Generation Investment Study

Volume 5: Generation and Transmission Appendices

Appendix 8: Specific candidate plants and rehabilitation

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A8.1 ALBANIA

The report for the Power Transmission and Distribution Project, Module B: Least-Cost Power Generation Investment Plan (January 2003) provides extensive information on specific candidate plants. Locations have been specified for both hydro and thermal generation although for the latter a range of fuel options are considered and these have been described below.

A8.1.1 Specific Candidates: Hydro Projects

Options exist for some 2265 GWh on the Drin, Vjosa, and Devoll rivers.

Table A8.1 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
DRIN RIVER						
Bushati	84	350	134,000	1591	4	2010
VJOSA RIVER						
Kalivaci[1)]	90	400	97,100	1079	3	2008
DEVOLL RIVER						
Bratila[1)]	80		81,200	1030	3	2009
Skavic[1)]	350		586,200	1675	5	2016

** These Hydro stations have been confirmed by NAE as those that were worked out in Tirana during discussions with SEETEC*

[1)] – There are no hydro conditions for this plant. Hydro conditions are defined based on the energy/power production during an average (p=55%), wet (p=20%) and dry (p=25%) year.

A8.1.1.1 HPP Bushati

Bushati hydropower plant is planned to be the last downstream hydropower plant of the Drin River cascade. Bushati is designed as a pure run-of-river plant that should take benefit from the seasonal regulation of the Drin River reservoirs. An intake structure situated approximately 3 km downstream the plant of Vau i Dejes derivates the water into a 6 km long headrace canal which leads water to a power plant equipped with two Kaplan units of a total capacity of 84 MW. The total discharge of 540 m3/s of the power plant returns to the river by a 6 km long tailrace canal to Lumi Buna River. Annual energy production has been evaluated at 350 GWh.

Bushati is considered a planned project. In February 2001, Albania's national power utility KESH concluded a contract with China Water & Electricity Corporation (CEW) to implement Bushati HPP on a turnkey basis. In parallel a loan agreement was signed for financing the project. Both contracts were suspended until the feasibility has been confirmed by an independent assessment. MIE, National Agency of Energy, KESH and VATEC (Austrian

Company) undertook to carry out the Environmental Impact Assessment for Bushati HPP, which was expected at the end of 2004.

A8.1.1.2 HPP Kalivaci

The hydropower scheme is located on the Vjosa River downstream of Kalivaci (Dorze), approximately 28 km from the town of Tepelena. This hydropower plant is situated downstream on the Vjosa River hydro development scheme.

The Kalivaci scheme comprises a fill-type dam using excavation materials and gravel, a diversion tunnel and a power station. The hydropower plant will be constructed on limestone formations. The river is exploited from a head of 110 m to 65 m. An Italian company BEGETI has this concession and is in the process of carry out a detail geological survey for this site.

A8.1.1.3 Bratila HPP

This hydropower project is situated on the Devoll River, approximately 20 km from the town of Gramshi at the waterfall of Grabova. The HPP will be located in the upper part of the river's hydro development scheme. It can be constructed according to two variants. In the first variant, the riverhead is taken between 440 m and 300 m, and in the second variant, the riverhead is taken between 530 m and 300 m. The Bratila hydropower scheme comprises a dam, with a diversion tunnel and a power station. The dam should be a concrete arch-type structure. The hydropower plants will be constructed on rock formations.

A8.1.2 Specific Candidates: Thermal Plants

The Power Transmission and Distribution Project, Module B: Least-Cost Power Generation Investment Plan (January 2003) identified a number of sites for thermal power stations and different possible generation technologies for these sites. These sites are Vlore (2 units), Fier (1 Unit), Elbasan (2 units), Cerrik (1 unit), Durres (2 units), Korce (1 unit – only SCGT option).

The report states that the use of indigenous coal (lignite) is not a realistic option. It was also found that imported coal was not an attractive alternative due to economics, environmental issues, and tourism along the coast.

Table A8.2 Specific Candidates: Thermal Plants

Generation Type	Potential Sites	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
SCGT	Korca	108	Gas	15[2)]	2.5	226
CCGT	Korca	105	Gas	20[2)]	2[2)]	642[2)]
CCGT[1)]	Vlora	135	Dest Oil	20[2)]	2	435
CCGT[1)]	Vlora	2 x 200	Dest Oil	20[2)]	3	340
CCGT[1)]	Vlora	200	Dest Oil	20[2)]	3	353

1. *These Thermal stations have been confirmed by NAE as those that were worked out in Tirana during discussions with SEETEC*
2. *These values are based on the generic plants presented on Sections 2.4 and 2.8.7.*

A8.1.2.1 TPP Vlora

This southern coastal site is located in the industrial area of Vlora at the chemical plant of PVC on contaminated ground, only 100m from the waterline.

Fuel oil supply for this site may be provided through the Narta storage park facilities. Further fuel oil storage facilities (6 reservoirs) are under construction. Unloading and transport facilities for imported coal do not exist.

Based on the National Strategy of Energy (2003), the World Bank, European Investment Bank and European Bank for Reconstruction and Development have expressed their support to finance a new TPP. The construction of the combined cycle TPP will be divided in three phases. Each phase will have an installed capacity of 135 MW and a first investment of 100 Million USD. The first phase and the comprehensive, site selection study, feasibility study, environmental impact assessment and technical specification study were completed by September 2003 (selection of the location: Vlora B Zone). By July 2004, negotiations with the banks were finalized. There is interest from private investors in the BOT Concessionaire Contract to build two other units. A proposal is in the discussion phase to build on the same site 2X200 MW combined cycle power plant.

A8.1.2.2 TPP Fier

The potential site at Fier is a greenfield area adjoining the industrial area including Fier power plant, currently the only operational thermal power plant in Albania). The new site is located between the cooling towers related to the Czech steam turbine unit of the power plant and the small Gjanica river.

Fuel oil supply would require construction of a new pipeline (on the same right of the way as the old one) from Vlora-Fieri-Ballshi of 12” with 60 km length advancing from Narta-Skrofotine-Mbyet-Ballesh (three pumping stations), or rehabilitation of the existing pipeline (from refinery to Fier site) and improvement of loading and unloading systems at the storage park at Mbyet (on top of the hill very close to the existing Fier power plant), or by construction of a new oil terminal at Seman (the closest point at the coast line from Fier site) and an oil pipeline of around 13 km up to the Fier site, or by road truck (road distance Vlora to Fier is 33 km) or railway transport from Vlora Terminal (railway distance Vlora to Fier is 35 km).

Supply with imported coal could be either by construction of a coal terminal at Seman and 13 km road transport to Fier site, or from Durres coal terminal to Fier site by road coal trucks (road distance Durres to Fier is 88 km), or by railway transport (railway distance Durres to Fier is 81 km).

However, based on the National Strategy of Energy, the Fier site is selected only for the rehabilitation of Czech unit 60 MW.

A8.1.2.3 TPP Elbasan

One site at Elbasan is allocated on an empty field close to the metallurgic plant. Process cooling could use water from the Shkumbini River or from wells. The second site at Elbasan is located close to the metallurgic plant and the ex-coal storage facilities of the existing coal power plant.

Both potential Elbasan sites could be supplied with fuel oil from Vlora terminal either by road truck (road distance Vlora to Elbasan is 139 km) or by railway transport (railway distance Vlora to Elbasan is 122 km). Supply with imported coal could be from Durres coal terminal either by road truck (distance Durres to Elbasan by road is 89 km) or by railway transport (railway distance Durres to Elbasan is 72 km).

However, studies have shown that the coal option is not feasible from an economic point of view. There is an offer to build a diesel engine power plant (24 MW) on the site of the previous thermal plant, which will serve as auto producer for the steel factory integrated with the transmission network.

A8.1.2.4 TPP Durres

The first of Durres coastal sites at Porto Romano is allocated on an empty field next to the former chemical plant within residential areas on contaminated ground. The second site at Durres is allocated at Bishti Palles, 2 km north of the first site. Both Durres sites can be supplied with fuel oil by road truck from Durres port oil facilities (approx. 10 or 12 km respectively), assuming rehabilitation of roads. Alternatively, a new oil terminal at Porto Romano (or Bishti Palles) and an oil pipeline of around 2 km could be constructed. Imported coal could be supplied by road truck as well from Durres port facilities.

In this site is planned to build the open cycle gas turbine (diesel fuelled), which will serve to cover part of peak demand.

A8.1.2.1 TPP Korca

The potential site is a greenfield site close to the closed coal fired power plant of Korca, and to Zemlak substation 400/110 kV, which is currently under construction. The site is located in the eastern mountains at an altitude of 900m and limited cooling water resources are available from the Devollit River.

Fuel oil would have to be supplied to Korca by road truck from Vlora (road distance Vlora to Korca is 245 km), imported coal by road truck from Durres (road distance Durres to Korca is 237 km).

In view of the exposed location and distance from fuel imports via these Adriatic ports, Korca is considered as a potential site only for expansion candidates fired by natural gas, as it is located on the pipeline routing of future gas supply options.

It was concluded in mid-2004 that this site is feasible only if natural imported gas is transported via-Greece to Albania.

A8.1.3 Rehabilitation

A detailed assessment of each plant has been undertaken and, although no costs have been given, it is likely that significant refurbishment will need to take place at all stations within the period of the current study.

All the equipment of the thermal power plants is old, ageing and heavily corroded. The plants are almost at the end of their technical lifetime and cannot be reactivated.

Out of eight Thermal Power Plants installed in Albania, only the power plant in Fier is still partially in operation. The eight stations consist of the two larger plants in Fier and Ballsh and six smaller plants at Tirana, Cërrik, Vlorë, Kucovë, Korçë and Malig. The smaller plants are at the end of their technical lifetime and have been out of service for a long time.

In order to get the Czech unit back into operation, for safety and availability reasons urgent measures at the mechanical, instrument & control and electrical part are required.

This study assumes that the Chez unit will be rehabilitated during 2005 and 2006. After the rehabilitation, the unit will recover its initial capacity (60MW), and will be in operation from 2007. There is also the rehabilitation of one of the 12 MW units at Fier, during the 2005-2006 period.

The urgency for the rehabilitation of Fier TPP is not only for technical and safety reasons, but also to reduce the electricity generation unit cost, which is actually very high in Albania. The rehabilitation will lead to a higher technical capacity, more security and a lower electricity generation unit cost.

Table A8.3 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
Fier Czech	60	1999	2005	2006	2007	60	After 2020
Fier China	12	2004	2005	2006	2007	12	After 2020

A8.2 BOSNIA AND HERZEGOVINA

A8.2.1 Candidate Hydro Projects

The information here presented for the hydropower candidate plants for Bosnia and Herzegovina has been collected from different sources. EPHZHB have supplied the information on Pec Mlini and Mostarsko Blato. EPRS have supplied information on Buk Bijela, Srbinje, Dabar, Nevesinje, Bileca, and Banja Luka. Information on Konjic, Vrhpolje, Ustokolina, and Glavaticevo comes from the EPBiH Website.

Table A8.4 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
EPBiH						
Konjic[1)]	2 x 57 + 1x7	290	162,600	1,336	4	
Vrhpolje[1)]	2 x 30	152	68,500	1,141	4	
Ustikolina	3x21.2	255	109,400	1,719	4	
Glavaticevo	3 x 55.6 + 1x5	295	224,700,700	1,320	4	
EPHZHB						
Pec Mlini	2 x 15		Expected start production date of October 2004			
Mostarsko Blato	80	247			3	2006
EPRS						
Dabar	160	303.1	171,700	1,077	4.5	2011
Nevesinje	61	44.2	127,300	2,093	4	2011
Bileca	36	127	81,200	2,454	4	2011
Buk Bijela	3 x 150	968	362,600	806	5.5	2010
Srbinje	3 x 18.5	161	114,700	2,067	4.5	2010
Krupa	3 x 16	179.1	66,200	1,364	5	2010
Banja Luka	2 x 18	143	72,900	1,959	5	2010

1. *There are no hydro conditions for this plant. Hydro conditions are defined based on the energy/power production during an average (p=55%), wet (p=20%) and dry (p=25%) year.*

A8.2.1.1 HPP Buk Bijela and HPP Srbinje

These candidate plants are cascaded on the Drina river with HPP Buk Bijela having significantly more electrical capacity and storage than HPP Srbinje. HPP Buk Bijela has a head of 94 m and a useful reservoir capacity of 328 M m^3; the corresponding figures for HPP are 4.6 M m^3 and 14 m.

In addition to these specific schemes there are 49 other small schemes that could provide a capacity of some 90MW with an annual production of 283GWh.

Information for these generators has been supplied by EPCG and EPRS, the first set of cost figures is by EPCG and the second set is by EPRS. The latter, being more recent, are likely to be more reliable. One third of the output of HPP Buk Bijela would belong to Montenegro. EPRS consider this scheme will to go ahead.

A8.2.1.2 HPP Dabar, HPP Nevesinje, and HPP Bileca

These are on the same cascade. EPRS consider this scheme will go ahead.

A8.2.1.3 HPP Krupa and HPP Banja Luka-low

These are on the same cascade and listed by EPRS as certain.

A8.2.2 Specific Candidates: Thermal Plants

Table A8.5 Specific Candidates: Thermal Plants

Plant Name	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Earliest available year	Overnight Cost (€/kW)
Banja Luka	135	Lignite	30	2010	731
Ugljevik II	300	Brown coal	30	2012	914
Gacko II	300	Lignite	30	2019	1,033
Tuzla VI – unit 7	370	Lignite	30[1)]	2010	1,500
Tuzla B	500	Brown coal	30[1)]	2011	2,000
Kakanj VI – unit 8	230	Brown coal	30[1)]	2015	1,500
Kamengrad	2x215	Brown coal	30[1)]	2015	2,000
Kongora	2x275	Lignite	30[1)]	Unknown	1,703

1. *These values are based on the generic plants presented on Section 2.8.7*

There is no information on any other plants and it is assumed that these are the only thermal plants under consideration in Bosnia and Herzegovina. Banja Luka is a CHP plant. Banja Luka, Ugljevik II and Gacko II have been listed as certain by EPRS

Construction of a new thermal plant Miljevina installed capacity of 110 MW is expected in the period after 2020 year.

A8.2.3 Rehabilitation

Table A8.6 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
Gacko	300	2007	2008	2008	2009	300	After 2020
Ugljevik	300	2009	2010	2010	2011	300	After 2020
Tuzla 3	100	2001	2002	2002	2003	100	After 2020
Tuzla4	200	2001	2002	2002	2003	200	After 2020
Tuzla5	200	2004	2005	2006	2007	200	After 2020
Tuzla6	215	2005	2006	2007	2008	215	After 2020
Kakanj5	110	2002	2003	2004	2005	110	After 2020
Kakanj6	110	2008	2009	2009	2010	110	After 2020
Kakanj7	230	2003	2004	2005	2006	230	After 2020

A8.3 BULGARIA

A8.3.1 Specific Candidate Hydro Projects

Bulgaria has rather modest hydro potential. Most of the hydro potential is located in 6 hydro cascades located in the highest mountain ranges. The Belmeken-Sestrimo cascade and Iskar cascade are located in the Rila Mountains; the Vacha cascade, Batak cascade, and Arda cascade in the Rodopi mountains. Other cascades are at Iskar, in the Rila Mountains, and Sandanska Bistritsa, in the Pirin mountains. The most economic hydro projects in these hydro cascades have already been developed. Currently, several projects are considered as candidates for potential future construction. The most probable projects to be developed are Gorna Arda (installed capacity 156 MW, average annual generation 537 GWh). Tzankov Kamak (80 MW, 198 GWh) is already under construction and is expected to be on line in 2009. The candidate hydro projects shown in the following table have been included in the major recent energy studies.

Table A8.7 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
HPP Gorna Arda	156	537	122,419	815	4	2011
HPP Tzankov Kamak[1)]	80	198	91,790	1,147	7	2009

NOTE: 1. Under construction

A8.3.2 Specific Candidates: Thermal Plants

Based on the information provided by NEK, the following candidates for new electricity generation sources have been adopted:

- New lignite fired thermal units with a single capacity of 300 MW;
- New nuclear capacities;
- New natural gas fired capacities with steam-gas cycle and single capacity of 250 MW and 500 MW

The candidate new thermal power plants burning domestic or imported coal were assumed to be equipped with FGDs for SO_2 control in the studies.

Table A8.8 Specific Candidates: Thermal Plants

Plant Name	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
TPP Domestic Lignite	300	Domestic Lignite	30[1)]	4	1,013[1)]
TPP Single Shaft (CCGT)	300	Natural Gas	20[1)]	2.5[1)]	579[1)]
TPP Single Shaft (CCGT)	500	Natural Gas	20[1)]	3.0[1)]	483[1)]
Belene NPP Unit 1	1000	Nuclear	40	N/A	1,361

1. *These values are based on the generic plants presented on Sections 2.4 and 2.8.7.*

A8.3.3 Power Plant Rehabilitation

Bulgaria has developed a rehabilitation program for the thermal units on the power system. This programme is presented in the following table.

Table A8.9 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
TPP Maritsa East 3 Unit 1	210	2005	2006	2006	2007	214	After 2020
TPP Maritsa East 3 Unit 3	210	2004	2005	2005	2006	214	After 2020
TPP Maritsa East 3 Unit 4	210	2006	2007	2007	2008	214	After 2020
TPP Maritsa East 2 Unit 1	150	2004	2005	2005	2006	169	After 2020
TPP Maritsa East 2 Unit 2	150	2005	2006	2006	2007	1690	After 2020
TPP Maritsa East 2 Unit 3	150	2006	2007	2007	2008	169	After 2020
TPP Maritsa East 2 Unit 4	150	2007	2008	2008	2009	169	After 2020
TPP Maritsa East 2 Unit 5	210	2008	2009	2009	2010	210	After 2020
TPP Maritsa East 2 Unit 6	210	2007	2008	2008	2009	210	After 2020
TPP Bobov Dol 1	210	2008	2009	2009	2010	223	After 2020
TPP Bobov Dol 2	210	2009	2010	2010	2011	223	After 2020
TPP Bobov Dol 3	210	2010	2011	2011	2012	223	After 2020
TPP Varna 1	210	2008	2009	2009	2010	218	After 2020
TPP Varna 2	210	2009	2010	2010	2011	218	After 2020
TPP Varna 3	210	2010	2011	2011	2012	218	After 2020

Table A8.9 Rehabilitation Program – Thermal Plants (Cont.)

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
TPP Varna 4	210	2011	2012	2012	2013	218	After 2020
TPP Varna 5	210	2012	2013	2013	2014	218	After 2020
TPP Varna 6	210	2013	2014	2014	2015	218	After 2020
TPP Ruse 1	30	2008	2009	2009	2010	30	After 2020
TPP Ruse 2	30	2009	2010	2010	2011	30	After 2020
TPP Ruse 3	110	2004	2005	2005	2006	110	After 2020
TPP Ruse 4	110	2007	2008	2008	2009	110	After 2020
TPP Ruse 5	60	2010	2011	2011	2012	50	After 2020
TPP Ruse 6	60	2011	2012	2012	2013	50	After 2020

A8.4 CROATIA

Information on candidate plants is taken from the HEP report "The Needed Development of New Power Plants and Facilities in the Republic of Croatia in the Period 2001 – 2020 (Master Plan), November 2001".

A8.4.1 Specific Candidate Hydro Projects

Some 192.86 MW of hydro capacity is realizable representing an annual energy provision of 703GWh, but construction costs are generally expensive and may not be competitive compared with other hydro schemes within the region. The one exception to this is Senj, which although competitive on a €/kW basis, does not have a high-energy output and would need to be used as a peaking station.

No information has been given within the report on planning or construction periods, but given information for similar schemes in other countries it might be expected that appropriate studies, planning consent and building would take a minimum of 7 years leading to the earliest availability in 2012.

Following discussions with HEP, Novo Virje and Senj 2 have been removed from the list of plants used in the study.

Table A8.10 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period[1)] (Years)	Earliest Available Year
			€ '000	(€/kW)		
Lešće	40.1	94	80,000	1,995	7	2012
Podsused	43	215.2	150,000	3,488	7	2012
Drenje	39.3	185.2	125,000	3,181	7	2012
Krcic	7.86	37.1	30,000	3,817	7	2012
Ombla	63	171.8	80,000	1,270	7	2012
Kosinj	22	116.7	77,790	3,536	7	2012

1. Estimated value. Includes for studies, planning and building

A8.4.1.1 HPP Podsused

Hydro power plant Podsused will use the waters of the Sava River. Its location is upstream from Zagreb, just before the mouth of river Krapina into Sava. It would be a multipurpose hydropower establishment. Except for electricity generation, it would provide flood protection for both riverbanks, improve the economical features of some water supply sources and facilitate leisure industry.

A8.4.1.2 HPP Drenje

Hydro power plant Drenje is the third power plant along the Sava River (in Croatia). It is a hydro power plant of multipurpose character similar to those given above.

A8.4.1.3 HPP Lešće

Hydro power plant Lešće is another plant using the waters of Gojačka Dobra. Upstream is hydro power plant Gojak which has been in service for many years (using waters of Ogulinska Dobra and Zagorska Mrežnica).

A8.4.1.4 Hydro power plant Krčić

Hydro power plant Krčić is a derivation-type energy facility, placed at the source of Krka nearby Knin.

A8.4.1.5 HPP Ombla

Hydro power plant Ombla would be a multipurpose unit. By its design, the dam, reservoir and engine room would be laid under ground. In addition to electricity generation its construction would allow better water supply for the neighbouring tourist area, while long distance transport of water is also under consideration.

A8.4.1.6 Reservoir system Čaprazlije

Reservoir system Čaprazlije would consist of establishments situated at Livanjsko Polje. Their purpose would be to bring waters to hydropower system Orlovac and to increase electricity generation. The construction of the Čaprazlije reservoir system would enable the potential generation to increase by 115.2 GWh, but would require an investment of 39.2 $ M. This will not increase generation peak capacity but would increase overall energy supplies.

A8.4.2 Specific Candidates: Thermal Plants

It is understood that the Croatian State Parliament has passed a Decision that no more coal fired thermal power plants would be built in Croatia, or considered.

Within the Master Plan report, there are no specific thermal candidate plants listed. However, a number of non-specific coal and gas candidate plants are listed and two are described here. The use of gas for electrical generation is dependent on the construction of appropriate pipelines and/or adequate terminal facilities for the importation of LNG.

Table A8.11 Specific Candidates: Thermal Plants

Plant Name	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
Conventional Boiler	600	Hard Coal	30	5	1,300
CCGT	300	Natural Gas	20	3	680

A8.4.3 Rehabilitation

At present there is no specified plan for rehabilitation of existing thermal power plants. For that reason, Electric Power Industry of Croatia proposed a shutdown scenario. This scenario is based on the idea that thermal plants should operate for 35 to 40 years after which they would be retired from the system, and their locations taken into account as potential sites for new TPP units. According to this scenario all existing units will be decommissioned between 2009 and 2015, except unit 2 at TPP Plomin, unit 4 at CHP Zagreb (new unit) and gas fired units at CHP Zagreb, which will operate beyond 2020.

For all existing plants to be decommissioned before 2020, desulphurization and other environmental protection measures relating to emission limits under EU Directive 2001/80/EC will not be applied. They will operate in compliance with Article 4 of the Directive.

A8.5 Macedonia

A8.5.1 Candidate Hydro Projects

The total technically usable hydroelectric potential of all rivers in Macedonia is estimated at about 5,500 GWh per year. However, some of this energy potential cannot be economically utilized and, therefore, will never be developed. Most of the potential new hydro projects that are considered as candidates for construction in the period until 2020 are located in the drainage area of the Vardar river, the largest river in Macedonia. These projects include the reservoir Lukovo Pole, hydro power plants Gradec, Cebren, Galiste, Veles, and a number of small hydro power plants in the Vardar Valley. In addition, there is a candidate hydro project Boskov Most located on the River Mala in the water basin of the River Crn Drim. The main characteristics of the selected hydro plants are shown in Table A8.1 and a brief summary of each candidate project is presented below.

Table A8.12 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
Spilje 2 (new unit at HPP Spilje)	73	33.0	35,022	480	2.5	2009
Boskov Most	45	152	45,000	1,000	4	2010
Storage Lukovo Pole	--	115.0	35,590	--	4	2010
Gradec	55	245	156,781	2,850	4	2010
Matka 2	35	45	39,420	1,126	4.5	2009
Cebren revers	156	165	158,496	1,016	6	2012
Skocivir	46	108	50,000	1,087	4	2010
Veles	93	300.6	251,131	2,700	7	2012
Galiste	193	262.5	200,541	1,037	7	2012

A8.5.1.1 HPP Boskov Most

The candidate hydro project Boskov Most (70 MW) is located on the River Mala, in the water basin of the River Crn Drim. The expected average annual electricity generation is 126 GWh. HPP Boskov Most is designed to have a nominal head of 365 m and a maximum turbine flow of 22 m^3/s. The investment cost for the construction of HPP Boskov Most is estimated at EUR 70 million, and the construction period at 4 years.

A8.5.1.2 HPP Gradec

The location of the proposed HPP Gradec (54.6 MW) is on the River Vardar, about 30 km north of the Macedonian-Greek border. The expected average annual generation amounts to 252 GWh. HPP Gradec would have a reservoir with a maximum storage capacity of 108 hm^3, and an operational storage of 43 hm^3. The investment cost for construction of HPP Gradec is estimated at EUR 156.8 million, and the construction period at 4 years.

A8.5.1.3 HPP Veles

HPP Veles (93 MW) would also be located on the River Vardar, upstream of the HPP Gradec. The projected annual average generation of HPP Veles is estimated at 300 GWh. The designed maximum storage capacity is 191 hm^3 with an operational volume of 64 hm^3. Its total investment cost is estimated at € 251.0 million, and the corresponding construction period at 7 years.

A8.5.1.4 Storage Lukovo Pole

Lukovo Pole is envisioned as an additional reservoir in the Mavrovo hydroelectric system in western Macedonia. The Mavrovo system consists of three hydro power plants: Vrben (12.8 MW), Vrutok (150 MW), and Raven (19.2 MW). While Vrben and Raven are run-of-river HPPs, Vrutok has storage with significant regulating capabilities (Lake Mavrovo, with a maximum storage capacity of 357 hm3). The Lukovo Pole reservoir would not have an associated power plant, but would rather provide additional storage for the three downstream power plants in the Mavrovo system. It would also help reduce water spillages that usually occur in the spring.

Lukovo Pole would provide additional water inflows of 68 hm3 per year for the Mavrovo system. These additional water quantities would be collected at the high altitude areas of the Korab Mountain (1,600 m above sea level) and diverted into the Lukovo Pole reservoir and further down to the Mavrovo system. Without Lukovo Pole this water would belong to the Crn Drim River drainage area. However, with Lukovo Pole it would be diverted into the Vardar River drainage area.

The additional inflows would provide an average annual increase in electricity generation in the Mavrovo system of 115 GWh per year, with 22 GWh at HPP Vrben, 83 GWh at HPP Vrutok, and 10 GWh at HPP Raven. On the other hand, the reduced inflows in the Crn Drim River drainage area would have an impact on the generation of the HPP Spilje. The annual electricity generation of HPP Spilje would decrease by 12 GWh.

The total investment cost for the construction of the storage Lukovo Pole is estimated at EUR 35.6 million, and the required construction time at 4 years.

A8.5.1.5 HPP Cebren

The location of the candidate HPP Cebren is on the River Crna, upstream of the existing HPP Tikves and upstream of the candidate HPP Galiste. There are two alternatives designs for the HPP Cebren: (1) a low dam -- 90 m; and (2) a high dam --192.5 m alternative. The low-dam alternative would have an installed capacity of 148.5 MW and an average annual electricity production of 165 GWh. The high-dam alternative would have an installed capacity of 253.8 MW and an average annual generation of 292 GWh.

The low-dam alternative would also include the candidate hydro project Skocivir (46 MW), which would be located immediately upstream of HPP Cebren, thus fully utilizing the hydraulic potential of the Crna river. The expected annual electricity generation of HPP Skocivir is 104 GWh.

A8.5.1.6 HPP Galiste

The location of the proposed HPP Galiste (193.5 MW) is on the Crna river, upstream of the existing HPP Tikves and downstream of the candidate project Cebren. The expected average annual generation is 257 GWh. HPP Galiste would have a maximum storage capacity of 344 hm3 and an operational volume of 260 hm3. The investment cost is estimated at EUR 200.2 million, and the construction period would last 7 years.

A8.5.1.7 HPP Spilje 2

There is a possibility of increasing the capacity of the existing HPP Spilje (84 MW), located on the River Crn Drim, by constructing an additional generating unit and a penstock. The capacity of the new unit would be 72.8 MW, thus bringing the total plant capacity to 156.8 MW. The corresponding increase in annual electricity production is estimated at 33 GWh. The investment costs for the candidate project Spilje 2 are estimated at EUR 35 million, and the construction period at 2.5 years.

A8.5.1.8 HPP Matka 2

Hydropower project Matka 2 (33.2 MW) is situated on the River Treska, which is a tributary to the River Vardar. The location of HPP Matka 2 would be just upstream of the existing HPP Matka. The projected average annual generation of HPP Matka 2 is estimated at 53 GWh. It was designed as a multi-purpose project with mandatory water releases from the reservoir amounting to 249.1 hm^3 per year. This water would not be available for electricity production. Mandatory water releases from the Matka 2 reservoir would amount to about 40% of the total annual water inflows into the reservoir (average annual inflows are estimated at 635 hm^3). The construction costs for HPP Matka 2 are estimated at U.S.$39.4 million, and the construction period at 4.5 years.

A8.5.2 Specific Candidates: Thermal Plants

The technical and economic data for the thermal candidate units are presented in the following table. The new coal-fired units are assumed to be equipped with electrostatic precipitators (ESP) and flue gas desulfurization (FGD) pollution control equipment.

Table A8.13 Specific Candidates: Thermal Plants

Generation Type	Potential Sites	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
Bitola 4	Bitola Site	225	Imported Lignite	30	5	959
Negotino	Negotino Site	250	Gas	25[1)]	2.5[1)]	579[1)]
Cogeneration	--	200	Gas	25[1)]	3	487
GT	--	65	Gas	15[1)]	1.5[1)]	341[1)]
GT	--	125	Gas	15[1)]	1.5[1)]	297[1)]
CCN	--	250	Gas	20[1)]	2.5[1)]	579[1)]

1. *These values are based on the generic plants presented on Sections 2.4 and 2.8.7.*

A8.5.2.1 Bitola 4 Candidates

The Bitola plant was originally designed to house four generating units. As there are only three generating units presently operating at this site, there is space available for a fourth generating unit. Since all the necessary infrastructure already exists at this location, it was estimated that the investment costs for the fourth unit would be about 10% lower than if the unit were constructed at a completely new site. However, as the existing coal reserves at Suvodol and Brod-Gneotino are not sufficient to supply the fourth generating unit during its economic lifetime, other fuel supply options have to be considered. Two options were selected as the most promising ones:

Lignite-fired unit based on lignite imported from Greece; and

Natural gas combined-cycle unit

Both options assume the same unit size (225 MW) as that of the existing generating units at TPP Bitola.

In the lignite-fired option, the electricity generating equipment would be the same technology type as for the existing Bitola generating units. However, even though the current environmental regulations in Macedonia do not require installation of FGD equipment, it was considered that all new coal-fired units will have, in addition to the electrostatic precipitator (ESP), a wet FGD system installed. Consequently, the operational and investment costs and characteristics of this candidate unit were adjusted accordingly for the system expansion analysis.

Another alternative is the replacement of the existing thermal generating units at Bitola with combined cycle units. The main assumption was that after retirement of the three lignite-fired units at Bitola, the existing location could be used for the construction of 2 combined cycle units with a net capacity of 348 MW each.

A8.5.2.2 Candidate Cogeneration Plants

A new cogeneration plant is being considered to supply heat and power to the city of Skopje. A feasibility study by Stork Engineers and Contractors B.V. has analyzed several possible options for the installation of a combined heat and power (CHP) plant in Skopje [Stork, 1998]. Stork recommended an electric power driven option with the principal purpose of providing electric power supply during the whole year, with additional heat supply for the residential district heating system produced during the winter. The recommended CHP plant would be based on a natural gas-fired combined cycle technology with a unit size of 180-200 MWe.

A8.5.2.3 Gas-Fired Thermal Candidates

Macedonia does not have any oil reserves and the reserves of coal and lignite are quite limited. At present, there is a significant natural gas supply available through a pipeline from Ukraine and Russia via Romania and Bulgaria. There are also plans to build new pipelines in the future and a gas distribution network.

Several gas-fired candidate technologies were considered as possible candidates for electric power system expansion. These included simple cycle gas turbines with installed unit capacity of 65 MW and 125 MW, and combined cycle generating units with capacities of 225 MW and 360 MW.

A8.5.3 Rehabilitation

Electric Power Industry of Macedonia plans to rehabilitate all lignite fired TPP units during the period 2010 to 2020. The complete scheme is presented in Table A8.14. In the case of Bitola units 1 and 2, the rehabilitation considers the option to convert the units to a combined cycle, using gas as a fuel instead of lignite. This modification would allow an increase to the installed capacity of the units. A similar alternative is presented for Negotino. All the rehabilitation works consider the installation of FGD in order to reduce the sulphur dioxide emissions, which currently value is in the range from 1,500 – 2,300 mg/m^3. According with the information received, primary measures would be applied for NOx emission reduction.

The third TPP Negotino, 1x210 MW, constructed to use fuel oil or gas, has not been in operation for some considerable time. There is no fixed plan for it to be used further, although work to consider rehabilitation or a change of fuel to coal from a local underground mine is underway. Some of the rehabilitation works proposed consist of fuel conversion from oil to coal or gas. In the event that the gas option is selected, the plant would be converted to a combined cycle with an additional capacity increment. The latter option has been considered as a candidate plant.

Sulphur dioxide emissions are in the range from 1500 – 2300 mg/m^3 and there is no plan for FGD installation. Primary measures will be applied for NOx emission reduction. Also reconstruction of electrostatic precipitators is planned, but the schedule is not defined, yet.

Table A8.14 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
Bitola 1	225	2012	2013	2014	2015	225	After 2020
Bitola 2	225	2014	2015	2016	2017	225	After 2020
Bitola 3	225	2018	2019	2019	2020	207	After 2020
Negotino	210	2008	2009	2010	2011	210	After 2020
Oslomej	120	2010	2011	2012	2013	120	After 2020

A8.5.3.1 Bitola Rehabilitation

At present there are three generating units in operation at TPP Bitola. All three units are lignite-fired and were commissioned in 1982, 1984 and 1988, respectively. The installed capacity of each unit is 225 MW and they are fueled by lignite from the nearby Suvodol coal mine. Suvodol is an open-pit mine equipped with three coal extraction systems (excavator, conveyer, spreader) that supply lignite to the generating units. Each generating unit consumes about 2 million tonnes of lignite per year.

The remaining quantity of lignite reserves in Suvodol mine at the end of 1999 was estimated at 55 million tonnes. An additional quantity of about 50 million tonnes of lignite can be extracted from the underlying seam, which can be utilized after the upper reserves have been exhausted.

This expansion option, which is usually referred to at ESM as "the rehabilitation of generating units at TPP Bitola," aims at fully utilizing the site of the existing TPP Bitola and the remaining lignite reserves. This expansion option assumes that after the expiration of their economic lifetime (30 years of operation), the generating units at Bitola will be retired and most of their electro-mechanical equipment replaced with new equipment. This process of taking old equipment out and installing new equipment is estimated to take about two years for each unit. It would include replacement of the boiler, turbine, generator, transformer, lignite supply system, and all other auxiliary systems and equipment, as necessary. Thus, the newly installed generating units at the existing site would have an estimated economic lifetime of 25 years. As the sulfur content of the Suvodol and Brod-Gneotino lignite is relatively low (about 0.5%), it would not be necessary to retrofit these units with flue gas desulfurization equipment (FGD) during their rehabilitation.

The retirement of unit Bitola 1 is scheduled for the end of 2012. If the rehabilitation work is performed in 2013 and 2014, the new unit could operate from the beginning of 2015 until the end of 2039. Similarly, generating units Bitola 2 and 3 are expected to retire at the end of 2014 and 2017, respectively. The rehabilitation work for Bitola 2 would be performed in 2015 and 2016 and for Bitola 3 in 2018 and 2019.

The existing coal reserves at the Suvodol open-pit mine will not be sufficient to provide enough lignite for the operation of TPP Bitola after the rehabilitation. In this regard, there are several alternatives that are being considered. They include the opening of the new Brod-Gneotino lignite mine, the use of heavy fuel oil to partially replace lignite, the importing of lignite from Greece, and the exploitation of the underlying seam in the Suvodol mine. These four main alternatives were considered in an earlier analysis and the results showed that the least-cost alternative is the rehabilitation of each existing unit and the transfer a part of the extraction equipment from the Suvodol mine to the Brod-Gneotino mine and purchase new extraction equipment to commence operation of that mine in 2009.

A8.5.3.2 Negotino Rehabilitation

TPP Negotino has been in operation since 1978. It has one heavy oil fired generating unit of 210 MW of installed capacity. For a long time the plant has been ’a cold reserve’ in the Macedonia Power System, due to the lower profitability of the electricity production based on heavy oil. Similar to the rehabilitation of generating units at TPP Bitola, there is a possibility to replace all major equipment at TPP Negotino, specially the boilers, and convert the unit to use lignite as primary fuel. The lignite coal reserves are located near to the power plant (2.3 km), and the estimated reserves are 105 mill tons. This conversion to lignite was selected as a possible option for rebuilding the Negotino generating unit. The construction period for mine opening would be 3-4 years and the project is estimated at EUR 100 million.

A8.5.3.3 Oslomej Rehabilitation

TPP Oslomej has been in operation since 1980. It has one lignite-fired generating unit of 120 MW of installed capacity that is supplied with fuel from the nearby Oslomej coal mine. The lignite reserves in the region will be sufficient only until 2014, which is the end of the 35-year economic lifetime of the generating unit. Similar to the rehabilitation of generating units at TPP Bitola, there is a possibility to replace all major equipment at TPP Oslomej and convert the unit to use heavy fuel oil as primary fuel. This conversion to fuel oil was selected as a possible option for rebuilding the Oslomej generating unit after its retirement in 2014. It would be performed in 2015 and 2016, and would provide an additional economic lifetime of 25 years. The cost of this conversion for the unit size of 120 MW was estimated at U.S.$78.4 million.

As another alternative a possibility to open new lignite mine at the location Popovjani, near to the TPP Oslomej, with presumed coal reserves of 10-12 mill tons, was considered. These reserves will be sufficient for 10-12 years of plant operation.

A8.6 MONTENEGRO

A8.6.1 Specific Candidates: Hydro Projects

The total exploitable hydroelectric potential of all rivers in Montenegro is estimated at about 6,952 GWh per year of which 1,861 GWh has already been utilized. The fully exploited capacity represents a peak total capacity of 2,675 MW and utilizes the potential of the Moraca, Zeta, Piva, Tara, Lim, Cehotina and Ibar rivers. Zeta and Piva already have hydro generation schemes on them. Additional hydro potential can be realized by inserting additional plant into existing cascades, diversion of water flows and opening up of completely new river resources. These projects will necessitate building a number of dams and diverting the Tara river into the head of the Moraca river to provide a significant head for generation at Kostanica.

The hydrology of all the candidate generators is particularly complex as the water flows in all power plants are related to each other by inflows from various tributaries. The rivers Tara, Piva, Cehotina, Uvac and Lim all feed into the river Drina at some point. Some water is extracted from the river Tara to be fed to Kostanica on the River Moraca, but this does not prevent further power plant being located at lower levels on the river Tara.

Table A8.15 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
TARA RIVER DIVERSION						
Kostanica	552	1120	265,900	482	5	2013
MORACA RIVER						
Andrijevo	2 x 63.7 3 x 63.7	319 517	154,600 159,300[2)]	1214 833*	6	2014
Raslovici	2 x 18.5 3 x 18.5	107 154	48,700 51,800[2)]	1317 934*	6	2014
Milunovici	2 x 18.5 3 x 18.5	117 156	48,300 51,300[2)]	1305 925*	6	2014
Zlatica	2 x 18.5 3 x 18.5	151 200	58,000 63,600	1566 1145	6	2014
TOTAL	238 357	694 1027	306,500 326,600	1288 915	6	2014

Table A8.16 Specific Candidates: Hydro Projects (Cont.)

TARA RIVER						
Tepca[1), 3)]	352	900	288,900	821	7	2015
Ljutica[3)]	250	528	231,100	928	6	2014
PIVA RIVER						
Komarnica	2x84	232	95,500	568	7	2014

1. *There are no hydro conditions for this plant. Hydro conditions are defined base on the energy/power production during an average (p=55%), wet (p=20%) and dry (p=25%) year.*
2. *Cost to build all 3 sets*
3. *Tepca and Ljutica are options - only one of them is going to be built*

A8.6.1.1 HPP Kostanica

The candidate hydro project Kostanica is located at the head of the river Moraca with water storage provided by two dams on the Tara river at Zuti Krs and Bakovica Klisura. This is then diverted by a tunnel into the Moraca river. The maximum net head is 706m with a useful reservoir capacity of 205M m^3.

A8.6.1.2 HPPs Andrijevo, Raslovic, Milunovici, Zlatica

This candidate project consists of four hydro power plants in cascade. The figures above are for possible two or three machines at each station. Two machines could be installed initially with a third one added later. HPP Andrijevo has by far the largest storage with a reservoir of 304 M m^3, which is fed from Kostanica. The other power plants have small water storage and rely on feed from the previous station in the cascade.

A8.6.1.3 HPP Tepca and HPP Ljutica

These are alternative schemes. HPP Tepca has a higher electrical rating and substantially more water storage than HPP Ljutica (1000 M m^3 compared with 310 m^3). HPP Tepca must be seen as the preferred candidate unless longer build times and a larger effect on the environment are over riding considerations.

A8.6.1.4 HPP Komarnica

This candidate project is higher on the Piva river than the existing Piva power plant and, therefore, the flows in both would be related. HPP Komanica would have a head of 153.4 m and an installed flow rate of 130 m^3/s. The useful reservoir capacity would be 160 M m^3.

A8.6.2 Specific Candidates: Thermal Plants

The technical and economic data for modeling the thermal candidate units are presented in the following table. Only a single candidate exists and is assumed to be equipped with electrostatic precipitators (ESP) and flue gas desulfurization (FGD) pollution control equipment.

Table A8.17 Specific Candidates: Thermal Plants

Generation Type	Potential Sites	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
Pljevlja II	Pljevlja	210	Lignite	30[1)]	3	751[1)]

1. *Based on a capital cost of 157.7 M€ and output of 210MW*
2. *These values are based on the generic plants presented on Sections 2.4 and 2.8.7.*

Discussions with EPCG staff during the second technical visit suggested that there is no other serious contender as a specific thermal candidate plant.

A8.6.3 Rehabilitation

Montenegro has only one TPP, TPP Pljevlja, 210 MW. In 2001 it was reconstructed and there are no plans for further rehabilitation before 2020.

There is a plan for reconstruction of ESP, for application of primary measures for NOx emission reduction and FGD installation by 2011.

A8.7 ROMANIA

The candidate plant are derived from Road Map report and include hydro and thermal plant as well as the retirements.

The "Road Map for the Energy Sector of Romania" report considers the following hierarchical order of projects for consideration in terms of their efficiency to meet the demand and energy requirements as well as reducing dependence on imported energy resources.

- Generator unit 2 (707 MW) and later on unit 3 (707 MW) at Cernavoda Power Plant.
- Additional economically feasible hydropower generation capacity estimated at 500-900 MW. (NB: The report also mentions some 21 hydro candidate plants in total but we assume only the most financially attractive projects have been included in the road map.)
- Power generation based on lignite and hard coal through rehabilitation of some of the existing power, where upgrading costs are less than 50% of that for a new capacity and/or new units, at the following locations: Turceni, Rovinari, Isalnita, Deva-Mintia. The rehabilitation projects could represent 35-45% of the total new power generation capacity.
- Only 15% of the total power generation to be secured from natural gas using high efficiency combined cycle gas turbines (CCGT).

A8.7.1 Specific Candidates: Hydro Projects

Table A8.18 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
New Hydro 1 1)	200	200	251,250	1256	5	2008-2010
New Hydro 2 1)	200	200	215,250	1256	5	2011-2015

1. There are no hydro conditions for this plant. Hydro conditions are defined based on the energy/power production during an average (p=55%), wet (p=20%) and dry (p=25%) year.

A8.7.2 Specific Candidates: Thermal Plants

Table A8.19 Specific Candidates: Thermal Plants

Generation Type	Potential Sites	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
CCGT Cogeneration	Bucuresti Sud	2x100	Gas	25[1]	3	413
CCGT Cogeneration	Bucuresti West	2x100	Gas	25[1]	3	413
CCGT	N/A	500	Gas	20[1]	3[1]	483[1]
CCGT	N/A	300	Gas	20[1]	3[1]	579[1]
TPP	Rovinari	330	Lignite	30	3	913
TPP	Doicesti with Atmospheric Fluidized Bed	150	Lignite	30	3	1,089
TPP	Isalnita with Atmospheric Fluidized Bed	250	Lignite	30	3	955
Lignite Subcritical	N/A	300	Lignite	30	4	1013
Lignite Supercritical	N/A	500	Lignite	30	4	1072
Coal Supercritical	N/A	500	Coal	30	4	908
Nuclear Unit 2	Cernavoda	707	Nuclear	40[1]	3	813
Nuclear Unit 3	Cernavoda	707	Nuclear	40[1]	3	1,421
Nuclear Unit 4	Cernavoda	707	Nuclear	40[1]	3	1,481
Nuclear Unit 5	Cernavoda	707	Nuclear	40[1]	3	1,540

1. These values are based on the generic plants presented on Sections 2.4 and 2.8.7.

A8.7.3 Rehabilitation

Table A8.20 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
Turceni Unit 3	330	2008	2009	2010	2011	300	After 2020
Turceni Unit 5	330	2004	2005	2006	2007	300	After 2020
Turceni Unit 6	330	2006	2007	2008	2009	300	After 2020
Rovinari Unit 3	330	2005	2006	2007	2008	300	After 2020
Rovinari Unit 5	330	2008	2009	2010	2011	300	After 2020
Isalnita Unit 7	315	2006	2007	2008	2009	315	After 2020
Paroseni Unit 4	150	2007	2008	2008	2009	150	After 2020
Palas Unit 1	50	2005	2006	2006	2007	50	After 2020
Galati Unit 3	105	2006	2007	2007	2008	105	After 2020
Galati Unit 4	60	2008	2009	2009	2010	60	After 2020
Galati Unit 5	105	2011	2012	2012	2013	105	After 2020
Galati Unit 6	105	2012	2013	2013	2014	105	After 2020
Deva Unit 1	210	2005	2006	2006	2007	210	After 2020
Deva Unit 2	210	2006	2007	2007	2008	210	After 2020
Deva Unit 4	210	2008	2009	2009	2010	210	After 2020

A8.8 SERBIA

A8.8.1 Specific Candidates: Hydro Projects

Table A8.21 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
Ribarići	47	78	95,475	2,031	5	2010
Bovan	2.3	7	1,884	819	2	2006
Svodje	48	65	73,700	1,535	5	2011
Vrutci	32	45	49,413	1,544	4	2009
Brodarevo	50	207	117,250	2,345	5	2010
Ćelije	4	12.6	2,513	628	2	2006
PS Bistrica	4x175	till 1,000	715,225	1,000	6	2012

1. *Svodje and Ribarići are storage HPPs.*
2. *Brodarevo is run-of-river HPP.*
3. *Vrutci is a multi-purpose reservoir, also used for water supply.*
4. *PS Bistrica is pumped storage HPP with weekly levelling and its annual production depends on the manner of commitment.*
5. *Bovan and Ćelije are small HPPs that would be built on the sites of the existing reservoirs and where construction activities have been performed. These are multipurpose reservoirs and they would also be used for water supply.*

A8.8.2 Specific Candidates: Thermal Plants

Table A8.22 Specific Candidates: Thermal Plants

Generation Type	Potential Sites	Installed Capacity (MW)	Fuel Type	Operating Life (year)	Const. Period (year)	Overnight Cost (€/kW)
Kolubara B[1)]	Kolubara	2x350	Lignite	30[1)]	4	611
TENT B3[1)]	TENT	620	Lignite	30[1)]	5	1,124
Kostolac B3	Kostolac	350	Lignite	30[1)]	5	1,175
Kolubara A6	Kolubara	200	Lignite	30[1)]	5	1,227
CHP Subotica	Subotica	250	Gas	25	2.5	N/A
CHP Beograd	Beograd	450	Gas	25	2.5	N/A
TPP A		600	Imported Coal	30[1)]	4	907
TPP B		450	Gas	25	3	483

1. *Kolubara B and TENT B3 are alternatives – only one of them is going to be built.*
2. *These values are based on the generic plants presented on Section 2.8.7.*

A8.8.2.1 Kolubara B

Construction has started and it was stopped, therefore it is anticipated that 700$/kW needs to be invested to complete construction. 500$/kW has been invested so far.

TENT B3 is based on the same coal as Kolubara B, therefore only one of these two TPPs can be built.

A8.8.2.2 Kolubara A6

This is the power plant that would use coal of low calorific value remaining after separation and drying. Fluidized bed combustion technology would be applied.

A8.8.2.3 CHP Subotica and CHP Belgrade

CHP Subotica and CHP Belgrade are combined power plants, which would also provide heat. Gas imported from Russia would be used as fuel. EPS consider that the current level of the Russian gas price is ca. 3.6 €/GJ.

A8.8.2.4 TPP A and TPP B

TPP A and TPP B are generic power plants based on imported coal (A) and gas (B). Sites would be determined according to the needs of electric power system and coal and gas supply possibilities. The price of imported coal would depend on the type of coal and transport requirements. Gas imported from Russia would be used as fuel at TPP B.

EPS has not provided overnight costs for CHP Subotica, CHP Belgrade, TPP A and TPP B.

A8.8.3 Rehabilitation

The Electric Power Industry of Serbia has defined plan of the rehabilitation of all coal fired TPP units, which will still be in operation in 2020. The rehabilitation of TPP Kostolac A unit 2, TPP N. Tesla A, unit 3 and TPP Kolubara A, unit 5 was completed before 2003. In the course of 2004, TPP N. Tesla A 3 and TPP Morava were rehabilitated. Between 2005 and 2010 all other units of TPPs N.Tesla A and Kostolac A will be rehabilitated.

In 2002 and 2003 the substantial reconstructions of all units of TPPs N.Tesla B and Kostolac B was completed and their rehabilitation is planned for 2011 to 2017.

The rehabilitation of CHPs Novi Sad and Zrenjanin is not planned before 2020. The plan is to modernize control systems in 2005 and 2006.

In the course of the rehabilitation of TPP N. Tesla B units, FGD plants will be installed. The installation of FGD plants at TPP Kostolac B will be implemented before rehabilitation in 2008 and 2009.

At all coal-fired plants, reconstruction of ESP will be completed and primary measures for NOx emission reduction will be applied in between 2004 to 2010.

Table A8.23 Rehabilitation Program – Thermal Plants

Plant Name	Installed Capacity (MW)	Retirement Date Dec 31	Rehabilitation				
			Start Jan 1	Finish Dec 31	Available Jan 1	Installed Capacity (MW)	Ret. Date Dec 31
Nikola Tesla A1	210	2008	2009	2009	2010	210	After 2020
Nikola Tesla A2	210	2009	2010	2010	2011	210	After 2020
Nikola Tesla A4	309	2005	2006	2006	2007	309	After 2020
Nikola Tesla A6	309	2006	2007	2007	2008	309	After 2020
Nikola Tesla B1	620	2010	2011	2011	2012	620	After 2020
Nikola Tesla B2	620	2012	2013	2013	2014	620	After 2020
Kolubrara 3	64	2004	2005	2005	2006	64	After 2020
Kostolac A1	100	2005	2006	2006	2007	100	After 2020
Kostolac B1	349	2014	2015	2015	2016	349	After 2020
Kostolac B2	349	2016	2017	2017	2018	349	After 2020
Novi Sad1	135	2004	2005	2005	2006	135	After 2020
Novi Sad1	120	2005	2006	2006	2007	120	After 2020
Zrenjanin	120	2004	2005	2005	2006	120	After 2020

A8.9 UNMIK

Significant work has been carried out and is reported in the Energy Sector Technical Assistance project for Kosovo, Module B Least Cost Power Generation Investment Program. All information on Kosovo is taken from this report.

A8.9.1 Candidate Hydro Projects

There is a single candidate project for hydro generation although, in reality, two stations would be constructed in a cascade. Although more than one option is considered the most probable parameters are as shown below.

Table A8.24 Specific Candidates: Hydro Projects

Hydro Candidate	Installed Capacity (MW)	Expected Annual Generation (GWh)	Investment Cost		Constr. Period (Years)	Earliest Available Year
			€ '000	(€/kW)		
Zhur	293	398	177,000	590	5[1)]	2013[1)]

1. Estimated data

A8.9.1.1 HPP Zhur

The Zhur HPP uses the stream coming from the Sharr mountains. Water abundance within this catchment area, feasible water storage on high elevations, and possible utilization of considerable concentrated head offer very favourable conditions for the construction of a significant hydro plant.

No figures for the construction period are available. An average figure for hydro project construction has been assumed together with an environmental and survey requirement of 3 years leading to an earliest available year of 2013.

A8.9.2 Specific Candidates: Thermal Plants

The above report cites a number of possible candidate generation plants although most are not specific, particularly in location. Based on information received from KEK and UNMIK personnel, only the building of a new Kosovo B3 has been was clearly identified, which will be fuelled by lignite from a new mine to be opened within the area.

Three possible sizes of plant for Kosovo B3 have been postulated and these are shown below. The parameters of each of these plants are listed, but this does not prevent installation of more than one of these units if it proves economic. Investment costs include the cost of equipment manufactured in compliance with environmental standards requirements.

The following table shows the specific candidates selected for the UNMIK system.

Table A8.25 Specific Candidates: Thermal Plants

Plant Name	Net Capacity (MW)	Fuel Type	Operating Life (year)	Earliest available year	Overnight Cost (€/kW)
Kosovo B3	180	Domestic Lignite	30[1)]	2010	1,089
Kosovo B3	220	Domestic Lignite	30[1)]	2010	1,069
Kosovo B3	300	Domestic Lignite	30[1)]	2010	994
TPP Domestic Lignite	300	Domestic Lignite	30[1)]	2010	1,069
TPP Domestic Lignite	500	Domestic Lignite	30[1)]	2010	994

1. *These values are based on the generic plants presented on Sections 2.4 and 2.8.7.*

A8.9.3 Rehabilitation

Rehabilitation of existing TPPs Kosovo A has not been planned by the KEK. Kosovo A Unit 1 is planned to be retired by end of 2006, and Kosovo A Units 3, 4 and 5 by end of 2010.