



MK0200036

DISTRICT HEATING SYSTEM OF BELGRADE SUPPLIED FROM THE CO-GENERATION PLANT "OBRENOVAC"

P.Tomic, B.Sc.Mech.Eng., JKP"Beogradske elektrane", Belgrade
Z.Dobric B.Sc.Mech.Eng, JKP"Beogradske elektrane", Belgrade
M. Studovic, doc.... Faculty of Mechanical Engineering, Belgrade

ABSTRACT

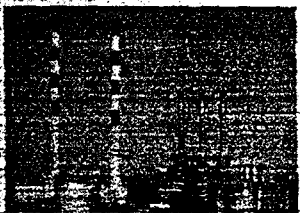
The paper presents most relevant technical and economic features of the Project called "System for supplying Belgrade with heat" (SDGB) from the thermal power plant "Obrenovac", based on domestic coal and reconstruction of condensing power plant for combined generation of electricity and heat for the needs of municipal energy consumption.

The system is designed for transport thermal energy, with capacity of 730MJ/s from the Thermal Power Plant "Nikola Tesla"/A to the existing heat plant "Novi Beograd" based on the natural gas. The paper also gives the comparison of most important technical and economic features of "SDGB" Project with the similar Project of District Heating System for supplying Prague with the thermal energy from thermal power plant Melnik.

Key words: Heat Transport System "SDGB" Project, Process and Equipment, Parameters, Status of Project, Investments.

INTRODUCTION

Basic characteristics of existing heating system of Belgrade, which is the part of the Public Utility "Beogradske elektrane" ("Belgrade Power Plants") has the heat consumption; 1.745 MJ/s in residential buildings (215.668 households, 40% of households in the city), 607 MJ/s of commercial buildings and 55 MJ/s of installed capacity for the



production of hot water for general consumption, as well as the total installed heat production capacity 2.407 MJ/s, distributed in 114 heating plants.

All major heating plants are using natural gas (or crude oil as the alternative) whereas heat plants with smaller capacity use heating oil or coal.

In the urban city of the heat plant "Novi Beograd" capacity 3x35MW, there is the possibility to produce the electric energy, in the combined gas turbine cycle with boiler utilizators (3x110MJ/s) fueled with petrol.

In 1999 year, heating energy output amounted to 2.071 GWh and the electric energy output was 3419 MWh.

In order to improve the energy efficiency and economy production further development and the promotion of heating system in Belgrade relies on the installation of district heating system based on the combined generation of electric and heating energy which uses local energy sources, available in close vicinity of the city. That is SDGB Project (District Heating System of Belgrade supplied from the Thermal Power Plant "Nikola Tesla"/A in Obrenovac).

The installation of this system will provide the reliable and cost effective heating of Belgrade urban areas, substitution of imported fuels with local ones, higher level of utilization of primary energy and reduction of environmental pollution.

Energy sources near Belgrade (coal basin Kolubara) as well as existing thermal power facilities (TPP "Nikola Tesla") are a good basis for the introduction of such system, in Belgrade.

In order to achieve in the shortest possible time required results of the district heating system, it has been decided that the introduction of this system will take place in two phases. In that respect, during the first step, the TPP "Nikola Tesla"/A would be used as the basic source for heat production, whereas in the final phase, planned thermal power capacities in the co-generation power plant "Kolubara B" would be also used for that purpose.

Existing heat consumption areas, which by their position and capacity correspond to the proposed basic thermal energy source, i.e. heat consumption areas, now supplied from the heating plants "Novi Beograd" and "Dunav", will be provided from a new heat transport system (SDGB).

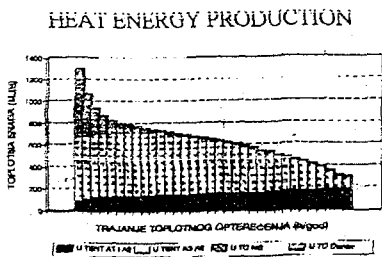
With these heating plants will exist at the same time as peak and reserve sources in Belgrade district heating system.



The first step of SDGB Project includes the construction of the pipeline, 28,5 km long, from the TPP "Nikola Tesla"/A in Obrenovac to the heating plant "Novi Beograd" and the construction of pumping stations "SAVA" in Obrenovac and in the heating plant "Novi Beograd" as well as the reconstruction of the unit 6 in the TPP "Nikola Tesla"/A, with construction of corresponding the heat exchanger stations. This new system will be connected with heat exchanger stations of TPP units 1 and 2, which are already operating as facilities for combined generation of electric and heating energy, today only for Obrenovac.

On such ways, in the first step the system could supply to Obrenovac 75 MJ/s and to Belgrade 270 MJ/s thermal energy. The second step would include the reconstruction of units 3, 4 and 5, the construction of pumping station "Ostruznica" and connection of SDGB with heating plant "Dunav". After that, the system in TPP "Nikola Tesla"/A will generates 780 MJ/s and by SDGB pipeline delivers to Belgrade the thermal energy with capacity more than 600 MJ/s.

System design and parameters



Design of the Belgrade long distance heating transport system, from the coal-fired thermal power plant "Nikola Tesla"/A is in progress. The main components of SDGB is hot water long pipe line from "Nikola Tesla"/A to the heating

plant "Novi Beograd" which links the pumping stations in this plant and heat exchanger stations in the TPP "Nikola Tesla"/A. The units 1 and 2, of TPP "Nikola Tesla"/A, are already reconstructed for the heat extraction for supplying Obrenovac with heat. Due to the fact that capacity of reconstructed unit 1 and 2 are greater than nowadays heat demand in the city of Obrenovac

nowadays, and the pressure of extracted superheated steam varied from 1,2 to 2,5 bar, these two units will provide a significant amount of the heat obtained by very high efficiency. Because that two district heating systems will be connected in such ways that return water from the Belgrade transport pipeline (SDGB) will flows to the inlet of units 1 and 2, driven by pressure difference. After water heating in units 1 and 2 the same amount of is returned to the units 3 to 6 by the pump pressure head and required amount of hot water is supplied to the heat consumers of Obrenovac. According to the suggestion of the steam turbine manufacture ALSTHOM, the available heat power for district heating, 145/180 MJ/s per each units, could be provided by the steam extraction at the crosser steam pipes between intermediate and low pressure turbine which correspond to the 5,5 bar and 3015 kJ/kg enthalpy. Steam extracted is being condensed in three heat exchangers (per unit) at the same pressure. The first heat exchanger could be connected in the serial with subsequent to parallel heat exchangers. This arrangement enables the more equal heat power of the exchangers and equalized temperature increase on the waterside. All the three exchanger have the same transfer area, the same design feature, except that the waterside passes in order to provide the same water velocity in the heat exchangers tubes, are different.

A control of heat exchanger station power is based on the by-pass line on the waterside of heat exchangers.

The forward hot water temperature, of the water from the basic source towards to Belgrade is constant at the air temperature between -15°C and +4°C. This ensures optimal cost effectiveness of basic source and transmission system operation.

The heating of return water is provided in two stages:

- In the first stage, the water is heated with existing parallel coupled heaters of units A1 and A2, with regulated pressure steam of 1,2 bar with maximum heating capacity from 150 MJ/s to 220 MJ/s depending on the temperature level of return water);

- In the second stage, with parallel-coupled heaters of units from A3 to A6, with regulated pressure steam of 5bar (from steam pipeline between IP and LP turbines), with minimum heating capacity per unit 145 MJ/s and maximum heating capacity per unit 180 MJ/s.

SDGB hot water transport pipeline is directly connected to steam heaters at consumers located on distribution network whereas the heating system of Obrenovac is indirectly connected via heat exchanger stations.

Project status and investment

In the vicinity of TPP "Nikola Tesla"/A, pipelines over a bridge reach the left bank of Sava River. From that point, pipelines fixed on low overhead supports are conducted to the outer border of populated area, and further in concrete channels until the heating plant "Novi Beograd". There are service roads along whole pipeline path.

For pumping of water from the TPP "Nikola Tesla"/A to the heating plant "Novi Beograd" and back, four-stage pumping will be installed (two stages on each hot line pipelines). Each pumping stage includes four pumps. The pumps will be stored in two pumping stations, PS "Sava" in close vicinity of the TPP "Nikola Tesla A" and PS "Ostruznica", located at nearly half length of long pipeline.

In the pump station "Sava", all pumps are with variable speed, whereas the pumps in pump station "Ostruznica" have a fixed speed.

Variable water flow through transport pipeline allows the change of transported heat quantity. This may be achieved by choosing the number of pumps, which will be put in operation, as well as by changing the pump speed in the pumping station "Sava".

The idea for heat supplying of Belgrade town from thermal power station was accepted and purpose justified still 1980 year when the Serbian electricity utility decided to build two power plants units for combined heat and electricity production (2x350MW +2x400MJ/s) in our lignite basin Kolubara 45km south from Belgrade. Due the shortage of oil and gas during 1992/1993 winter, we decided to use the possibilities of combined electricity and heat production in the TPP.



"Nikola Tesla"/A near town Obrenovac, 28,5km south from Belgrade, since such possibility have been included in design and delivering the steam turbine equipment for the four unit of ALSTHOM turbine (4x310MW).

During 1993/94 in cooperation with JKP "Beogradske elektrane" engineering enterprise ENERGOPROJEKT (ENTEL) from Belgrade prepared the SDGB Project documentation, with corresponding technical and economic parameters for realization such project. From the project studies as analysis of several similar projects in the Europe, respecting the various constrains in the TPP "Nikola Tesla"/A and Heating Plant "Novi Beograd", design diameter of main pipeline DN1000 and NP25 have been specified.

Until today, the construction of the bridge as the support for hot water pipeline and the traffic over river Sava near the TPP "Nikola Tesla"/A in Obrenovac as well as the underground channel section of the hot water pipeline through part New Belgrade area from heating plant "Novi Beograd" have been partially carried out.

Necessary finances for the realization on the first step of SDGB amount to: 84.000.000USD. The works include the connection of heat exchanger stations the units A1, A2 and A6 in the TPP "Nikola Tesla"/A construction of pump stations "Sava" and hot water long pipeline to the heating plant "Novi Beograd"

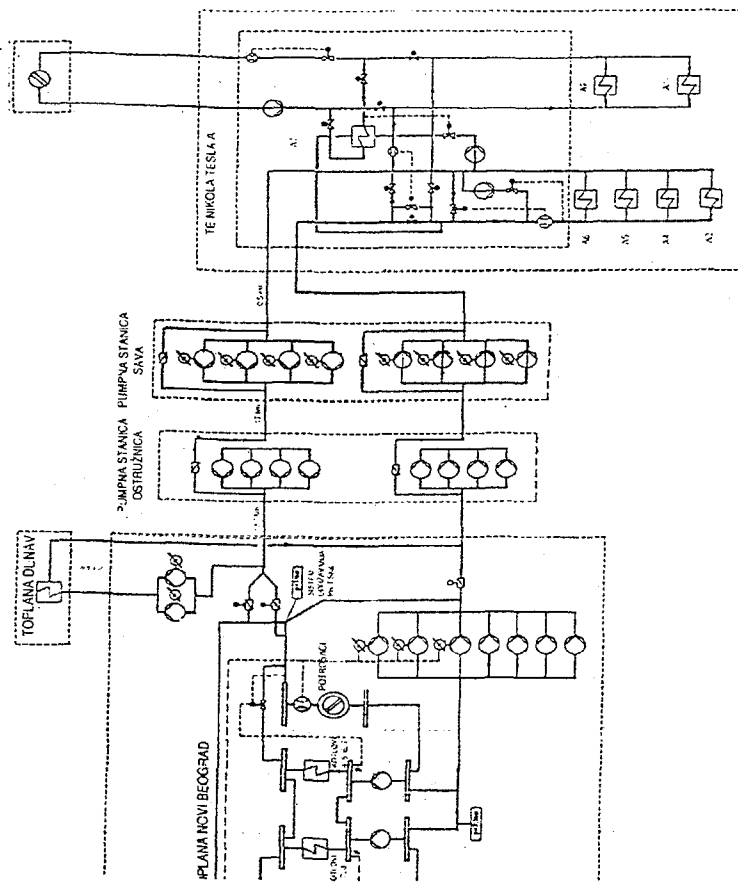
The following table represents the finances required for the equipment and works in the realization of the SDGB Project, including the participation in the construction of bridge over Sava River for main hot water pipeline according to the structure:

Pumping stations ("Sava" and "Ostruznica")	14 mil.USD
Adopting of the heating plant "Novi Beograd"	11.2 mil.USD
Main hot water pipeline with accompanying fittings	62 mil.USD
Preparatory and final works	4.4 mil.USD
Project designing and engineering	4.2 mil.USD
Unforeseen works/Additional expenses	15 mil.USD
Total for co-generation plant "Novi Beograd"	11.8 mil.USD
Reconstruction of units and heat exchanging stations in the TTP "Nikola Tesla A"	11.8 mil.USD
Total for SDGB Project	143 mil.USD

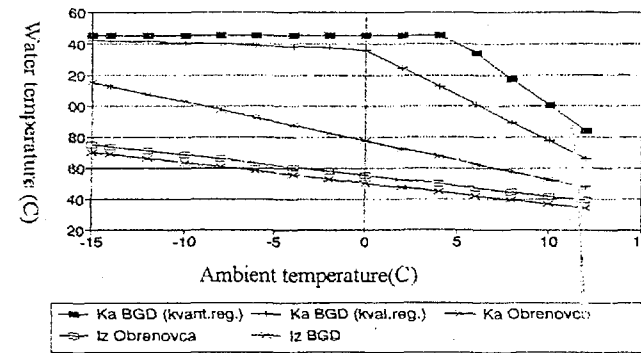
In this amount (143.0 mil.USD), the bridge and the accompanying transport route dedicated to the public traffic participate with 18.0 mil.USD (these works have already been completed), which means that the investment in the pipeline amounts to 125.0 mil. USD.

Preliminary comparative analysis of the above investment structures show that the investments in SDGB Project are acceptable from economic point of view and that they are socially justified. If a model analysis of economic effects based on the role of Yugoslav industry in the creation of added value in the gross national product were carried out, elements of social justification of this project would be even more evident.

SDGB - principle scheme



WATER TEMPERATURE CHART



COMPARISON OF TECHNICAL AND ECONOMIC PARAMETERS OF SDGB PROJECT AND SIMILAR TPP MELNIK TO PRAGUE

The energy source of the heating system TPP Melnik-Prague was constructed on the basis of reconstruction of 6 steam turbine units with the capacity of 55 MW in the TPP Melnik (coal fueled) and with heating capacity of 600 MJ/s, dedicated to the covering of base load in the consumption area of Prague.

The TPP Melnik is located at 34,2 km away from Prague (more precisely from the heating plant Treboradice, which is the first heating plant in the north of Prague). The main two-pipes hot water pipeline has been constructed, with pipes of 1200 mm in diameter, which "cross" twice Vltava river, and four times the railway tracks.

The realization of the project started in the year 1989. In 1994, the technological and economic documentation has been updated and the realization has been continued upon the establishment of the company "Energotrans" and the financial support in the form of credits has been ensured. The project had to be updated mainly from the aspect of introduction of market economy elements and the support of the Czech Electric Power Utility, whose participation in the project has been marginalized. With consulting services provided by specialized agencies, this project has been implemented in very short period of time and it was based on commercial credits of several bank institutions from the Czech Republic and some other European countries. Total expenses, related to investments in the reconstruction of units, construction of main hot water pipeline 34,2 km long, with pumping substations of TPP Melnik and the

heating plant Treboradice, with a modern measuring and control equipment, amounted around 180 mil.USD.

	TPP "Nikola Tesla"/A Heating Plant "Novi Beograd"	TPP Melnik- Heating Plant Treboradice (Praque)
Energy source	4 units of 305 MW each	6 units of 55 MW each
Power of source	660/580 MJ/s	600MJ/s
Dist. Source-heating Plant in town	28 km	34,2 km
Main hot water pipeline	2x1000mm	2x1200mm
Main/return tem.	145/70°C	150/70°C
Nominal presssure	2.5 MPa	2.5 MPa
Flow	1845 kg/s	2000 kg/s
No of pumping substation on the pipeline path	1x 2	none
Power regulation investments	combined 143 mil.USD	combined 180 mil.USD
Annual supply of heating energy	6.200 TJ/year	8.000 TJ/year

Analyzing the features and parameters of these two systems for providing the corresponding amount of heating energy, it is obvious that they have many common points, even that the path length of SDGB is for 20% shorter than the other one whereas the ground heights differences from the energy source to the consumption area are ten times smaller.

CONCLUSION

Future development of district heating systems in urban areas will be primarily based on energy sources with combined processes and combined generation of electric and heating energy, due to the fact that these technologies are not only proven in practice, but are the only technical mean for more rational use of imported energy, as well as for the higher efficiency of energy conversion and reduced environmental pollution.

It is quite evident that the major potential from technical, energy and economical point of view for the achievement of better efficiency results in use of energy produced with the local coal and rational use of imported natural gas in Serbia, lies in planned reconstruction of the condensing units in the TPP "Nikola Tesla" A for the purpose of combined generation of electricity and thermal energy, as the basic energy source or the heating purpose in the area of New Belgrade and Belgrade, according to the District Heating System (SDGB) Project. Due to the overall energy and economic effects which will be achieved after the implementation of the SDGB Project, and for protecting of electric distribution system in Serbia during winter days, due to insufficient supplies of imported energy sources for the heating plant "Novi Beograd", it is evident to give to this Project the first priority in the realization of planned energy objects in the Serbia.

BIBLIOGRAPHY

1. District Heating and Environment, Proceeding of Workshop, Helsinki University of Technology, 1995.
2. Technological Project of "SDGB", Energoprojekt ENTEL, Belgrade 1996.
3. Technical Data Heat Feeder Melnik-Praha, Czech Republic, Energotrans, Praha, 1995.
4. M. Fishedick, New Requirements for Future Growth of Cogeneration from a Global Perspective, EuroHeat and Power, No. 10, 1998.
5. Armand Colling, Cogeneration, District Heating and Cooling in The EU Energy Policy, 28th biannual congress of EuroHeat and Power, Unichal 9-11 June, 1977.
6. A. Bratic, M. Studovic, P. Tomic, Energy Efficiency of Combined Generation of Electric and Heating Energy, ENYU, Zlatibor 1999.
7. Feasibility Study for Construction of "SDGB" - First Phase, CES Mecon, 1997.
8. DUP of Main pipeline from TPP Nikola Tesla A - Heating Plant Novi Beograd - Hydro Project. District Heating System of Belgrade Supplied from TPP Nikola Tesla A - Technological Project, Energoprojekt, 1997.