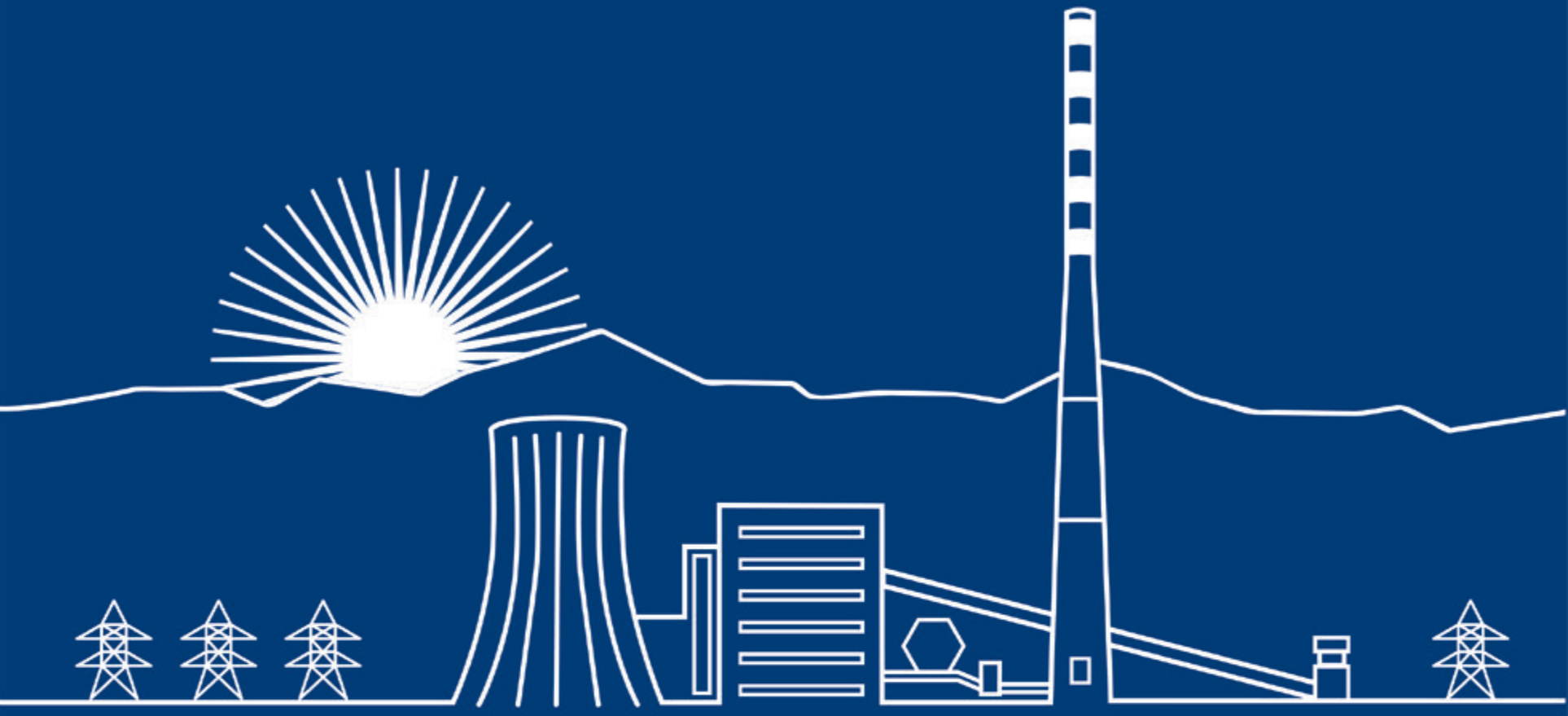

TPP „PLJEVLJA“

Montenegrin Electric Enterprise

epcg
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TPP "PLJEVLJA"

CONTENTS:

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ABOUT US

Elektroprivreda Crne Gore A.D. Nikšić (EPCG) is the national electric power company performing its commercial activity in the area of electricity generation and supply. Portfolio of our activities also includes sale of electricity, as well as construction and maintenance of electric power facilities, designing and supervision.

***Our ge**nerating capacity is the total installed capacity of 874 MW out of which 649 MW (74,3%) relates to hydropower plants Perućica and Piva while the remaining 225 MW (25,7%) relates to the thermal power plant Pljevlja.*

EPCG is seated at the address no 2 Vuka Karadžića St. in Nikšić

TPP PLJEVLJA

TPP Pljevlja is the first condensing thermal power plant in Montenegro. Water reservoir as well as all the auxiliary, technical and control-administrative facilities (apart from decarbonisation and recirculating cooling system) were constructed for two units of 210 MW capacity each. However, only one operating unit was constructed and its synchronisation to the grid was done on 21st of October 1982.

Thermal power plant mainly combusts Pljevlja coal, the guaranteed calorific value of which amounts to 9211 kJ/kg (2200 Kcal/kg) and lower quantity of coal from Berane mine.

TPP Pljevlja immensely contributes to stable operation of EES of Montenegro, given that it stands for the basic plant, which has the greatest importance in covering the constant load diagram.

TPP Pljevlja has been organized as follows:

- Sector for operative control and planning,
- Sector for operations and,
- Sector for maintenance and works.

Sector for maintenance and works consists of:

- Department for electrical works,
- Department for mechanical works and,
- Department for operative support.

CONSTRUCTION

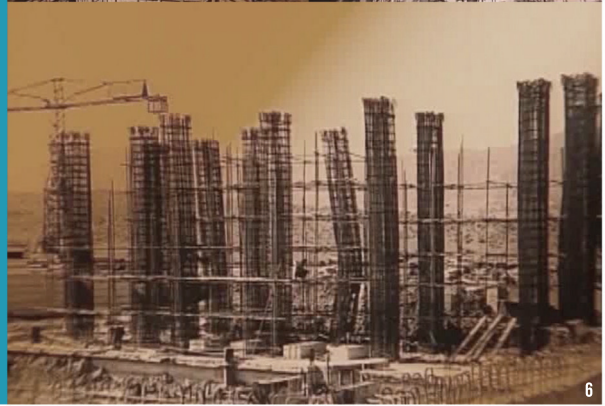
Corner stone for construction of TPP Pljevlja has been placed on 20th of November 1974.

In midst of September 1978, the employed of the Company Vatrostalna from Zenica started concreting 250 m high chimney, the highest in Montenegro, and apart from TPP Trbovlje chimney the highest in former Yugoslavia. 26 poles were embedded in chimney's corner stone and all of them were 25 meters dug in the ground. Chimney diameter is 22 meters long in its base and 8 meters in the crest. At the same time intensive works had been carried out at both Otilovici dam on Cehotina River and a penstock, by means of which the reservoir water was to be supplied in order to cover facilities' operating and cooling needs.

Works on the main operating facility and major part of civil works on the structure and power house were completed by midst of March 1979.

In that period, 30 Companies from all former Yugoslavia's regions were carrying out works on construction of TPP Pljevlja. The Company Industrijaimport from Titograd carried out all the import activities for the needs of TPP Pljevlja, while freight forwarding was carried out by Zetatrans.

In March 1979, the Employer signed with the Company "Montenegro" from Nikšić a Contract on construction of a dam around the ash and slag landfill. Contract value was 135 million of dinars worth, construction deadline was 12 months and 450 000 m3 of material was to be embedded. Exploitation of the open cut mining Borovica was envisaged for regular plant operation, and works on stripping of mine were in the final phase at the end of July 1979. It was assumed that open cut mining may provide 1.2 million tons of coal per year.



Construction of 59 meters high Otilovici dam was almost finished in October 1979, and a road was built along the pipeline from dam to thermal power plant. Works on 250m high TPP chimney were completed on June 8th, 1979. Approximately 80 employees were engaged and they embedded 3.100 m3 of concrete and 800 tons of reinforcement bars.

The next task was internal lining of chimney by fire-resistant brick, which should have lasted for 5 months. After the main chimney construction was done, the employees started to construct the cooling tower, which is 7 meters wide in its foundation and 55 meters long at crest point. Cooling tower is 93 meters high and 5 000 m3 of concrete and 1.200 tons of reinforcement bars were needed for its construction.

After four delays, TPP Pljevlja boiler heating started on 4th of September 1982. Boiler heating was supposed to last till the beginning of October when TPP Pljevlja was expected to generate the first kWh of electricity. Thermal power plant started trial operation on October 21st, 1982, when the first kWh of electricity were delivered to EES of Montenegro. At that time, one Unit with 210 MW installed power was commenced and its planned annual generation was 1146 GWh of electricity.

IN THE LATE 1970s, TPP PLJEVLJA WAS THE BIGGEST AND MOST IMPORTANT INVESTMENT IN MONTENEGRO. WORKS WERE VALUED AT 4 MILLIARD OF DINAR.

TECHNICAL FEATURES

Energy transforming process in TPP consists of gradual conversion of chemical fuel energy into heat and electricity, transmitted thereafter into the grid and used in industry, households, traffic etc.

Operating facilities, receivers and heat transmitters in the process of energy transformation are water and steam. The sequence of the process is as follows:

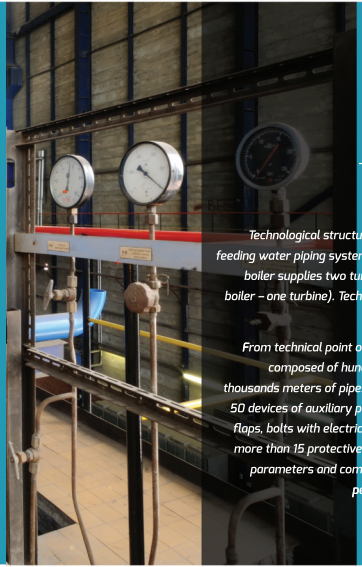
1. Firstly, in presence of oxygen and air the fuel combusts in the boiler furnace whereby the chemical energy of fuel is transformed into the thermal energy of flue gases;

2. Heated flue gases convert water into steam, which is further heated so as to reach as high working capacity (potential energy) as possible;

3. The overheated steam is introduced into the turbine. At that place the potential energy of steam converts into kinetic energy, and the latter by moving the rotor blades converts into mechanical;

4. Finally, in the electricity generator, which is directly started by turbine shaft, mechanical rotation energy is converted into electricity at generators connections.

Main equipment of thermal power plant consists of:
- Boiler
- Turbine
- Generator
All the above mentioned processes of transforming the chemical energy into electricity take place in the Main Equipment of TPP.



Auxiliary equipment consists of:

- Condenser
- Water heaters
- Cooling and cooling-reduction stations;
- Pumps (feeding, condensing, circulating);
- Ejectors;
- Pipelines.

Technological structure of TPP is determined by live steam and feeding water piping systems. It can be centralized (for example: one boiler supplies two turbines) or designed for a unit system (one boiler – one turbine). Technological scheme of TPP Pljevlja has been designed as a unit system.

From technical point of view steam unit is very complex system composed of hundreds of mechanisms, devices and tens of thousands meters of pipes. This 225 MW steam unit has more than 50 devices of auxiliary power supplies, approximately 250 valves, flaps, bolts with electric drives, over 70 automatic regulators and more than 15 protective devices. There are almost 300 controlled parameters and commencement of unit implies consistent and perfectly held hundreds of logic operations.

BOILER

- Boiler unit E 670-140-1, as a single-cylinder vertical pipe system with natural circulation and secondary steam superheating, was envisaged for operation in the unit that has 225 MW turbine combusting powdered brown coal and with hard slag discharge.

Boiler has been designed to operate with the following parameters:

- Rated capacity – 700 t/h
- Operating pressure in boiler cylinder 160 bar
- Pressure in the primary super-heater's outlet collector 140 bar
- Primary steam temperature 543 °C
- Secondary steam pressure at boiler inlet 27bar
- Secondary steam pressure at boiler outlet 25.84 bar
- Secondary steam temperature at boiler inlet 325°C
- Secondary steam temperature at boiler outlet 543°C
- Feeding water temperature 247°C
- Furnace chamber volume - 6490 m^3
- Boiler water volume - 202 m^3
- Boiler steam volume:
- Primary part 111 m^3
- Secondary part 157 m^3

Turbine

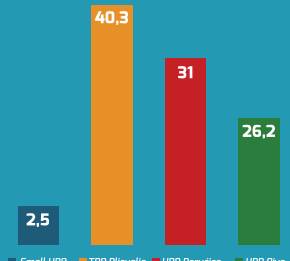
Turbine type K-200-130 is a single axis triple-cylindrical unit, with rated capacity of 130 bar, 225 MW capacity, steam flow rate of 680 t/h and 540°C temperature. Number of turbine revolution is 3000 o/min.

Generator

Hydrogen cooled Type TVV-200-2A Y3	
Apparent capacity	250 MVA
Active power	225 MW
Voltage	15.75 kV
Stator current	9164 A
Power factor	0.90
Efficiency coefficient	98.6%
Stator winding phase connection	double star
No. of revolutions	3000 o/min
Frequency	50 Hz

GENERATION

Since its commencement date i.e. October 21st, 1982 up until December 31st 2016, total net generation of TPP amounts to 33,132,625 MWh of electricity.



Participation (in percents) of PPs in total EPCG electricity generation in 2016

THE YEAR OF 2011 STANDS AS A RECORD YEAR WHEN 1,452,277 MWH OF ELECTRICITY WAS GENERATED, WHILE THE MAXIMUM MONTHLY GENERATION WAS REACHED IN DECEMBER 2016 WHEN 152,420 MWH OF ELECTRICITY WAS GENERATED.

RECONSTRUCTION AND MODERNIZATION

After 26 years of TPP's operation with the old Russian equipment, the system for control and management was reconstructed in 2009. Electrostatic precipitator has been replaced, as well as 6 kV and 0.4 kV facilities, excitation system and low pressure rotor in the turbine what implies increase in unit's power from 210 MW to 218.5 MW. Through subsequent reconstructions, implemented from 2012 until 2016, Unit reached the capacity of 225 MW.

Replaced electrostatic precipitator reduced emission of dust particles emission from the average 350 mg/Nm3 to approximately 15 mg/Nm3.

The old control system equipment was built in relay technology with non-standard signals. The need for efficient automated management of the technological process in all modes of operation, as well as the need to raise the level of process analysis, arose. Therefore, the management system has been replaced with a single, microprocessor, programmable, distributed, redundant, modern DCS system capable of realizing the functions of measurement, control, regulation, signaling, technological protection, monitoring, monitoring the cost-effectiveness of the block, with other systems on the block and data preparation in DCS for display on the existing computer network of Elektroprivreda Crne Gore.

Modernization process has been implemented on grounds of both, the above mentioned and the need to increase profitability, reliability and safety of TPP Pljevlja generation. In the course of modernization, the existing I&C equipment and pertaining protection system were replaced by ascertained, microprocessor based distribution system (DCS) with screen visualization.

A part of the equipment in the bay, regulating and ON-OFF valves with drives and sub-distribution cubicle for valve and flap driving with the corresponding modern equipment was replaced during the modernization. Status of the equipment in the bay was improved by procurement of new equipment (of the same or upgraded technological level).

New governing system, as a central point in technological process, enables simple and more reliable operation over unit for people who are in charge over that part of equipment, higher level of automation and governing, much faster and precise diagnostic of failures. Therefore, engineering is faster and with many more functions at many levels, so it can be said with certainty that all the goals of introducing a new governing system have been achieved, given that such governing system allows constant improvements and upgrading without any additional costs. In addition, it has been successfully connected to other IT systems, such as the heavy oil management system, the char removal system, the vibration measurement system, the electrostatic precipitator monitoring system, and so on.

Due to high one spot information availability, the system offered to TPP's employees a more complete analysis of the technology and generation process. The system, by its redundancy, also guarantees even the higher safety and reliability level. Protections system has been configured so as to react in case of interference, in order to prevent danger and protect the plant, and is tasked by controlled shutting down of the plant. Further, replacement of significant number of actuators – propulsion force would immensely contribute the overall readiness of the entire system.

The system protection is configured to act in the event of interference, in order to prevent the danger and protection of the plant, and has the task of controlling it in a quiet state.

Therefore, the new automation system implemented all the requirements, such as high reliability, safety, availability, flexibility during upgrading at all levels, conformity during controlling and application of up-to-date technical solutions.

It is important to point out activities that contributed to better operation of the unit during recent years. According to this, chemical water treatment is performed with chemicals manufactured by renowned world manufacturers with full process automation, large part of the boiler pipeline system is replaced, primarily super heaters. Also, insulation of the boiler plant is completely replaced, deslagger system below the boiler is reconstructed and numerous technological changes were performed in addition to reconstruction of the cooling system of turbo-unit, in order to increase unit's efficiency.

CWT plant was also modernized, including complete replacement of demineralization lines. Discharge manholes were also replaced with certain level of reconstruction on the boiler, including pertaining air channels; significant interventions on the boiler achieved much better sealing of the gas-air duct. On-line oil analyser was put into function on the line of oil receipt, and all preparations for application of new standards for calculation of coal quality were made, in line with all the applicable EU standards.

ENVIRONMENT

Being a responsible business company, Elektroprivreda Crne Gore strives to stablish an optimal synergy level between its energy facilities and environment. We improved de-dusting system of TPP Pljevlja by assembly of a contemporary electrostatic precipitators in 2009, and thereby reduced particles emission from the average 350 mg/Nm3 to 15 mg/Nm3.

We apply the prescribed measures we thereby take care about environmental impact of ash and slag landfill Maljevac and we intensively prepare for the Project on ecological 37 million worth recovery of TPP Unit I. This Project implies reduction in sulphur and nitrogen oxides in flue gasses, waste water treatment will be more efficient, and we shall remove asbestos from the plant, replace auxiliary fuel – heavy oil with light oil as well as modify the existing hydraulic ash and slag transport by its transposition into the low water regime or the technology of waste stabilisation. In parallel to those measures we shall devote ourselves to improve energy efficiency performances in order to evaluate the technical and economic feasibility of material investments.

As for the strategic plans referring to the possible extension of thermal complex of TPP Pljevlja with a new Unit (TPP Pljevlja Unit II Project), the Request for exemption mechanism was approved to EPCG at the end of 2016, according to the Decision of Ministerial Council of Energy Community D/2013/05/MC-EnC on implementation of the Directive 2001/80/EU about high furnaces (LPC). According to that Decision, TPP Unit I may operate 20 000 hours in the period 2018 – 2024 (whereby emissions would be reduced by approximately 50 %). Afterwards it may operate only in case the plant meets requirements stated in IED 2010/75/EC.

Construction of TPP Pljevlja Unit II would enable district heating, which would significantly improve environmental status in Pljevlja, cause by, to a large extent, influence of individual furnaces and heating plants.

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