„DISTRICT HEATING IN BITOLA, NOVACI, AND MOGILA" – STAGE I

Prepared by: Development and Investments Department

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INTRODUCTION

The introduction of a district heating system for the city of Bitola and its surroundings is an idea that has existed for decades in the past. The idea of introducing a heating system by using the heating energy from REK Bitola may also be seen as a kind of social responsibility of JSC ESM to the city of Bitola and its surroundings, having in mind the significant impact of REK Bitola on the environment. On the other hand, it is important to note that, when it comes to consumption, the use of heating energy will replace a considerable amount of the electricity, oil and wood that is currently used for heating. The implementation of this project will replace the use of electricity for heating to a great extent, thus increasing the level of safety and security of the electricity distribution grid.

In terms of energy efficiency, the heating source of a district heating system with sizeable capacity and equipped with a modern system of regulation and automation of the heating energy generation process has a significant advantage over the individual heating sources used by the consumers. The possibility of heating energy generation was considered as early as in the stage of construction of REK Bitola, i.e. during the stage of its design. Several studies were conducted within the period the 1981 – 1986 to treat the issue:

1. Information on the opportunities for district heating in Bitola – Trombev, Mijakovski, Pejchinovski, Volkanovski; 1981 (not available)
2. Technical solution for a district heating system in Bitola – Teploenergoproekt Kiev; 1981 (partially available)
3. District heating in Bitola – previous studies, SOZT MZT Skopje, organizational unit "Goce Radosavljevich", Bitola 1985
4. Investment and technical documentation for district heating in Bitola, SOZT MZT Skopje, organizational unit "Goce Radosavljevich", Bitola 1985 (partially available)

As part of the program for cleaner and more efficient production, financed by the Government of Norway and implemented by Norsk Energi and the Climate Changes Center, a pre-feasibility study was developed under the title "District Heating in Bitola with Heating Energy from REK Bitola" in April 2011.

In 2012 year, "Ekonerg" from Croatia began its work on the Feasibility Study, which provided the main guidelines for the implementation of the project itself.

The implementation of the first stage of modernization of REK Bitola's turbines envisages the installation of appropriate equipment for recovery of steam from the turbines, to allow for the generation of heating energy; this is practically the start of realization of the idea.

Negotiations with international financial institutions began in 2013, during which interest in financing the project was expressed by KfW Bank.

Fig. 1 Project location

TECHNICAL CHARACTERISTICS

The district heating system foresees generation of heating energy by recovering the steam from turbines 2 and 3 in TPP Bitola. By means of a 12,61 km long hot water transmission line going through arable agricultural land along the settlements of Novaci and Logovardi would supply city of Bitola with heating energy.

The climate in Bitola and the surrounding municipalities is basically of a moderate continental nature with pronounced continental elements, dry and hot summers and short, dry and cold winters. The mean annual air temperature is 11.1 °C and the lowest projected one is -18 °C.

Going through the steam-water transformers, the steam recovered from the turbines generates heating energy transported via the hot water transmission line to the primary pump station in the city of Bitola.

The heating energy will be distributed to Bitola by a primary and secondary hot water transmission line to the ultimate users. The hot water distribution line (DL) from REK Bitola to the municipality of Bitola will be constructed from two previously isolated pipes with a leakage detection system. The temperature regime of the transmission line is defined at 115/70^{0}C (incoming temperature of 115^{0}C, return temperature of 70^{0}C).

Regarding the supply of lignite for REK Bitola, this is currently done by exploiting the Suvodol and Brod-Gneotino mines; in addition, coal supply from underlying coal series will begin within recent time period. At the same time there is ongoing development of Main Mining Project for opening the Zhivojno mine, TOR for analysis of possibility for

supplying TPP Bitola with coal from potential deposit Mariovo was prepared and Study for supplying TPP Bitola from the coal reserves in the potential deposit Mariovo is prepared in 2016.

The table below is a summary of the remaining coal reserves to be exploited in the wider area of Bitola; these reserves may be used as fuel for the thermal power plant.

Table 1 Remaining exploitable reserves

Mine / Deposit	Remaining exploitable reserves (December 2016 data) (millions of tons)
Suvodol open cut mine	2,4
Suvodol ground coal series	49,9
Brod-Gneotino	22,3
Zhivojno	21
Brod-Gneotino underground mine	40
Mariovo	60
Total	**195,7**

The above stated quantities of coal have been calculated on the basis of the worst possible scenario, based on the assumptions of maximum errors in the estimates of proven geological reserves; these are the quantities required for 30-35 years of operation of TPP Bitola.

In addition to the domestic lignite, JSC ESM is also considering other possibilities of providing fuel for TPP Bitola, such as:

- Imports of coal with high calorific value;
- Natural gas.

It needs to be emphasized that, in line with the long-term development plans of JSC ESM, it is foreseen that REK Bitola will both in the present and future times be the main pillar of the energy system. This means that the heating energy required for the district heating system will certainly be provided.

TECHNICAL DESCRIPTION OF THE PROJECT "DISTRICT HEATING SYSTEM FOR BITOLA, MOGILA AND NOVACI" STAGE ONE

The first stage in the introduction of a district heating system to supply heating energy to the municipalities of Bitola, Novaci, and Mogila using the heating energy from REK Bitola will include the construction of:

1) a heating energy generation system (HS – REK)
2) a hot water transmission line (HTL),

3) a primary pump and heating station in Bitola (PPHS),
4) a hot water distribution grid (HDG) in Bitola
5) heating substations (HS) in buildings.

The concept of a district heating system is given in the simplified diagram contained in the addition to the Feasibility Study and the general piezometric diagram of pressure drop in Figure 2.

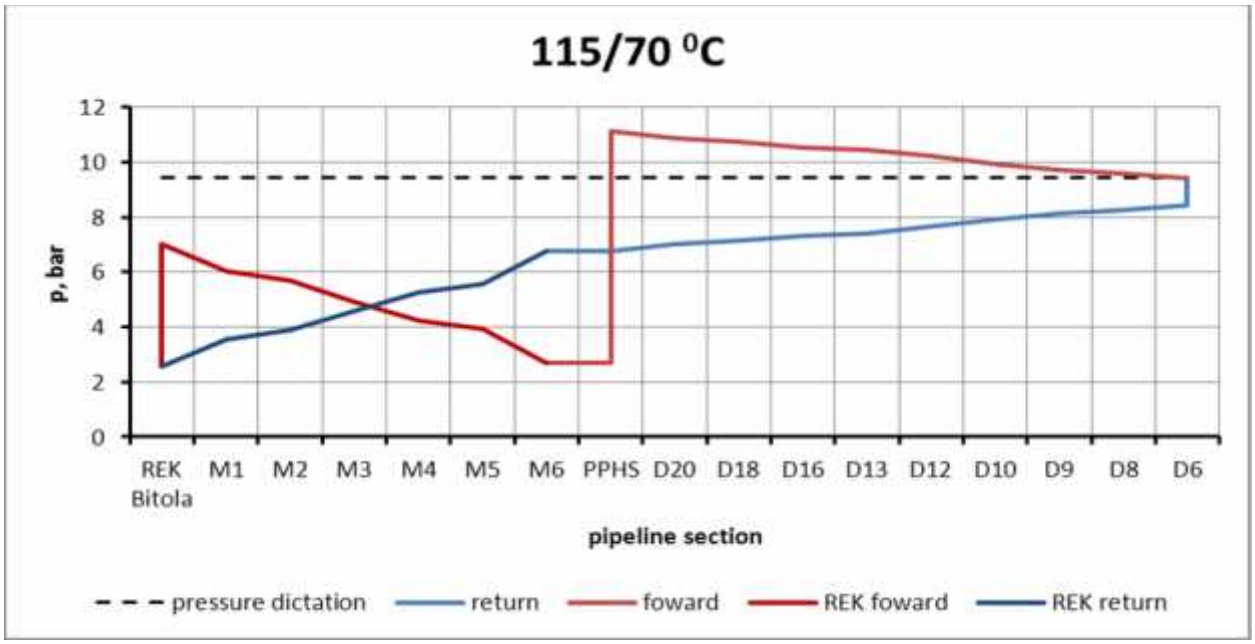

Figure 1- General piezometric diagram of pressure drop

Heating energy generation system (HS – REK Bitola)

The heating energy generation system consists of:

1) A system for recovery of steam from the steam turbines at blocks 2 and 3 for the needs of the stage one heat transformers (up to 115°C)
2) Stage one heat transformers (2 x 50 MW)
3) Pump station (circulation pumps)
4) Pressure maintenance system in the Distric Heating System

System steam recovery from steam turbines unit 2 and 3 for stage one

Unit 2 and 3 in REK Bitola were reconstructed in 2012 and 2013 in order to enable them to recover steam from the turbine. The reconstruction will allow for regulated recovery of steam for heating the water in the district heating system.

Steam recovered from the turbines will be transported via a steam pipeline equipped with control, safety and lock valves. The condensate from the hot water heater is sent back to the turbine ring of each unit mixed with the main (turbine) condensate, and passes through the condensation regeneration system for previous heating.

Stage one heat transformers

In the first stage, the heat transformers will be located on the plateau (elevation point 0), between unit 2 and 3. To ensure the supply of district heating during this stage, two 50 MW heater transformers will be installed at the hot water station located at REK Bitola. The heat transformers will be classical one, with U pipes and, depending on the accessibility of the area, may be vertical or horizontal.

The generation of heating energy by the hot water heat transformers will be controlled by the steam, i.e. by suppressing the steam to maintain the temperature required at the hot water outlet.

Table 2 Heat transformers data

Basic hot water heat transformers	**Number of heat transformers 2 x50 MW heating energy generation: 100MW**
Primary:	Secondary:
Steam / Condensate	Hot water
Pressure 1.9 Bar (a)	Pressure 10.0 Bar (a)
Temperature 205/70 °C	Temperature 70/115 °C

Pump station (circulation pumps)

The pump station will be located at elevation points -3,60m between unit 2 and 3. At the pump station, there are electromotor pumps with a regulated number of revolutions. This concept allows for energy efficient operation, i.e. reduction in the consumption of electricity, depending on the flow in the system. The system also foresees static pressure maintenance pumps, unless it is a hydraulic regime.

Hot water transmission line

The hot water transmission line consists of pre-isolated pipes placed directly into the ground. These pre-isolated pipes have a leakage detection system. The starting point of the transmission system is the hot water station, i.e. the heating station HS-REK, with the end point at the primary pump and heating station Bitola (PHS).

Local pump and heating stations for the settlements of Novaci, Mogila and Logovardi (LPHS - S)

In the first stage of the project, only the connections to the future distribution grids for these settlements will be installed, while the users will be connected following further analyses of the justifiability and according to the specific interests of the users.

Primary pump and heating station Bitola (PPHS)

The location of the primary pump and heating station is defined in the physical plan at the city entrance, on the crossroad between the streets of Zheleznichka and Cvetan Dimov, on the east side of the railroad. The main purpose of the PPHS is to increase the hot water pressure in the transmission line, in order to achieve the required parameters for circulation through the hot water distribution grid in the city.

Hot water distribution grid (HDG) in Bitola

The main purpose of the hot water distribution grid is to distribute heating energy to the consumers. The main hot water grid ought to be installed in such a way that it will connect the heating source (or several sources) to the heating energy consumers in the shortest possible way. The urbane, hydrological and other technical conditions for installation of the pipes should be taken into account. The hot water grid is constructed of pre-isolated pipes placed directly into the ground and equipped with a leakage detection system.

The temperature regime of the hot water transmission grid is as follows:

- Incoming temperature 115 °C
- Return temperature 70 °C

Hot water distribution grid in the settlements of Novaci and Logovardi

In the first stage of the project, only the connections to the future distribution grids for these settlements will be installed. Users will be connected following further analyses of the justifiability and according to the specific interests of the users, through heating substations (HS) in the buildings of the end users.

Environmental protection and energy efficiency aspects

Over the past decades, the city of Bitola has had experiences with a district heating system, which operated using liquid fossil fuel; this, however is not the case today. Both households and public buildings currently use various types of energy for heating purposes: crude oil, household oil, wood, coal and electricity. The implementation of this project will not only improve the comfort of the citizens, but will also reduce the negative impacts on the environment that are present especially in the winter periods.

Potential reductions of emissions that would result from the implementation of this project:

Table 3. Potential reduction of emissions (t/year) in the city of Bitola (as per the Project Study)

Emission source (type of heating)	NOx	SO_2	CO	PM	CO_2
Individual (wood)	10.3	2.1	1,237.7	175.3	
Central (wood)	48.5	12.1	1,617.5	202.2	
Individual (household oil)	0.060	0.343	0.120	0.018	
Central (household oil)	47.6	136.3	19	13.1	35,300
Individual (coal)	0.106	0.42	5.3	0.528	3,430
Central (coal)	3.8	11.47	116.6	11.7	
Reduction of electricity generation	255.77	999.27	8.93	114.48	98,980
TOTAL	***366.2***	***1,162***	***3,005.2***	***517.3***	***137,800***

The implementation of the District Heating System (DHS) will optimize the use of energy resources that would otherwise be used on an individual basis. Once the DHS is implemented / built, energy efficiency of al facilities – industrial, individual, commercial and public will be increased. Part of them are connected or will be connected to new DHS and all necessary measures need to be undertaken to comply with the legal norms for consumption of energy/m^2 annually.

Calculation of the reduced electricity generation

In the process of generation of heating energy by recovery of steam from the turbine, there is a certain loss of the electricity generated due to the heating energy produced. It is expressed appropriately in power (heat and electricity), the rough estimations, without connecting to concrete temperature regime, are losing of 0,18 MW of electricity for 1MW of heat. Having in mind the only temperature regime (115/70^{0}C) adopted for the Feasibility Study, it has been precisely calculated that the loss of electricity per each 1MW of heat is within the range of 0.184 and 0.253MW.

Table 4. Costs for lost electricity generation depending on the power factor provided

Heating power factor (MW)	Loss of production at TPP Bitola [MWh_{el}] electricity	Regulated price of electricity [€/MWh]	Value of production loss (€)
60 (base year)	19,200	40.75	782,400
80 *(next year)	25,600	40.75	1,043,200

100** (second year)	32,000	40.75	1,304,000

*refers only to the maximum power factor of steam recovered from turbines

**refers to the total installed demand of 100 MW for which energy is provided – maximum 100 MW from REK Bitola and an additional 20 MW from peak boilers

INVESTEMENT COSTS

	EUR	*%*
Studies, design, land acquisition	1,900,000	4%
Civil engineering works	29,787,800	64%
Equipment	9,735,200	21%
Consultants	964,000	2%
Contingencies	3,950,000	9%
TOTAL	***46,337,000***	***100%***

Activities in progress for the project "District heating in Bitola, Novaci and Mogila" - I phase

► Loan agreement with a sovereign guarantee with a KfW Bank was concluded
►A contract for consulting services with IC Consulenten Austria has been concluded on
►A tender for LOT 1 was announced on 19.06.2017
► Bids were received for LOT 1 on 31.7.2017
► Evaluation of received bids for LOT 1
► Preparation of technical specification for LOT 1 (draft version)
► Preparation of tender for pre-qualification for LOT 2 (draft version)
► Aproval of tender documentation for LOT 2 from KfW
►Contract with Power Machines for nominated subcontractor for LOT 2
►Starting an expropriation process

CONCLUSION

In addition to the positive financial parameters for the feasibility and acceptability of the project, the positive parameters of the comparative analyzes of the price of the competitive fuels with the competitive fuels from the aspect of environmental protection and energy efficiency, which results in:

- Reduction of emissions from combustion of wood, household and coal fuel in small domestic stoves as well as in furnaces of public and commercial buildings, SOx, NOx, CO, etc. ;
- Reduction of CO2 emissions at the level of R. North Macedonia;
- Improving the quality of ambient air;
- Improving the quality of the agricultural arable land;
- Reduction of noise;
- Reduction of negative impacts on natural ecosystems;
- Safe and continuous supply of thermal energy;

- Reducing the likelihood of possible inadequate treatment of waste oil in the preparation, this is used for heating;
- Reduction of respiratory diseases;
- Increasing the quality and service of living;
- Reducing the consumption of electricity used for heating the premises;
- Reduction of losses in distribution of electricity to low voltage and high voltage networks;
- Optimization of the energy resources used for heating the premises in individual objects.