P04

TGT 1-3 units replacement project in thermal power plant Brestanica

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SUMMARY

The present gas turbine units PB 1–3, in operation since 1975, are nearing the end of their service life despite regular maintenance.
The gas turbine units PB 1–3 will be replaced in phase Ia and phase Ib with two new gas turbine units (PB 6 and 7) with capacities between 40 MW and 70 MW, which will continue to ensure a high level of availability and startup reliability of the power plant. At the same time, this will increase the power plant's environmental responsibility.

KEYWORDS

Power plant, replacement, energy, project, development, gas turbine

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INTRODUCTION

Nowadays gas turbines have great significance in electro-energetic systems. In year 1905 the Brown Boveri company erected first commercial gas plant for production of electric energy. In all states in development gas plants are mostly used for covering system reserves.
At the greater disorders in electro – energetic system tertiary control has relevant role at the failure of larger blocks in system when it helps secondary control and together they remove incurred unbalance of active power. Therefore, in electro – energetic system units that can cover tertiary control must be always available. Reserve of overall power must be activated in 15 minutes that can offer fast gas turbines, accumulated hydroelectric power plants and pumped storage power stations.

REASONS FOR REPLACEMENT

The very adaptable GT units PB1 – 3, which enable black starts are independent offsite power supply for nuclear power plant Krško in case of power grid failure or other incidents. Their life span is coming to the end, although they do not have a lot of operating hours, is coming to the end. Maintenance, as effective and extensive as it is, cannot make up for the large number of starts of these old machines.

Gas turbine	
Manufacturer	AEG Kanis
Turbine type	PG 5341
Number of compressor stages	17
Compression ratio	10,5 : 1
Number and type of combustion chamber	10, radially fitted
Number of turbine stages	2
Nominal rotation speed	5120 min^{-1}
Nominal load fuel consumption	Fuel gas: 8894 Sm^3/h
	Fuel oil: 4054 kg/h
Generator	
Nominal output	32 MVA
Nominal voltage	10,5 kV
Nominal speed	3000 min^{-1}
Frequency	50 Hz
Nominal cos φ	0,8
GT Unit	
Nominal output	23,1 MW
Nominal efficiency	26 %
Start-up – normal time	< 15 min

Table 1: GT units PB1 – 3 description

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Picture 1: GT units PB1 - 3

Complying with high reliability, availability and ecological standards will become ever harder in the future using GT units PB1-3.

ROLE OF TEB – ANCILLARY SERVICES

Purpose and role:

- Provision of safety, reliability and availability of the power grid

Scope:

- Frequency and power regulation: primary, secondary and tertiary regulation
- Voltage regulation
- Starting the unit without external power supply
- Compensation of the deviations of actual interchanges of control area from the planned values
- Compensation of electrical losses occurring in the transmission network

Black start and island mode operation

- TEB is important element in ensuring nuclear safety – as a reliable and independent source of backup power supply of NEK in case of power system collapse,
- Starting aggregates without an external power supply with the possibility of island mode operation.

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NEW GAS TURBINE PROJECT DEVELOPMENT

With the intention of expert studies and evaluation of all conditions and demand, which will make new GT units environmentally and economically feasible, TPP Brestanica commenced project development.

The first step was to carry out input studies to asses input data to be used in further project development. Important conclusions, justifying the replacement of PB1-3:

- GT units PB1-3 lifespan is coming to the end,
- Revitalizing GT units PB1-3 is financially and technically unfounded,
- GT units PB1-3 have a crucial role in nuclear safety, therefore new GT units must replace obsolete and worn out GT units,
- GT units supplying auxiliary power to nuclear power plant Krško, must have black start capability and comply with BAT (best available technique) criteria:
    - to start-up in less than 13 minutes
    - option to operate on gas and oil
    - black start option
    - island operation option
- With the construction of new, big production units in the Slovene power grid, demand for tertiary regulation will increase,
- New GT units have lower emissions, therefore are much more environmentally friendly; New gas turbines must fulfill environmental emissions requirements for NOx, SO2, CO, noise, including all characteristics in accordance with EU Directive 2010/75/EU on The Industrial Emissions Directive
- The location of TPP Brestanica, with the entire necessary infrastructure already at hand, is the most suitable.
- Tertiary regulation demand foresight
- After initial input studies, several more steps have been made:
- Pre-investment study (project development phases),
- Design concept (technical and technological concept details) and
- Investment program (financial aspect of the project)

In accordance with the pre-investment study, PB1-3 replacement project will be carried out in two phases:

- **PHASE Ia:** Erection of one new 40 - 70 MW class GT unit (PB6), which will fully fulfil the demands for auxiliary supply of nuclear power plant Krško and partially fulfil tertiary regulation demands,
- **PHASE Ib:** Erection of one more GT unit (PB7)

Phase 1 provides a part of needs for tertiary regulation and necessary power for backup power supply of NEK and future need for Slovenian Energy System.

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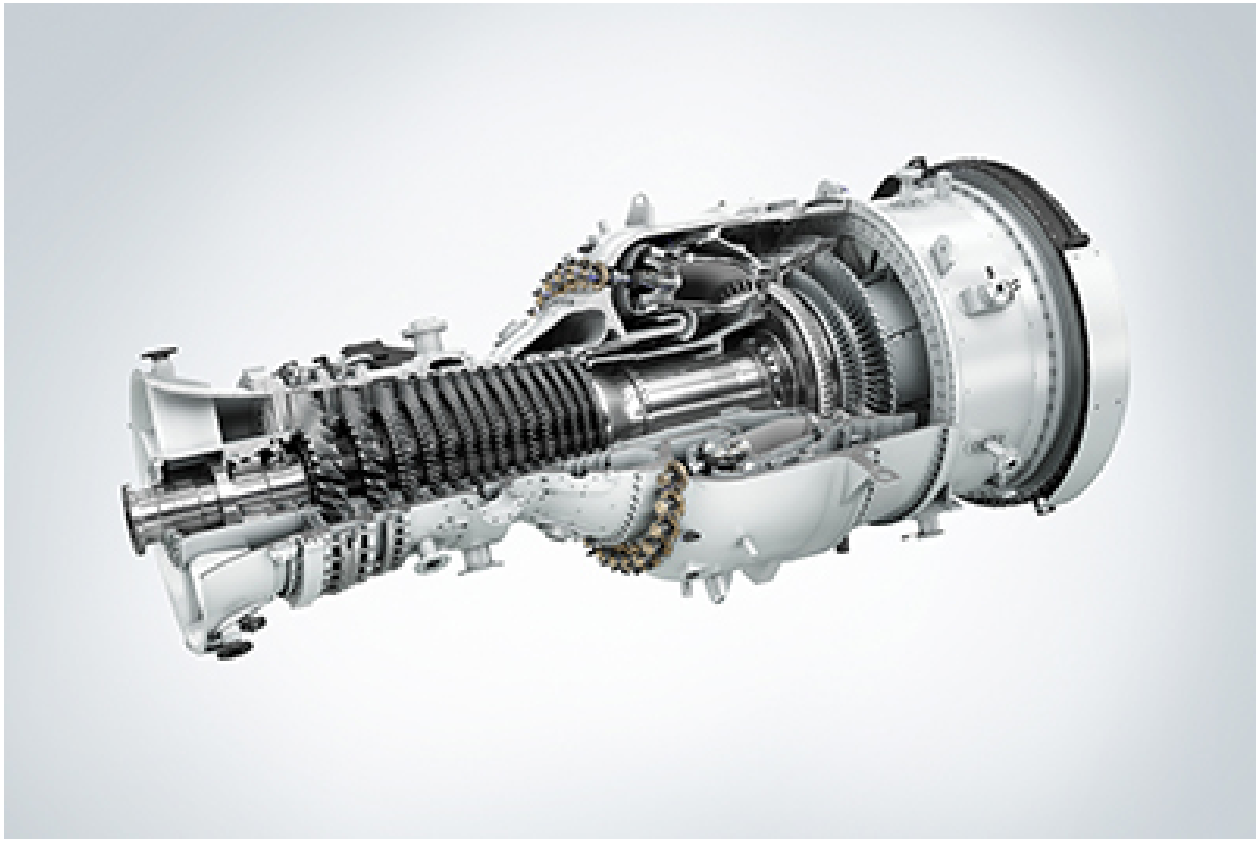
Picture 2: Phase Ia and Ib

SIEMENS GAS TURBINE



Picture 3: Siemens SGT-800

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Drive shaft position	Cold end
Type of compressor	Axial flow
Number of compressor stages	15 stages total (3 stages with variable guide vanes)
Number of compr. extractions	5 (3rd, 5th, 8th, 10th and 15th stage)
Pressure ratio	21:1 (at ISO and N.G. fuel)
Nominal output (net)	50,5 MWe (at ISO and N.G. fuel)
Nominal heat rate (net)	9400 kJ/kWh (at ISO and N.G. fuel)
Nominal efficiency (net)	38,3 %
Nominal exhaust flow	134 kg/s (at ISO and N.G. fuel)
Nominal exhaust temperature	553 °C (at ISO and N.G. fuel)
Type of turbine	Axial flow
Number of turbine stages	3 (Stage 1: Film cooled; Stage 2: Convection cooled; Stage 3: Non-cooled)
Turbine inlet temperature	1230 °C (average thermodyn. mixed gas temp.)
Rotor weight (including blading)	7200 kg
Rotor construction	Electron beam welded compressor, bolted turbine discs
Nominal rotor speed	6600 rpm
Thrust bearing type	Tilting pad (forced lubrication)
Journal bearing type	Tilting pad (forced lubrication
Nominal thrust load	200000 N
Type of combustor	Single, annular combustion chamber Low emission variant, dry
Number of burners	30
Burners type	Single fuel or dual fuel

Table 2: Gas turbine SGT-800 data

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