for construction of large hydro power projects - first of all a settlement referring to the rights of property with the owners and providing a large amount of funds - a company limited by shares with a specialized name Vodné dielo Žilina (Hydro Power Project Žilina) (VDŽ a.s.) was established, the founders of which claimed that they can accept and meet the offer of a short delivery date from abroad and substantially more profitable from the point of view of finance. A construction of the hydro power project at the end of the first quarter of 1997 is shifted into a position in which the conditions for meeting the aforementioned delivery date are getting into a real shape step by step.

## **II. Goals of a Territorial Decision**

A decision on location of a construction of the Hydro Power Project Žilina was issued by the Regional Office for Environmental Protection in Žilina on February 8, 1994. The issuance of it was preceded by assessment of impact of the hydro power project on environment by EIA methodology (Environmental Impact Assessment) despite the fact that the Act No.127/94 of the National Council of the Slovak Republic on impact assessment became valid only after issuing the territorial decision. After a survey of the site affected by the construction, discussions with residents of the villages affected by the construction and respective authorities of government, a null variant (not to construct the project) was assessed with two final variants of a design of the hydro power project. A complex assessment including offenses on an environment from the past is an assumption for total improvement of a present state. The results of this highly evaluated assessment entitled the Ministry of Environment Protection of the Slovak Republic to issue a positive stand point to the construction of the hydro power project. The requirements resulting from the stand point on impact assessment of the hydro power project on environment represent first of all to build a substitute biocorridor, stabilize land slides of Dubeň, provide liquidation of uncontrolled wastes in an inundation and in the areas affected by the construction, in cooperation with the regional authorities to participate actively in building public utilities in the affected villages (waterpiping, sewerage, introduction of gas) and to provide a complex monitoring of the area of interest of the hydro power project Žilina.

Large constructions cause troubles to inhabitants in the area affected by the construction especially during extensive building activities. Also for this reason, it is usual that within a construction of a hydro power project designed for power utilization, the requirements of the affected area which are not directly related to power production are also dealt with as related investments (which could also be dealt with separately). Such as protection of the area against floods, adjustment of outflow rates, creating conditions for shipping, urban design of the affected area, waterpipings, sewerage, introduction of gas, recreation, etc.

The tasks specified in a decision on location of the construction are regularly checked by regional and local authorities. Reports on a course of meeting the conditions have been positive so far and problems are solved among respective participants to satisfaction of those involved.

### III. Building Part

Basic data:

Water reservoir

- reservoir length 7.2 km
- reservoir width 250 - 600 m
- total volume of the reservoir 17.9 mil. cu.m.
- live storage of the reservoir 8.0 mil. cu.m.
- water level fluctuations in operation 1,7 m
- max. water level elevation 352.0 m a. s. l.
- reservoir dam - max. height 15,0 m, dam crest width 6.0 m, it is sealed with a film joined to an underground wall
- water flows in the river Váh in Mojš:  
Q1r average = 95.6 cu.m.s<sup>-1</sup>, Q100 = 2140 cu.m.s<sup>-1</sup>  
Q100pm = 1490 cu.m.s<sup>-1</sup>  
Q1000pm = 1690 cu.m.s<sup>-1</sup>  
pm = after modification of influence of Lipt.Mara and Orava hydro power projects.

The Váh river deepening

- the Váh river channel bottom deepening within a range from 0.0 to 9.0 m
- the river channel bottom width 45.0 m
- the changed river channel meets the requirements for shipping.

At present, after issuance of a territorial decision, Vodné dielo Žilina company limited by shares with its founders Vodohospodárska výstavba š.p., Slovenské elektrárne a.s. - VET o.z., Povodie Váhu Piešťany, š.p. and Váhostav Žilina a.s. gained the first partial building permit for a hydrnode of the hydro power project on September 27, 1994. Consequently, after handing over the site, the major supplier of the construction Váhostav Žilina a.s. started with a building job. Since that date, the time for construction of the hydro power project stated in a construction schedule for 4 years has started, i.e. the project will be finished in October 1998.

At the beginning, the investor's and its maker's (its fiduciary Vodohospodárska výstavba š.p.) activities were aimed at issuance of building permits step by step. It was especially the work with settlement referring to the rights of property which belongs to the most demanding work in preparation of the construction so far. Unsettled proprietary conditions in the area of concern neglected in the past, uncertain competencies, still require an excessive effort to provide land for the construction. First of all due to this reason, a phase construction and issuing building permits step by step so that there was a harmony with possibilities to purchase lands and also a schedule of a course of construction and consequent commissioning of capacities were agreed upon. A construction of a hydroelectric power plant and a weir started in the first phase and then deepening of the Váh river downflow the hydrnode and the right hand bank of the Váh river.

Construction of family houses for relocation of inhabitants living in a flood plain is a separate chapter. A construction of 140 family houses including 112 in a fully new village

Nová Mojšova Lúčka, 25 family houses in Rosinky and 3 family houses in Mojš are of concern. A large amount of negotiations about technical details and details referring to the property rights with respective displaced people (e.g. a house type selection out of more than 20 types) had to be held before the actual construction. The following rule of construction was accepted - for a house in a flood plain, one house in a place of relocation with certain financial limitations (e.g. co-ownership with VDŽ a.s. in a new house). This very sensitive process took longer time than we had expected initially and due to this reason relatively short period of time remained for the actual construction.

At present, nearly all of the building permits for the whole complex of the hydro power project have been issued except a part of the left hand dam (a temporary conflict in moving those relocated people), changes in the upper end of a reservoir and a demolition work - houses of relocated people.

At the beginning of the construction, the investor had troubles with financing in the whole first year of its course. At this time, the major supplier of the construction Váhostav a.s. Žilina was helping to overcome the troubles by short time loans and thus to ensure a continuous progress in compliance with the basic dates of the construction schedule. The construction financing was, after considering different variants, finally settled in a form of a state guarantee for a foreign credit for the hydro power projects Gabčíkovo, Žilina and the tank reservoir Tichý potok for Vodohospodárska výstavba š.p. Bratislava. The new relationships between VDŽ a.s. and VV š.p. (Vodohospodárska výstavba š.p.) resulting from the foregoing are covered by a separate contract.

The hydro power project status of construction 2 and 1/2 years since the beginning of the construction (at the end of the first quarter of 1997).

The major supplier of the construction Váhostav a.s. Žilina keeps the schedule of the construction, both the date and objective performance of the crucial objects. 2,380 thous. cu.m. of soil out of the total amount of 3,200 thous. cu.m. are built in the right hand dam of the reservoir; 1,700 thous. cu.m. out of 2,900 thous. cu.m. are dug out from the deepening of the Váh river; 193 thous. cu.m. out of the total amount of 220 thous. cu.m. of concrete are built into the hydronode.

Relocation

*Rosinky.* The construction of 25 family houses is finished, a process of handing them over to the relocated people from the flood plain in Hruštiny is taking place.

*Nová Mojšova Lúčka.* The construction of 112 family houses is about to be finished, technical facilities of the village (roads, electric lines, waterpipng, sewerage, telephone, cable TV) are finished.

*Mojš.* 3 family houses are being built by the supplier.

The building job is in the stage which gives an assumption for putting the first machine (TG1) into a test operation by the end of 1997 and thus also finishing the construction in October 1998.

#### **IV. Technological Part**

Basic data:

The hydroelectric power plant

- two Kaplan turbines, turbine wheel diameter 4,800 mm, turbine absorption capacity  $2 \times 160 \text{ cu.m.s}^{-1}$ , average turbine head 24.1 m
- total designed capacity 62 MW
- yearly production 173 GWh of electricity, mostly a peak one
- power output into 110 kV switchgear.

Weir

- three weir fields  $3 \times 12.0$  m wide
- damming height of a segment 11.4 m, of a flap 3.3 m, total height of the gate 14.7 m, hydraulically controlled.

The complete technological part of the hydronode (hydroelectric power plant + weir) is provided by the consortium ABB/VOEST ALPINE. Both the preparation and realization of work in the construction are carried out in compliance with the signed contract and according to a schedule of a progress of work which is evaluated regularly and respective changes are dealt with efficiently without affecting the final dates. By the end of the first quarter of 1997, the gate guides were built into the lower and partially into the upper waters and a damming crane was assembled at the outflows from the hydroelectric power plant. Parts of the segments of the gates in the first and second fields were assembled in the weir. An assembly crane required for installation of generators and turbines is operational on an assembly block. The stator of the first generator is finished, the turbine wheel of the first Kaplan turbine is fitted in a shaft. Other technological parts are delivered according to the schedule and there is an assumption to rotate the first set by the end of 1997.

Kaplan turbine.

A proof of guaranteed parameters of the turbine designed in the offer of VOEST ALPINE was carried out according to the signed contract on a model at VOEST ALPINE MCE test laboratories in Linz. A model measurement was carried out on a model of a turbine wheel of Kaplan turbine with diameter 350 mm. All of the measurements were carried out according to a valid methodology IEC 995 and proved the parameters stated in the offer with a reserve.

Some other basic data:

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|-----------------------------|--------------------------------------|
| - emphasized efficiency     | ETA-W = 94.74%                       |
| - max. turbine rate of flow | $Q_{\max} = 160 \text{ cu.m.s}^{-1}$ |
| - min. turbine rate of flow | $Q_{\min} = 50 \text{ cu.m.s}^{-1}$  |
| - average turbine head      | H = 24.1 m                           |
| - max. turbine capacity     | $P_{\max} = 38.1 \text{ MW}$         |
| - turbine runaway speed     | $n_{p\max} = 400 \text{ rpm}$        |

Generator.

SAV 600/115/40 type ABB synchronous generator of a classical design is used which meets all of the requirements specified in the project. Some of the basic technical parameters of the generator:

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|--------------------------|-------------------------|
| - nominal apparent power | P = 41.5 MVA            |
| - nominal voltage        | U = 10.5 kV $\pm$ 5%    |
| - synchronous speed      | $n_s = 150 \text{ rpm}$ |
| - runaway speed          | $n_p = 400 \text{ rpm}$ |
| - critical speed         | $n_k = 480 \text{ rpm}$ |

- power factor	cos $\varphi$ = 0.85
- external stator diameter	7,600 mm
- internal stator diameter	5,968 mm
- total stator weight	60,000 kg
- external rotor rim diameter	5,470 mm
- weight of a rotor with a shaft	140,000 kg
- moment of inertia	GD <sup>2</sup> = 3,040 t.sq.m.
- stator and rotor insulation	F class
- generator overload	within a nominal capacity range 110% - 150% 12 minutes up to 2 minutes
- efficiency at a nominal voltage, frequency with mechanical, ventilation and additional losses including the loss in an excitation system at 50% up to 100% of the nominal capacity	97.33% up to 97.88%

### **V. Preparation of Putting the Objects into Operation**

Based on articles and a statute, the Vodné dielo Žilina company limited by shares provides work for preparation, construction and operation through its founders primarily.

Operation of objects of a water management part of the hydro power project will be provided by Povodie Váhu š.p. Piešťany and that of objects of a power part by Slovenské elektrárne a.s. - o.z. Vodné elektrárne Trenčín. Technical means for dispatching control from Trenčín are covered by a delivery of the hydro power project Žilina construction. Negotiations on drafts of contracts for the a.m. work are being held at present.

### **VI. Conclusion**

The main goal of an entrepreneurial association of power engineering institutions and water management institutions in a form of establishment of the Vodné dielo Žilina company limited by shares was to overcome controversial jurisdictional issues in mutual relationships. Solving the differences in social missions of these institutions and eliminating prevailing departmental approaches, there was an effort to reach unification of forces, capacities and a capital to create a joint program of construction of hydro power projects with energy utilization within mutual interests, economic possibilities and needs of stock holders in the company limited by shares in the first step of construction of the Hydro Power Project Žilina while respecting the interests of the whole society expressed in the policy statement of the Slovak Republic, economization and profit, utilization of capacities of domestic suppliers, monitoring and utilization of beneficial relations with foreign partners to achieve better, insufficient so far, utilization of primary permanently renewable power resources for a society in creating job opportunities for our industry and civil engineering.

The results achieved in finishing the preparation and in realization of the Hydro Power Project Žilina proved advantageousness of such approach even if an increasing presence of eccentric competing interests should be mentioned. Integration of mutual interests within the established company limited by shares means to create equal conditions for all of the partners and not a power liquidation of specificities, specialties and individualities, both of value and legal ones. To integrate does not only mean to join a new covenant but also to create it together. A natural process of self-saving of subjects does not have to lead to disintegration but also to searching for new forms of cooperation.

Hydro power projects with power utilization must be built in such places in which there are suitable conditions for their operation created by the nature on a stream. Their power contribution is, as a rule, a contribution for the whole electric system. The part beneficial to the public is a contribution for the region affected by the construction. During the construction, they offer jobs not only, but especially, for the residents of the region affected by the construction but also for workers in cement works, brickworks, steel works, and other kinds of industries providing supplies for the construction, industry of services.

Changes in legislation supporting construction of hydro power projects with power utilization, purchasing system and electric energy prices remain still unsolved. Energy prices are distorted compared to relations in western market economies and do not allow either reproduction of a production base or gain and pay back the credits and compound interest. An additional idea of the state about financing the part of hydro power projects with power utilization beneficial to the public from resources gained in operation of the built objects without any form of easement of taxation and charges shifts a return of invested resources behind a border of an entrepreneurial interest.

An economic efficiency of investment in the whole power engineering and thus also in hydro power engineering shows up only in far-away periods of time. Thus the model of financing the power-plant engineering development cannot be solved successfully from the point of view of a short period of time but taking into account a long-term development and a long continuous period of preparation and construction of power-plant objects. Construction of hydro power projects with power utilization does not bring fast profits for investors. Thus the model of financing the power-plant engineering development cannot be solved successfully from the point of view of a short period of time but taking into account a long-term development and a long continuous period of preparation and construction of power-plant objects. But it is an investment which does not bring troubles with a product, electric energy.

A look at programs of development of a further use of hydropower potential of streams in the states of Europe is not affected by a lack of interest but vice versa by a considerable support of a state for entrepreneuring entities even at a relative abundance of electric energy in a domestic market.