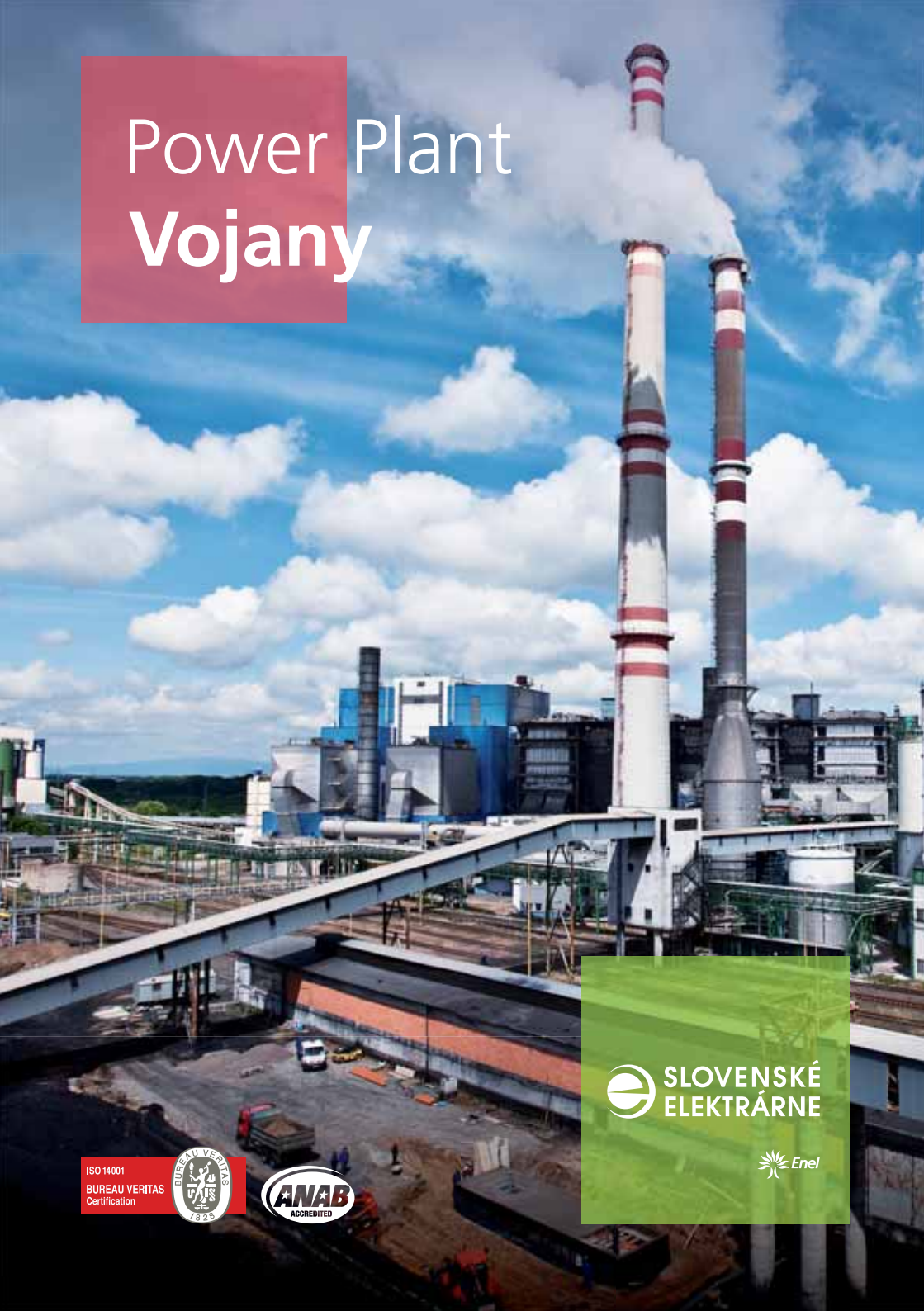
Power Plant **Vojany**



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Power Plant Vojany

Power Plant Vojany (SE – EVO) is situated in Eastern Slovakia, district Michalovce, 7 km west of Veľké Kapušany. It consists of two energy production plants: Power Plant Vojany I (6 x 110 MW) and Power Plant Vojany II (6 x 110 MW). With its total installed capacity 1320 MW, SE-EVO is the largest thermal power plant in Slovakia. The mission of the Vojany Power Plant is to provide ancillary services for the transmission grid (TG) of the Slovak Republic with the highest quality, safety, and reliability and the lowest impact on the environment. Combined combustion of biomass contributes to fulfilment of our objective to operate power plants in cleaner way and friendlier to the environment. SE – EVO is an important benefit for the Slovak electrical grid due to broad range of power regulation particularly in case of units 5 and 6 at EVO I. Its installed capacity of 1,320 MWe represents 11.8% of the production capacity of Slovenské elektrárne.
By the end of 2007 the operation of EVO I units was based on the requirement of the transmission grid operator due to the n-1 criterion. Since 2008 EVO units have been operated on commercial and environmental basis. In reality, currently the renovated units 1, 2 and the new units 5, 6 are being utilized.

History Lesson

Good geographical position close to Ukrainian border, possibility to consume water from Laborec river and unused labour potential were the most important reasons for selecting this locality in the south Zemplín area as the best place for construction of Power Plant Vojany.

The Headquarters of the power plants in construction elaborated the original investment – construction of a power plant with capacity 4 x 110 MW in November 1959 and it was approved by the former Ministry of Power Engineering and Water Management in 1960. Lack of electricity in the developing economy of Czechoslovakia at the end of 50's was a basis for the Ministry of Power Engineering and Fuels to increase the installed capacity of the power plant up to 6 x 110 MW. The general designer of the construction was Energoprojekt Praha Company. Erecting the technological part was provided by ŠKODA Plzeň (in Pilsen) - supplying branch in Prague and construction works were done by Chemkostav Humenné Company in cooperation with dozens of other companies. Construction of the Vojany Power Plant took place in 1961 - 1966. The individual units of the power plant were commissioned into operation in 1965 - 1966. At the end of '80s complex extended overhaul was performed on units 1 and 2 that included the replacement of mechanical precipitators with electrostatic ones and turbine generators modernization. In 1997 an extended programme for reconstruction and restoration started at Vojany. Through the above mentioned programme in 1997 – 2001 desulphurisation and denitrification on EVO I units No. 1 and 2 and restoration of EVO I units No. 5 and 6 – replacement of classic combustion technology with combustion in fluid circulating layer were carried out.

Power engineering balance of Czechoslovakia did not improve even in the beginning of 60's and the country step by step increased its dependency on energy import. In relation to the development of the fuel basis concept, the top priority became completing the missing power generating plants. Good conditions for construction of the Power plant Vojany II were provided by EVO I, the already completed broad-gauge railway siding, and sufficient water resources which were supported by construction of water reservoir Zemplínska šírava. The design was based on the design of EVO I using original fuel sources. Due to the fact that the soviet counterpart pointed out to the fact that EVO II cannot be supplied with black anthracite coal, the fuel basis of EVO II was changed to heavy fuel oil during the construction. Due to the change of the fuel basis building a distillation unit called Slovnaft, unit Vojany was required.

Investment into Power Plant Vojany II was approved on 31 December 1966. Its construction started in 1968 and the individual units were commissioned in 1973 - 1974. The plant reached full installed capacity of 660 MW on 3 September 1974 by putting the unit No. 6 into trial run. After the crisis of energy industry in 1978 the supply of heavy fuel oil was limited and units at EVO II were reconstructed for combustion of natural gas.
Units No. 1 - 4 were reconstructed in 1997 - 2000 in the Renovation and Reconstruction Project for SE - EVO by replacement of burners with low-emission ones (Low - NOx).

Electricity Generation Technological Procedure

Fuel

Fuel Basis

The fuel basis of EVO I consists of black anthracite coal with heating capacity of 25 GJ . t^{-1} imported from the Russian Federation using the broad-gauge railway connected to the railway siding. After the completion of the 1st phase of the biomass co-firing project, the fuel basis was extended by wood chips. The fuel basis of the EVO II plant is represented by natural gas with heating capacity of approximately 35 GJ . 1000 m^{-3} from the international high pressure gas pipeline BRATSTVO from Russia and by heavy fuel oil with heating capacity of approximately 39.6 $GJ.t^{-1}$

Supply, Discharge, and Manipulation with Fuel

The coal from Ukraine and Russia is delivered in integral sets of wagons with 65 t capacity. The volume of the fuel provided through the broad-gauge railway siding is measured on a PIVOTEX dynamic wagon weighbridge. The fuel discharge is performed through the rotary tilter (discharge speed 780 – 1,170 t/hour), the wagons are cleaned by a vibrator which is a part of the tilter. The bunker under the rotary tilter is discharged by force feed carts to the belt conveyors.

Further Modifications and Fuel Manipulations are based on:

- the possibility to grind and sort the fuel, while the grinding station can be bypassed;
- transport of fuel to the coal yard;
- transport of the fuel to the loading bin and loading into wagons of the standard gauge wagons for re-expediting of fuel to domestic customer, and for weighting on the electronic wagon weighbridge;
- transport of fuel to the coal bunkers of boilers in the Vojany Power Plant I.

The coal depot has capacity of 400 000 t which enables 60 days full power operation without fuel supplies. The fuel is manipulated on the depot using bulldozers, the fuel is transported from the depot using bucket loader through the bunkers under the depot, with force feed carts and conveyer belts. Conveyer belts output with width of 1,000 mm is 2 x 600 t . hrs^{-1}.

Biomass is transported to SE-EVO using trucks - lorries. For its storing a depot next to the coal depot was built. The biomass is then collected by spiral conveyer and transported by conveyer belts to the boilers with circulating fluid layer.

Water Management

The cooling water for the cooling circuit is delivered from the central pumping and cleaning station at Laborec river, where the tilting gate weir ensures minimum required pressure for pumps of the pumping station – 6 pumps with rated output of 3.4 $m^3 . s^{-1}$. The cooling water for the power units is delivered through 3 pipelines (1 pipe for 2 units) in which KLÖCKNER pressure filters (Germany) are implemented. For cooling of the turbine condensers warmed water from the waste channel is used. This water is recirculated by three pumps with output of 3.4 $m^3 . s^{-1}$ for suction of cooling water pumps, through three forced draft fan cooling towers. Apart from the cooling water for the large cooling circuit which is the largest consumer, part of the raw water from the central pumping station is processed in the demineralization station. Demineralised water is added to the technological circuit water – steam on the power units for making up for the circulation losses. The demineralisation station for EVO I and EVO II is in one building. Its average output is 190 $t . hrs^{-1}$. It was reconstructed in 2010 and new technology was implemented. The cooling water for the large cooling circuit of EVO II is provided through the EVO II pumping and filtration plant by six pumps with specific output of 3.4 $m^3 . s^{-1}$ through three discharge lines. The cooling system is a closed loop one. Warmed-up water from the condensers is delivered into three ITTERSON cooling towers which are 100 m tall. Cooling water loss from the circuit of the large cooling is made-up for from the pumping station located at the annex of the pumping station using two pumps with specific output of 0.76 $m^3 . s^{-1}$ through pipeline with diameter 600 mm. The filtration plant is located in the same building as the EVO II pumping and filtration plant. It ensures supplies of filtered water for machinery of both plants and fire preventing water.

Boiler room

The boiler is a single drum boiler with natural steam circulation, pulverized heating, wet bottom furnace, and it has a design with two drafts and melting and cooling area. From the front and back wall of the combustion chamber 10 swirl pulverized-coal burners are connected, on boilers No. 1 and 2 the design of burners is low–NOx. For start-up of the boiler and stabilizing the burning process gas or heavy oil burners are implemented in the axis of the pulverized-coal burners. Flying ashes precipitation in K1 and K2 is performed by 2-stage-electrostatic precipitators with efficiency of 98.5%. The slag is disposed hydraulically using dredging pumps to the sludge bed, using the system of returnable water. The flying ashes are disposed either together with slag (molten) or delivered through dry transport to the stabilized substance plant or to a potential customer. The boilers are equipped with two grinding circuits with drum ball mills, two pulverized coal bunkers, two forced draft, flue gas, and primary fans. Boilers No. 5 and 6 were replaced with fluidized bed boilers. The reconstruction represents complete replacement of both power units – boilers, turbines, generators, output transformer, and step-down transformer, electric components, and I&C system. Flue gas from the boilers is delivered by flue gas ducts to the 200 m tall stack made of reinforced concrete. On the boilers No. 1 and 2 desulphurization and denitrification of flue gas was implemented in the years 1997 – 1999. The boilers in EVO II are single drum boilers with natural steam circulation and oil or gas heating; the design is double draft and half-external. The boilers were originally constructed for solid fuel. During construction they were re-designed for combustion of heavy oil and in 1978 – 84 they were re-designed for combustion of natural gas. In the front wall of the boiler there are 12 oil or gas burners connected to the combustion chamber in three lines. Each boiler is equipped with two forced draft air fans and smoke fans. Flue gas is delivered by steel flue gas ducts to 170 m-tall stack. On the units No. 1 – 4 the technology of denitrification was applied on the boiler to reduce NOx emissions down to the level of permitted emission limit defined by the Act on Air. The burners were replaced with low-emission ones (Low-NOx). The gas supplies from BRATSTVO high pressure gas pipeline is done through plant's own gas regulation station 6.4/0.3 MPa. Its capacity is 120 000 $Nm^3 . hrs^{-1}$ and it enables current operation of four units.

Turbine Hall

In the turbine hall there are located six turbogenerators in transversal island layout with the output per unit 110 MW. The turbogenerators constitute part of units (one unit is steam boiler, steam turbine, generator, output transformer, and step-down transformer). The steam turbine is impulsive, condensing with eight unregulated off-takes, three-casing (HP, MP and LP casing), with regenerating condensate heating and HP and LP release valves. In 1989 at unit B1 and in 1992 at B2 during the complete extended overhaul the original turbines were replaced with new innovated 2B-ŠKODA type turbines. Rotors of the individual turbine casings are separated and interconnected by firm couplings, including rotor of the generator. The axial force of the whole rotor set is concentrated on the double end axial bearing located between the HP and MP turbine casing. The amount of steam coming into turbine is regulated by four control valves at the inlet to the high pressure casing and by two pressure arresting valves at the inlet to the MP turbine casing. The steam coming from the HP turbine casing is reheated in the boiler and let to the MP casing. The steam coming from the low-pressure turbine casing is let to the two-way condensers cooled by water. The cooling water source and operation of the cooling circuit has been described in detail in the paragraph 2. The original K 110 – 130 ŠKODA turbines are equipped with primary hydraulic system for speed regulation and condensation operation. The refurbished 2 B type turbines at unit 1 and 2 are equipped with electric and hydraulic regulation system consisting of two parts:

- electronic part -- containing circuits ensuring superior regulation functions for the primary physical quantities of the unit during start-up, loading, standard operation, and shutting down.
- hydraulic part – containing elements required for conventional revolutions regulation on the TG and its safety system.

Units No. 5 and 6 are equipped with turbines from Russian Federation from the contractor Leningradsky Mechanichesky Zavod. Generators No. 1 – 4 are cooled by hydrogen, generators No. 5 and 6 are cooled by air, the output voltage is 13.8 kV. Internal consumption power supply is provided by a connection to the grid from the generator to the block (output) transformer through step-down transformer to the hv (6.3kV) and lv (0.4kV) substation for internal consumption.

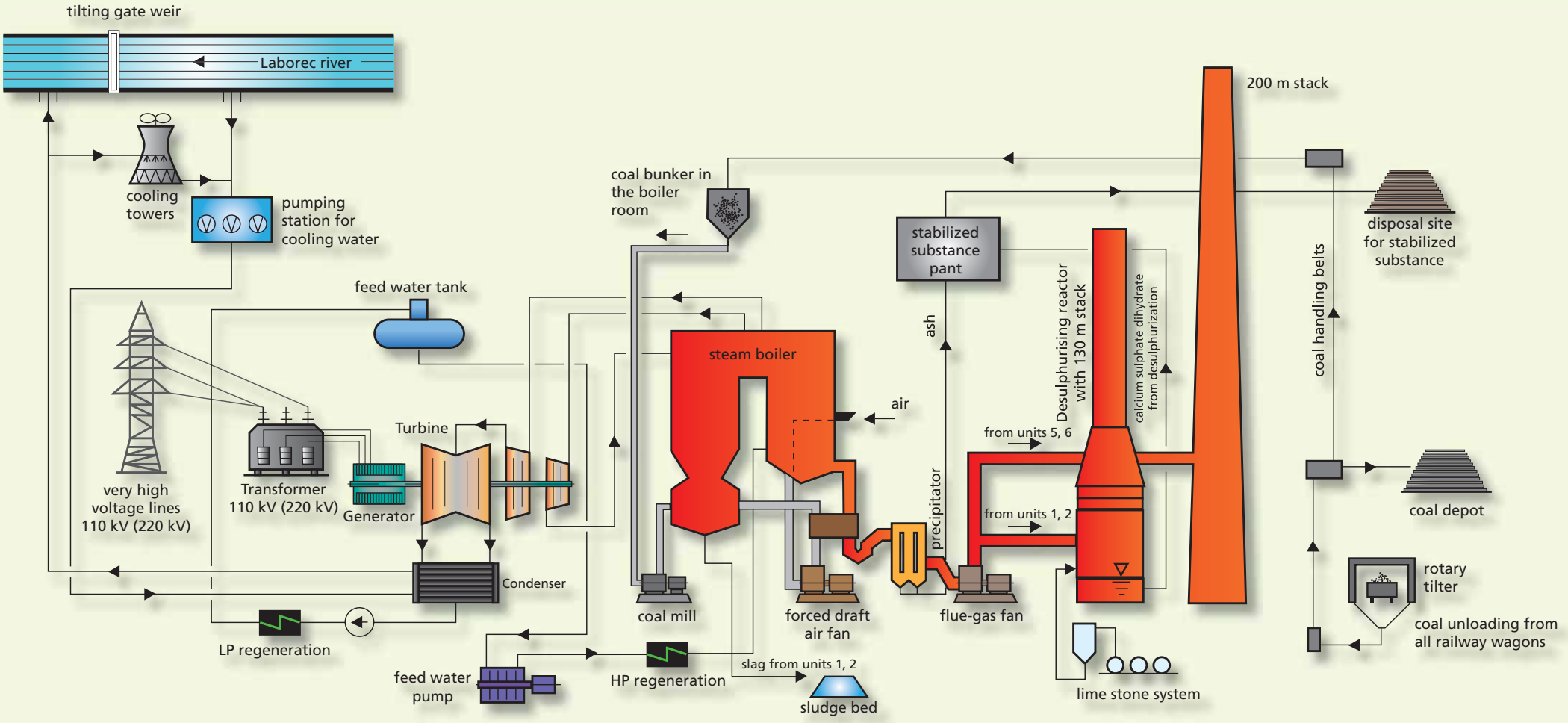
The power output from the units 1 and 2 is connected to the distribution network for 110 kV and units 3 - 6 are connected to the transmission grid 220 kV. The power output from the units in EVO II is connected to the remotetransmission system through the 400 kV electric substation in Veľké Kapušany.

Instrumentation and Control System

Management of the power units is ensured by the Damatic DNA system (units 1 and 2) and by the Teleperm XP (units 5 and 6) system from Siemens which replaced the original MODIN type systems based on the technique of integrated circuits. The system is secured by control functions, information functions including alarms, and protection functions. The information system includes displaying the technological schemes in three dimensions.

For control of the EVO II power units 1 – 4 the Damatic XDi system is used. The system is based on microprocessors basis which use for their activities main programme products from WINDOWS and UNIX environment. The unit 5 is controlled by the original hardware DIAMO system and unit 6 is controlled by the Damatic XD system.

Schema
EVO I


tilting gate weir
Laborec river
cooling towers
pumping station for cooling water
feed water tank
very high voltage lines 110 kV (220 kV)
Transformer 110 kV (220 kV)
Generator
Turbine
Condenser
LP regeneration
feed water pump
HP regeneration
coal bunker in the boiler room
steam boiler
air
coal mill
forced draft air fan
slag from units 1, 2
sludge bed
ash
precipitator
flue-gas fan
from units 5, 6
from units 1, 2
Desulphurising reactor with 130 m stack
calcium sulphate dihydrate from desulphurization
lime stone system
stabilized substance pant
200 m stack
disposal site for stabilized substance
coal handling belts
coal depot
rotary tilter
coal unloading from all railway wagons

Environment

Before the Act on Air Protection No. 309/1991 Coll. as amended came into force, the implementation of a complex programme "Vojany Power Plant Refurbishment" was started in order to comply with required emission limits. The Programme was split into several activities with high priority:

- desulphurization and denitrification of EVO I units 1 and 2;
- refurbishment of EVO I units 5 and 6 - construction of boilers with circulating fluid layer;
- storage for stabilized substance;
- denitrification of EVO II boilers;
- In July 2009 the first stage of the project "Co-combustion of Biomass in the Boilers with Circulating Fluid Layer" was completed by implementing co-combustion into standard operation.

Desulphurization and Denitrification on EVO I Units 1 and 2

Vojany I Power Plant was commissioned in 1966 and its designed service life was 20 years (120,000 service hours). In spite of regular maintenance and partial reconstruction, it was inevitable at the end of 80's to refurbish the production facilities. At the units 1 and 2 of EVO I complete extended overhauls (CEO) were performed in 1987 – 1989 (K1) and in 1989 – 1992 (K2). Apart from increased operational safety, efficiency of the energy transformation, and extension of equipment's service life, the mechanical precipitators with low efficiency were replaced with electrostatic ones and thus tenfold reduction of solid emissions' outlet into environment was achieved.

After the Act No. 309/1991 Coll. on Protecting Air from Polluting Substances as amended became effective, it turned out that emission limits of boilers after CEO did not meet legal requirements. Based on the performed professional assessment and analysis it was decided that desulphurisation and denitrification equipment would be installed on units 1 and 2.
The desulphurization process is used for absorbing sulphur dioxide (SO_2) by lime stone suspension. Hot smoke gas enters into the rinsing tower after solid polluting substance is removed. The SO_2 together with diluted suspension reacts here with calcium carbonate. The resulting gypsum suspension is transported to the building for stabilized substance production and it is mixed with ashes from boilers K1 - K6. The mix is then transferred to stabilized substance storage area.
Denitrification of flue gases consists of primary measures – replacement of burners with low-emission (low-NOx) ones and of secondary measures – injection of ammonia water directly into the boiler. By chemical reaction of ammonia with NOx at temperatures 850 °C – 1,150 °C nitrogen and water is generated. Several injection spots are required for removing NOx in the operational range of the boiler. The amount of released SO_2 emissions was reduced to 1/12th of the original amount and the amount of solid particles and NOx emissions to one third. The erection was performed by Austrian Energy & Environment Graz (Austria) in 1996 – 1999.

Reconstruction of EVO I Units 5 and 6

To improve technical, economical, and ecological serviceability of the Vojany I Power Plant it was inevitable to reconstruct the power units.
The reconstruction was based on replacement of the existing steam boiler, precipitators, generator, instrumentation and control system, and electric equipment. At EVO I units 5 and 6 the technology for combustion in circulating fluidized layer was implemented, which enables to minimise requirements related to service and maintenance, it provides better utilization of fuel in the process of power generation and it lowers significantly adverse effects on the environment. The top criterion for selecting a boiler type became a guarantee for respecting emission limits defined by Slovak law. In relation to the technology change coal with broader scale of quality characteristics than before can be burned.
The process of electricity production consists of classic cycle including steam fluidized bed boiler as the source of high pressure steam, condensing turbine, and generator. Fuel combustion takes place in the boiler at approximately 900 °C. Low combustion temperature significantly decreases the generation of NOx emissions and creates suitable conditions for desulphurisation process. Lime stone is pneumatically added to the combustion changer. It binds sulphur from the fuel and thus reduces SO_2 emissions below the state defined limits.
The reconstructed units became an important regulation source, particularly in the area of secondary regulation, where the position of conventional power plants is irreplaceable. Reconstruction of EVO I units 5 and 6 was carried out during 1997 – 2001. The main contractor for the construction was the company Slovenské energetické strojárne, a.s. Tlmače.

Storage for Stabilized Substance

Storing the combustion products from conventional power plants affects landscaping of the country around the plants. There fore Vojany Power Plant approaches this issue consistently and sensitively. Implementation of the project of reconstruction of EVO units resulted not only in decreasing negative effects on environment but also in change of waste ash material characteristics. Production of the new kind of waste required change in the ash off-take technology, in transportation, and storing.
Storage area for stabilized substance at EVO I is designed for maximum power of all units after reconstruction. It serves for storing waste after desulphurization from units 1, 2 and from reconstructed units 5 and 6 in form of a concentrated mixture (stabilized substance). Regarding the further use of the stabilized substance the possiblity of its further processing in form of additives into concrete mixtures has been considered.
The storing area capacity is 9,914,510 m^3, the storing area is 42.8 ha, expected service life is 22 years. The construction was performed in 1997 – 1999.
The main contractor was Hutné stavby, a.s. Košice.

Replacing EVO II Burners with Low Emission Ones

The Vojany II Power Plant significantly participated on reliable covering the needs of electricity and simultaneously for meeting regulation requirements of the transmission grid in the SR. Its power output significantly contributed to framework tasks in the western UCTE system. At the moment, EVO II units do not operate due to high costs of power generation. The denitrification project at EVO II units achieved the objective of reducing NOx values to permitted emission limits (300 mg . Nm^{-3}) in compliance with valid legislation for environment protection, by replacing the existing burners for low-emission ones (low-NOx). The construction included also a system for control and continuous measurement of the amount of discharged emissions.
Replacement of burners at unit 1 – 4 was performed in 1997 – 2000 by Austrian Contractor Austrian Energy & Environment.

Project for Co-combustion of Biomass at SE - EVO

The project for Co-combustion of Biomass at SE – EVO contributes to production of electricity from renewables in compliance with the position of the Enel Group which belongs to active players on the world market of electricity generated from renewables. Despite the fact that combustion is concerned, this method of electricity generation is considered to be renewable, considering the carbon recycling process. The carbon dioxide absorbed by the plants during their growth is returned during combustion back to the environment and there is no pure discharge of emissions. This is different to combustion of fossil fuels, which were formed in long periods of time and are burnt nowadays and thus the use of biomass is justifiably considered to be renewable and ecological regarding the time of its formation and time of its use. For Slovenské elektrárne biomass is an important challenge because SR undertook to EU to increase the share of renewables approximately by 14%. The Project is a result of feasibility analysis of burning biomass in power equipments of our company and it was prepared by a specialized department for new development, which prepared the above mentioned analysis already in 2007. The investment intention of the first phase of the project for Co-combustion of Biomass and Black Coal in Fluidized Bed Boilers of EVO I was approved by the management of the company on 28 February 2008 and carried out from April to July in 2009.

The purpose of the project was to enable co-combustion of biomass particularly in form of wood chips mixed with black coal - 4 – 5 % share of the caloric value in the fluidized bed boilers. Project included building a fixed storage with fire preventing wall for 400 t of biomass between the deep bunker and coal depot and it also included building of installed technology with capacity of 45 t/h for off-take, sorting, grinding of large pieces, weighting, and transportation of biomass to the current deep bunker. The biomass is added to the conveyer belts of the existing coal handling system. So the mixture is transported by original conveyer belts, which served for coal transport to the combustion chamber.

Effect of the Emissions on the Environment

The construction was performed based on the Decision of the Environment Inspectorate in Košice, as a specialized building office, as of March 2009 about issuing a building permit through the amendment of the integrated permit as per Act on Integrated Pollution Prevention and Control in the Environment. Management of Trade Relations and Regulated Activities Department provided for a certificate on the origin of the energy generated from renewables i.e. the Green Certificate.
For further development of the use of biomass, support and appropriate legislation are important. Important step in this area is passing the Act on Renewables Act No. 309/2009 Coll. This Act defines methods and conditions for support of electricity generation from renewables and of highly efficient combined production. The Engineering Department in Slovenské elektrárne prepare second phase of the project which should be released during 2011. Realization of the project will have positive effect on environment, combustion process, it will improve public relations, and will enable broader scale of opportunities for CO_2 trading. Co-combustion of biomass with 4 – 5 % share can prevent more than 40 kg of emissions per each produced MWh. The project will have positive effect on operational expenditure savings related to lime stone consumption and production and disposal of ashes or consumption of steam and demineralised water. In the next phase of the project, the objective will be assessment of the option to increase the share of biomass in co-combustion up to 9 %. An analysis proved that the surroundings of the power plant have good potential for quick growing energy plants which brings an opportunity to cooperate closely with the region around the power plant.

The region Eastern Lowland, where the Vojany Power Plant is located, is part of the Great Hungarian Plain and it is composed of slightly wavy flat land up to the lowest point of 93.8 m altitude. Assessment of the wind conditions at the Eastern Lowland proved that the area is homogenous and from exhalants scattering point of view it is well ventilated.

One of the main objectives of air protection at SE-EVO is continuous reduction of gaseous and solid emissions of pollutants into the atmosphere to such levels that can be technically and economically reached. One of the main methods how to perform this objective is to improve the quality of the burnt coal by good selection based on physical and chemical analyses. Better quality of the burnt fuel contributes to reduction of emissions of pollutants released into the atmosphere. Emissions of polluting substances are measured by the automatic monitoring system (SOx, NOx, CO, CO_2 and solid particles) or calculated with use of general emission factors published in Journal of the MoEn SR No. 8/2008 based on the amount of burnt fuel and its quality parameters (Corg).

Monitoring of the immission load of surroundings of the power plant is done by the automatic monitoring station in the municipality Leles which provides for continuous monitoring of pollutants concentration in the air (SO_2, NOx, solid particles) and meteorological quantities (air temperature, relative air humidity, wind speed and direction, atmospheric pressure, precipitation amount, radiation balance). Daily protocols with statistically processed data are provided to the District Office of Environment, Michalovce and to the Slovak Hydrometeorological Institute in Bratislava.

EVO I Technical Data

Construction started	1961
Commissioning into operation	1965 - 1966
Installed capacity	660 MW
Number of units	6
Fuel	black, half-anthracite coal with low
	contents of volatile substances,,mining
	localities Donbas and Kuzbas
Start-up fuel	natural gas, black oil (mazut)
Cooling	flow

Units No. 1 – 4

BOILER

Manufacturer	První brněnská strojírna, Brno (PBS)
Type	single drum with natural steam circulation, pulverized
	heating and wet bottom furnace (units 1 - 4)
Rated load	97.22 kg . s^{-1}, (350 t . $hour^{-1}$)
Feed water temperature	240 °C
Fuel consumption	43.5 t . hrs^{-1}
Pressure of superheated steam, outlet	13.6 MPa
Temperature of superheated steam, outlet	540 °C
Pressure of reheated steam, inlet	3.2 MPa
Pressure of reheated steam, outlet	3.0 MPa
Temperature of reheated steam, inlet	357 °C
Temperature of reheated steam, outlet	535 °C boiler 1,2 ;
	540 °C boiler 3, 4

EFFICIENCY	88 %

Air Heaters

Type	regeneration (Ljüngström)
Number	2
Manufacturer	PBS Brno

Burners

Number	10 (5 burners on front and back wall of the boiler)
Type	vortex burner
Manufacturer	PBS Brno

Mills

Number	2 on boilers
Type	ball, closed grinding circuit
transport medium	hot air with interim hopers (2 x 100 t)
Manufacturer	PBS Brno

Raw Fuel Storage Containers

Number	2 on boilers
Capacity	2 x 500 t

Fans

Primary fan	2 x 100 % , radial , 29 m^3 . s^{-1}
Secondary fan	2 x 50 % , axial , 67 m^3 . s^{-1}
Mill fan	2 x 100 %, 1 (grinding circuit),
	radial, 17 - 22 m^3 . s^{-1}
Flue gas fan	No. 1 and 2 110 m^3 . s^{-1}
	1 x 100 % , axial, for boilers
	No. 3 and 4 156 m^3 . s^{-1}, 155 °C
	2 x 50%, axial for boilers
Manufacturer	Fan Howden (No. 1 a 2), ZVVZ Milevsko (No. 3 a 4)

Fly ash precipitators

Number	2 on boilers (2 flue gas duct branches on the boiler)
Disposal of ash	hydraulically to the sludge bed, system of returnable water
Type	**- for boilers No. 1 and No. 2**
	electrostatic precipitators, horizontal alignment EKOF, 2
	sections, 2 ks – in the left and in the right flue gas duct
	line, efficiency 98,5 %
	- for boilers No. 3 and No. 4
	mechanical cyclone separators, in 4 boxes, where 2 boxes
	operate as one precipitator unit for 1 flue gas duct
	branch, efficiency 84%
Manufacturer	ZVVZ Milevsko

Feedwater pumps

Number	3 per unit
Type	centrifugal, 14 lev., driven by electric motor through
	hydraulic coupling, regulation of feeding through
	changing pump revolutions (speed)
Manufacturer	Sigma Lutín

TURBINE

Type	3 casing, condensing, impulsive turbine, type K 110 - 130
	8 unregulated off-takes for regeneration, at turbines for
	unit 1 and 2 modification 2B with immersed flow part
	and possibility to connect 2 unregulated off-takes for
	heat supply purposes and 1 regulated off-take
Regulation	for turbines 1 and 2 electric hydraulic control system
	at turbines 3 and 4 mechanical-hydraulic system
Revolutions	3,550 min^{-1}
Output	110 MW
Steam pressure at HP casing inlet	12.75 MPa (HP – high pressure)
Steam pressure behind HP casing	3.3 MPa
Steam pressure at MP casing inlet	2,909 MPa (MP – medium pressure)
Steam temperature at HP casing inlet	535 °C
Steam temperature at MP casing inlet	535 °C
Cooling water temperature	15 °C, max. 28 °C
Manufacturer	ŠKODA Plzeň

GENERATOR

Active power	110 MW
Apparent power	137,5 MVA
Voltage	13,8 kV
Cooling	rotor, stator - H_2 ,
medium pressure	1.96 – 11.7 kPa 63.9 – 83.4 kPa
Manufacturer	ŠKODA Plzeň

TRANSFORMERS

Main output power transformer	units 1 and 2 - 125 MVA (121 + 5% kV)
	units 3, 4 - 125 MVA (242 + 5% kV)
Step down transformer	16 MVA, 13.8 + 5% / 6.3 kV
Manufacturer	ŠKODA Plzeň

Coal Depot

Capacity	150,000 t

Desulphurization and Denitrification of EVO I units 1 and 2

Quality of treated flue gas calculated per 6% O_2 in dry flue gas:	
in dry flue gass:	
• NO_x	max. 1 100 mg . Nm^{-3}
• SO_x	max. 400 mg . Nm^{-3}
• CO	max. 250 mg . Nm^{-3}
• dust	max. 100 mg . Nm^{-3}
Starting construction	1996
Completion of the construction and commissioning	1999

Units No. 5 and 6

Boiler

Manufacturer	SES, a.s. Tlmače
Type	single drum, with natural steam circulation and circulating
	fluidized bed layer (ACFB)
Rated load	324.5 t . hrs^{-1}
Fuel	black boiler coal
Start-up fuel	natural gas
Fuel Consumption – 100% power	41.5 t . hrs^{-1}
Feed water temperature	177 °C
Pressure of superheated steam, outlet	14.6 MPa
Temperature of superheated steam, outlet	540 °C
Pressure of reheated steam, outlet – max.	3.1 MPa
Temperature of reheated steam	540 °C
Efficiency - 100% power	92.7 %

Air Heaters

Type	tube
Number	2
Manufacturer	SES, a.s. Tlmače

Raw Fuel Containers

Number	2 on boiler
Capacity	2 x 500 m^3
Manufacturer	SES, a.s. Tlmače

Crushers

Type	hammer
Number	2 per boiler
Manufacturer	AUBEMA (Germany)

Lime stone collector - internal	
Capacity	1 x 200 m^3
Ash bunker - internal	
Capacity	1 x 100 m^3
Fly ash precipitators	
Type	electrostatic
Number	1
Efficiency	99,7 %
Manufacturer	ABB FLÄKT INDUSTRI (Sweden)
Fans	
Primary fan	1 x 100%, radial, 1 500 T
Manufacturer	ROTENUHLE (Germany)
Secondary fan	1 x 100%, radial, 1 500 T
Manufacturer	ROTENUHLE (Germany)
Blowers	
• of the seal pot	2 per boiler
• of the fluid layer cooler Nr. 1	2 per boiler
• of the fluid layer cooler Nr. 2	2 per boiler
• of the ash cooler	1 per boiler
Manufacturer	RKR Verdicht GmbH (Germany)
Disposal of ash and desulphurisation waste products	
Processing into stabilizing substance and storing at the disposal site	
TURBINE	
Type	three-casing, condensing, impulsive
	type K110-130, 8 regeneration off-takes,
	1 additional off-take
Regulation	
Revolutions	3,000 min^{-1}
Output	110 MW
Steam pressure at HP casing inlet	14.0 MPa
Steam temperature at HP casing inlet	535 °C
Steam pressure behind HP casing	2.94 MPa
Steam temperature behind HP casing	321 °C
Steam temperature at MP casing inlet	535 °C
Cooling water temperature	15 - 32 °C
Manufacturer	LMZ, Leningrad (Russia – St. Petersburg)
GENERATOR	
Active power	110 MW
Apparent power	137 MVA
Voltage	13.8 kV
Cooling	air cooling
Manufacturer	ELEKTROSILA, St. Petersburg (Russia)
TRANSFORMERS	
Main output power transformer	125 MVA, 242 + 8 x 2% / 13.8 kV
Step down transformer	25 MVA, 13.8 + 9 x 1.78 % / 6.3 kV
INSTRUMENTATION AND CONTROL SYSTEM	
Type	TELEPERM - XP
Manufacturer	SIEMENS (Germany)

EVO II Technical Data

Construction started	1968
Commissioning into operation	1973 - 1974
Installed capacity	660 MW
Number of units	6
Fuel	natural gas, heavy fuel oil
Cooling	circulation - 3 ITTERSON cooling towers, 200 MW
	11,500 m^3. $hrs.^{-1}$ per turbine
BOILER	
Manufacturer	První brněnská strojírna, Brno
Type	single drum with natural steam circulation,
	gas or oil heating
Rated load	98.61 kg . s^{-1} (355 t/hrs)
Fuel consumption (hrs)	30,000 N . m^3 natural gas, 28 000 kg heavy fuel oil
Pressure of superheated steam, outlet	13.5 MPa
Temperature of superheated steam, outlet	535 °C
Pressure of reheated steam, inlet	3.5 MPa
Temperature of reheated steam, inlet	353 °C
Pressure of reheated steam, outlet	3.2 MPa
Temperature of reheated steam, outlet	535 °C
Efficiency	91.5% (while air temperature in front
	of the Ljungstrom air heaters is 80°C)
BURNERS	
Number	12 (behind 4 burners in 3 lines above
	each other at the front side of the boiler)
Type	combined for burning natural gas or heavy fuel oil
Manufacturer	PBS
Gas pressure reducing station	
Capacity	120 000 m^3 . hod^{-1}
Fans	
Secondary fan	2 x 50 % , radial , 75 m^3 . s^{-1}
Smoke fans	2 x 50%, axial, 108 m^3 . s^{-1}
Manufacturer	ZVVZ Milevsko
Air Heaters	
Type	stam + regeneration (Ljüngström)
Manufacturer	PBS Brno
Feedwater pumps	
Number	3 per unit
Type	centrifugal, 15 lev., electromotor driven through hydraulic
	coupling, regulation of feeding through changing
	revolutions
Manufacturer	Sigma Lutín
TURBINE	
Same design as at the Vojany I Power Plant	
Basic turbine parameters	
Rated power	110 MW
Revolutions	3,000 min^{-1}
Steam pressure at HP casing inlet	13.0 MPa
Steam temperature at HP casing inlet	530 °C
Manufacturer	ŠKODA Plzeň
GENERATOR	
Active power	110 MW
Apparent power	137 MVA
Voltage	13.8 kV
Cooling	rotor and stator - H_2
Manufacturer	ŠKODA Plzeň
TRANSFORMERS	
Output main power transformer	125 MVA, 420 kV / 13.8 kV
Manufacturer	Zaporozh Transformator (Ukraine)
Step down transformer	16 MVA, 13.8 + 5% / 13.8 kV
Manufacturer	ŠKODA Plzeň

Contact:

SE, a.s., Power Plant Vojany
address: 076 73 Vojany
telephone: 056 631 1111
fax: 056 631 2940
e-mail: infoevo@enel.com
www.seas.sk