

Hydro Power Plants

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 SLOVENSKÉ
ELEKTRÁRNE





History of Constructing SE Hydro Power Plants

Using the power of water streams – hydro-energetic potential (HEP) – by hydro power plants that are currently part of Slovenské elektrárne portfolio started as early as in 1912 – at that time Rakovec small hydro power plant (SHPP) was put in operation on the Hnilec river.

It was followed by Krompachy SHPP on Hornád river in 1931 and by Ladce hydro power plant (HPP) on Váh river in 1936.

Large construction of the HPP Váh Cascade developed as late as in the building conditions after WWII.

At that time power plants were not built individually, but as whole groups of power plants in parallel.

Date of launching in operation:

- 1912 Rakovec SHPP
- 1931 Krompachy SHPP
- 1936 Ladce HPP
- 1939 Švedlár SHPP
- 1946 Ilava HPP
- 1949 Dubnica nad Váhom HPP
- 1953 Kostolná HPP
Dobšiná PSPP
- 1953 – 1954 Orava HPP
Nové Mesto nad Váhom HPP
- 1954 – 1955 Horná Streda HPP
- 1956 Trenčín HPP
- 1956 – 1958 Nosice HPP
- 1957 Krpeľany HPP
- 1958 Sučany HPP
- 1960 – 1961 Madunice HPP
- 1961 Lipovec HPP
- 1962 – 1964 Hričov HPP
- 1963 – 1964 Považská Bystrica HPP
- 1963 – 1965 Mikšová HPP
- 1966 Domaša HPP
- 1972 Ružín PSPP
- 1974 Ružín II SHPP
- 1975 – 1976 Liptovská Mara PSPP
- 1976 Bešeňová SHPP
- 1979 Tvrdošín SHPP
- 1981 – 1982 Čierny Váh PSPP
- 1985 Kráľová nad Váhom HPP
- 1988 Veľké Kozmálovce SHPP
- 1992 Gabčíkovo HPP ³⁾
- 1994 Dobšiná II SHPP
- 1994 S VII SHPP ³⁾
Mošon SHPP ³⁾
- 1997 Čunovo SHPP ³⁾

HPPs owned by Slovenské elektrárne, installed capacities, average annual production*³

Name of HPP	Flow	Installed capacity [MW]	Average annual production (2000-2009) [GWh]	Number TG
Orava	Orava	21,75	32,536	2
Tvrdošín	"	6,10	13,149	3
Čierny Váh	Váh	734,4 + 0,768* ¹	137,089/2,635* ²	6+1
Liptovská Mara	"	198,00	35,951/72,675* ²	4
Bešeňová	"	4,64	18,231	2
Krpeľany	"	24,75	61,878	3
Sučany	"	38,40	93,372	3
Lipovec	"	38,40	84,722	3
Hričov	"	31,50	62,035	3
Mikšová	"	93,60	179,305	3
Považská Bystrica	"	55,20	106,772	3
Nosice	"	67,50	167,864	3
Ladce	"	18,90	80,810	2
Ilava	"	15,00	83,804	2
Dubnica nad Váhom	"	16,50	81,839	2
Trenčín	"	16,50	80,691	2
Kostolná	"	25,50	104,512	2
Nové Mesto n.V.	"	25,50	99,786	2
Horná Streda	"	25,50	107,284	2
Madunice	"	43,20	132,815	3
Kráľová	"	45,06	114,105	2
Veľké Kozmálovce	Hron	5,32	10,678	3
Dobšiná	Hnilec	24,00	3,946/25,369* ²	2
Dobšiná II	Dobšinský potok	2,00	4,335	1
Rakovec	Hnilec	0,40	0,000	2
Švedlár	"	0,09	0,095	2
Ružín	Hornád	60,00	8,277/49,342* ²	2
Ružín II	"	1,80	6,222	1
Krompachy	"	0,26	0,518	1
Domaša	Ondava	12,40	11,775	2
Gabčíkovo* ³	Danube	720,00	2158,557	8
S VII	"	1,04	3,552	2
Mošon	"	1,22	5,492	2
Čunovo	"	24,28	145,726	4

*¹ Čierny Váh PSHPP - installed capacity of TG1-TG6 is 122.4 *6 for turbine and pump operations and TG7 0.81 MW for turbine operation from the flow in the lower tank

*² Čierny Váh PSHPP average annual production from pumping is 133.107 GWh and annual average flow production is 1.957 GWh

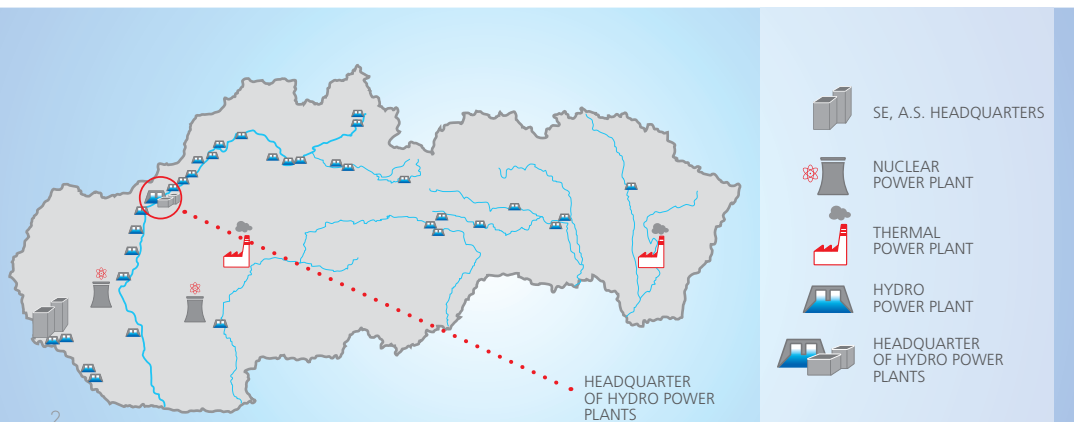
Liptovská Mara PSHPP average annual production from pumping is 35.951 GWh and annual average flow production is 72.675 GWh

Dobšiná PSHPP average annual production from pumping is 3.946 GWh and annual average flow production is 25.369 GWh

Ružín PSHPP average annual production from pumping is 8.277 GWh and annual average flow production is 49.342 GWh

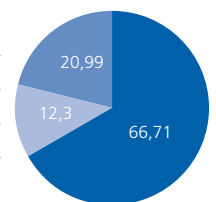
*³ Hydro power plants at the Gabčíkovo level (Gabčíkovo HPP, S VII SHPP, Čunovo HPP and Mošon SHPP) are not owned by SE, a.s.; Slovenské elektrárne only operates them in line with the Contract on VEG Operation

TG - turbine generator



Share of the respective SE resources at the electricity generation, including Gabčíkovo HPP

Resource Structure	Production [GWh]
Nuclear Power Plants	13 054,80
Thermo Power Plants	2 407,80
Hydro Power Plants	4 107,70



Operation of Hydro Power Plants



In particular, hydrologic and climate conditions influence operation of the SE, a.s. hydro power plants. Wide oscillation ranges of streams require coordinated resource application between the Production Dispatching of Slovenské elektrárne in Bratislava and Hydro-Energetic Dispatching of Slovenské elektrárne in Trenčín.

Electricity market and particularly changing conditions for providing ancillary services (AnS) impose increased claims on the producers and providers of these important services for the power grid. Safe and reliable electricity supply from respective turbine aggregates, distribution and transmission are essentially conditioned by perfect operational conditions of the equipment and thereby provide absolute availability of resources and flexibility when managing them. Operations and Maintenance departments have been established at Hydro Power Plants to safeguard

this condition. Their task is to care for the equipment both long-term and short-term (general and common overhauls, cycle work, reconstruction, minor maintenance) and to intervene when handling failures on the equipment. Diving centre at hydro power plants performs operative interventions when handling failures and defects on the TG technological equipment and its auxiliaries as well as regular inspections and controls under water. Failure-free operation and maintenance on the equipment are performed in conformity with the primary requirement regarding safety and environment. Diagnostics and prophylactics of respective parts of the electricity generation installations have a specific place and play an important role when operating hydro power plants. It acts mainly in the electro-diagnostics, mechanical diagnostics and in chemical/physical laboratories.

Legal changes and new technological criteria relating resources and distribution networks operated in the Slovak power grid (PG SR), in particular after joining UCTE, have induced modifications on SE-HPP technological facilities and control systems so that they can satisfy new quality requirements. Starting on 1 January 2009 all the power plants belonging to Slovenské elektrárne have turned into **unmanned operations** (except for Čierny Váh PSPP and Gabčíkovo HPP) requiring change in work organization at the control centre, management method and control of respective turbine aggregates, including remote control for electrical substations and water-technical installations.

Unmanned Operation

Hydro-Energetic Dispatching

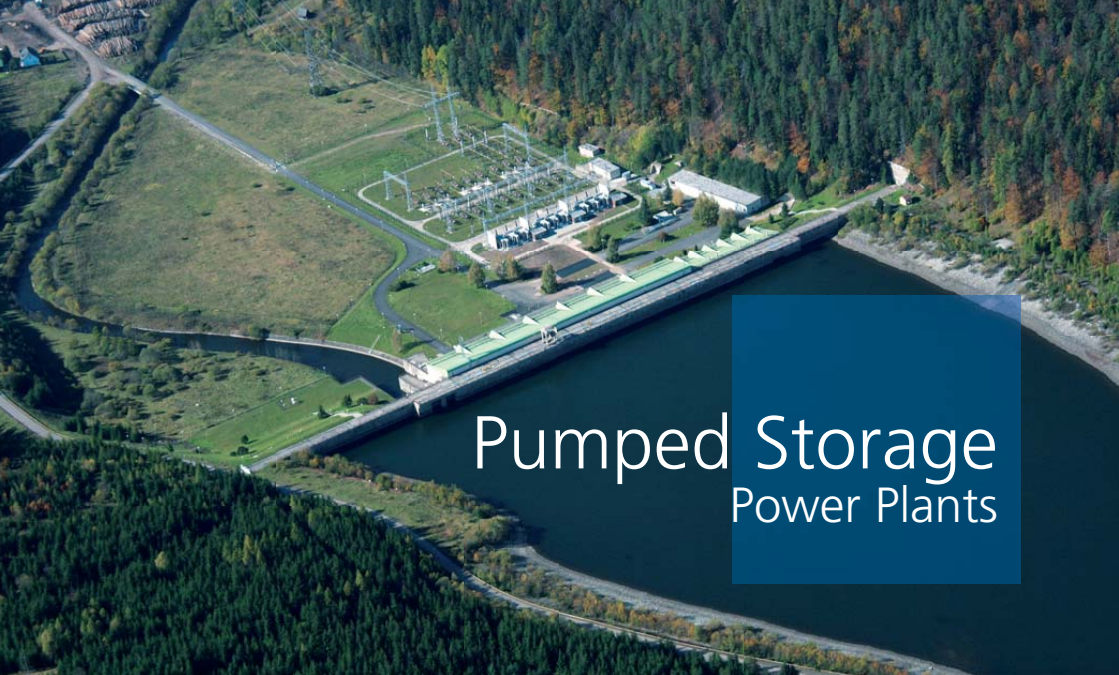
Core task of the hydro-energetic dispatching is given by its essence, i.e. providing electricity generation using hydro-energetic potential (HEP). On one hand there is the energy carrier – water and on the other hand its product – electricity. Electricity is taken, transmitted and delivered from the generator – power plant up to the customer through the power grid (PG) of Slovakia. Electricity from hydro power plants is distributed into different voltage levels. 400kV and 220kV lines are owned and operated by the Slovak Electricity Transmission System (SEPS) who got independent from Slovenské elektrárne in 2002.



Three distribution companies operate lower voltage grid up to the off-take place of the end customer. Hydro-Energetic Dispatching of the Hydro Power Plants shall program, operatively control (except for PSPP – put in operation from SE Production Dispatching) and evaluate the functioning of all the Váh Cascade hydro power plants and power plants on the rivers in East Slovakia, on the Hron river and Danube with the needs of our Company, Slovak power grid and requirements of the water management operators. The entire **Váh Cascade** is typical for its very strong hydraulic bonds between the respective water constructions with a very short water flow periods. Controlling the entire hydraulic chain with

permanent monitoring and review of operational data imply economic use of reservoirs and natural flows. Considering the incomplete Nagymaros level and based on agreements between the Slovak and Hungarian Government utilization of the **Danube flows** on the Gabčíkovo water construction and HPP operation are controlled with a level regulation system when providing the agreed flow rate balance in the original Danube channel through Čunovo. However, priority task of the whole set of Common Waterworks of Gabčíkovo – Nagymaros is to provide smooth international hydro nautics and flood protection. **Power plants in East Slovakia** built on rivers have their own specific features mainly in the area of satisfying water management requirements, their use to follow business intentions of Slovenské elektrárne in compliance with the legislation on water management demands daily re-assessment and projecting the operation method. When coordinating utilization of production resources situations occur when neither generation transfer between Váh and Danube helps nor solution with pumped-storage hydro power plants. That is the

time when capacity of thermal power plants must be regulated. HPPs can in certain operational situations replace even dropout of a thermal or nuclear unit. New **Automated System of Dispatching Control** (ASDR) at the Hydro-Energetic Dispatching in Trenčín was launched in 2007. It consists of operative control and monitoring system for hydro power plants (SCADA/AGC) closely related to the data warehouse archive (UDW). Both of them are based on applying the original Network Manager IT technology and on the hydro-modelling system for preliminary operation of hydro power plants. Communication subsystem contains system of redundant communication links supporting standard protocols.



Pumped Storage Power Plants

They play an important and crucial role in resource structure of Slovenské elektrárne. They are used to safeguard stability and quality of electricity distribution for respective customers. PSPP can “store” electricity, i.e. they can almost immediately generate electricity, if lacking. They are used when trading with ancillary services (AnS) as a black start, tertiary regulation TRV+, TRV-, etc. TG start-up into turbine operation takes app. 70 seconds and TG can get into pumping operation from 100 to 180 seconds. All the AnS provided and traded pass certification as requested by the applicable Slovak legislation.

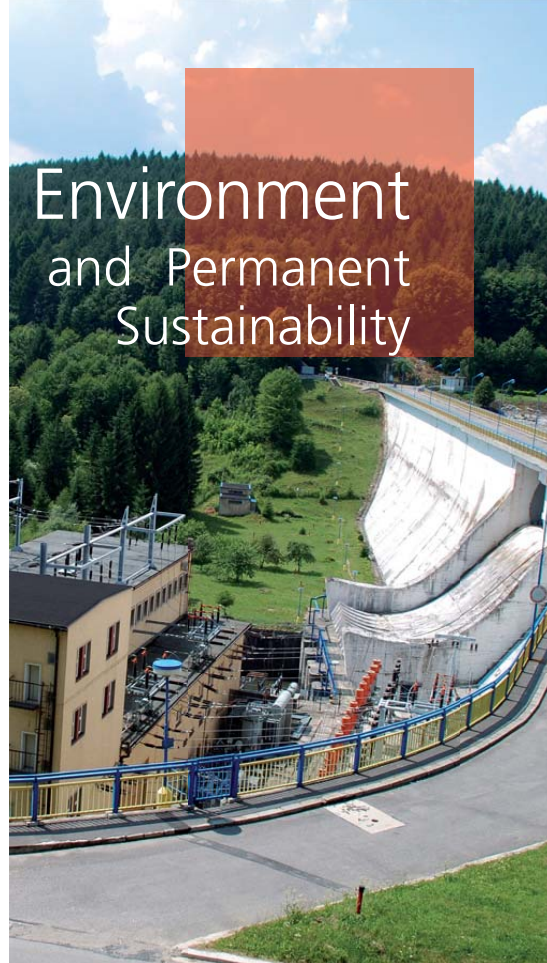
One of examples how PSPP can be used is replacing a dropout of a 400 MW nuclear unit, when the dispatcher at the SE Production Dispatching can see what capacity got “lost” and immediately reacts with a request to connect TG from Čierny Váh, Liptovská Mara or other HPPs. Project of virtual units allows providing AnS for SEPS-SED, eliminating production deviation in SE and electricity sale in parallel. Two virtual units have been implemented in hydro power plants – at Čierny Váh PSPP and Váh Cascade.

Currently (2010) SE deals with developing construction of small hydro power plants on the river Váh in Ružomberok - Kraľovany site, on the river Hron in Žiar nad Hronom and Žarnovica, Nový Tekov, Čata and Kamenín sites. The smallest Dobšiná III SHPP is the most developed one completing energy system of Dobšiná stations. SE continues with site monitoring favourable for construction of new resources as for instance Ipeľ pumped storage hydro power plant – significant equipment to accumulate energy.

Development of New Hydro Power Plants

Both environment and its protection are important in people’s lives and in running a business, too. Environment protection and prevention against environment pollution are one of the top priorities of the Company, while activities of all main production processes are adjusted to this priority and the Company’s effort is to continuously sustain the trend and to make it more efficient. Hydro power plants utilize renewable energy resource – water and/or hydro – energetic potential of our streams. There are no by-products during electricity generation that might impact the environment. Water used is not consumed, it is lead through turbine aggregates giving mechanical water energy and then it is again used on lower level. **Energetic potential of water streams is a clean, ecologic and naturally self-renewable energy resource.** No waste, emissions nor mining demand, processing nor delivery of energy raw material occurs while using it. The effort of Slovenské elektrárne is to continuously participate in increasing the hydro-energetic potential of Slovakia.

Slovenské elektrárne took a voluntary commitment to continuously improve behaviour with introducing and following management systems. In 2004 Hydro Power Plants station received certificate under ISO 14001:2004. In 2010 Slovenské elektrárne successfully passed certification of integrated management system in compliance with the international ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007 standards.



Environment and Permanent Sustainability

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