Generation Investment Study

Volume 5: Generation and Transmission Appendices

Appendix 12: Scenario A, B & C results

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A12.1 Scenario A Results

A12.1.1 Introduction

The analysis of alternative development options includes the preparation of three alternative generation expansion scenarios. The first scenario (Scenario A) consists of individual least cost plans for capacity expansion plans in each of the nine power systems, without the benefits of regional cooperation. The other two scenarios (Scenarios B and C), discussed in following sections of the report, include the benefits of regional cooperation and integration at various levels.

Scenario A is developed as a reference to compute the total net present value (NPV) of construction and operation costs within each jurisdiction over the study period of 2005-2020. The NPV sum for the nine individual jurisdictions is then compared to the NPVs of Scenarios B and C to evaluate the benefits of regional electric power planning and integration.

The WASP model is used to develop an expansion plan for each jurisdiction. Since Scenario A is only used for reference purposes, the expansion plans shown in the following pages are just an indication of least-cost plans. The plans are based on the medium load forecast and are developed from data provided by the utilities and other government agencies as presented in previous sections of this report as well as in Appendix 7: Country Data Profiles, and Appendix 8: Specific Candidate Plants.

The plans are based on the rehabilitation programs given by the utilities. No adjustments are made to the planned timing of rehabilitation. Rehabilitation costs were obtained from the utilities and reviewed and updated by the SEEC Environmental Team. Details of these costs are shown in Appendix 9 and in SEEC‘s report entitled “GIS – Implications for Investments in Environmental Protection”. Rehabilitation includes technical rehabilitation (life extension) and full environmental compliance (particulate, NOx and SOx controls) with EC regulations (Directive 2001/80/EC) for Romania and Bulgaria. For the other jurisdictions, rehabilitation includes technical rehabilitation and partial environmental compliance (particulate and NOx) for plants planned for rehabilitation.

In the following pages, Scenario A results are presented for each jurisdiction. First, screening curves, developed for the specific candidate plants to assist in running the WASP model, are presented. Then the results of the individual expansion plan are shown.

The Scenario A analysis is performed for the medium load forecast. The expected load forecast for each jurisdiction is presented in Tables 1 and 2.

Table 1: Medium Annual Peak Load Forecast (MW)

Jurisdiction	Year 2005	Year 2010	Year 2020
Albania	1,484	1,652	2,645
Bosnia & Herzegovina	1,863	2,076	2,855
Bulgaria	6,383	6,482	7,340
Croatia	2,817	3,290	4,448
Macedonia	1,360	1,373	1,946
Montenegro	616	620	682
Romania	7,372	7,950	11,418
Serbia	6,062	6,098	6,850
UNMIK	1,179	1,265	1,384
Total	**29,136**	**30,806**	**39,568**

Romania has the largest projected 2020 peak demand, followed by Bulgaria, Serbia, Croatia, BiH, Albania, Macedonia, UNMIK and Montenegro.

Table 2: Medium Annual Energy Forecast (GWh)

Jurisdiction	Year 2005	Year 2010	Year 2020
Albania	6,697	7,708	12,492
Bosnia & Herzegovina	10,448	11,886	16,428
Bulgaria	34,424	37,691	42,526
Croatia	16,396	19,157	25,907
Macedonia	7,121	7,759	10,985
Montenegro	3,608	3,632	3,984
Romania	49,627	53,518	76,864
Serbia	32,118	34,233	38,487
UNMIK	6,027	6,735	7,808
Total	**166,466**	**182,319**	**235,481**

In terms of energy demand, two-thirds of the total 2020 regional demand is consumed in Romania (33% of the total), Bulgaria (18%) and Serbia (16%).

Units already under construction or fully committed by the utilities are maintained in each of the jurisdictions' expansion plans. These units are shown in Table 3.

Table 3: Units Under Construction or Committed By Utilities

Jurisdiction	Unit Name	Net Capacity (MW)	First Year of Operation
Romania	Bucuresti Sud	100	2006
Romania	Bucuresti Sud	100	2007
Romania	Bucuresti West	100	2008
Romania	Bucuresti West	100	2010
Bulgaria	Maritsa East 1	2x275	2009
Albania	Vlora	132	2009
Total		**1,082**	

A12.1.2 Albania

Due to constraints in the limited number of candidate plants that can be analysed in WASP, all candidate plants used in each jurisdiction are compared to each other through the use of the screening curves method to select the most competitive candidates on a regional basis. The screening curve method expresses the total annualised electricity production cost for a generating unit, including all capital and operating expenses, as a function of the unit capacity factor. This approach is especially useful for comparative analyses of relative costs of different electricity generation technologies. Details of the methodology and results are presented in Appendix 9. The following candidate plants were retained for Scenario B:

The resulting screening curves of selected candidate plants for Albania are shown in Figure 1.

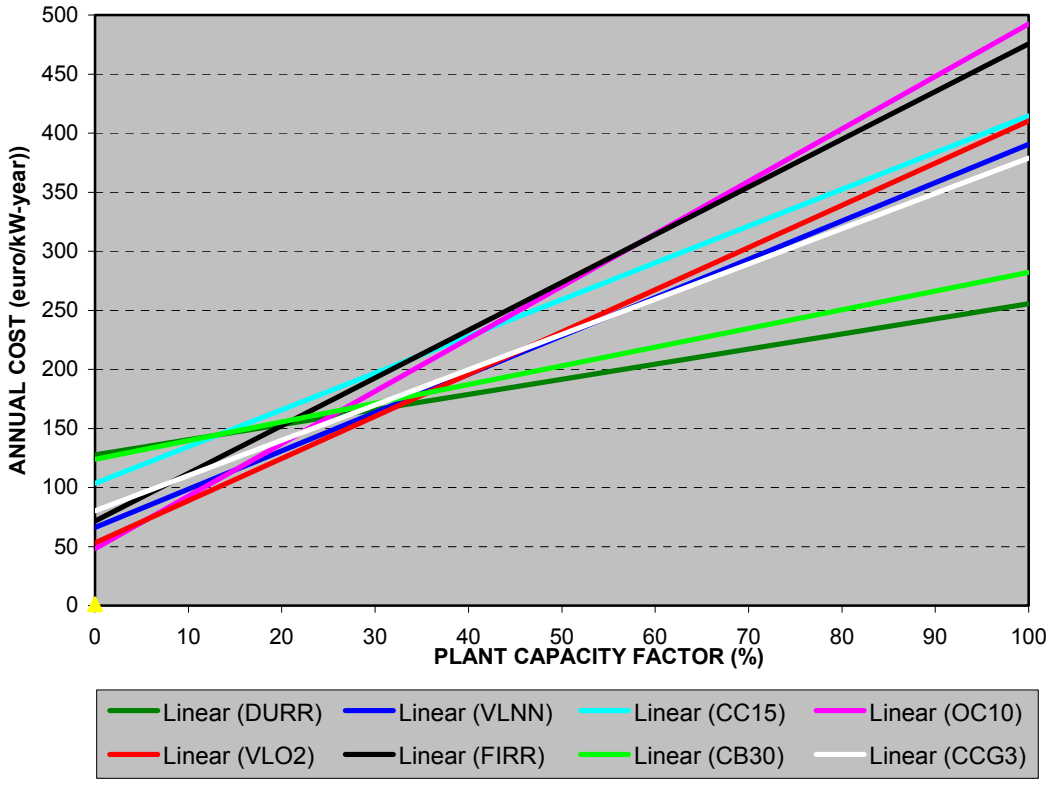

Figure 1: Albania Screening Curves

The total capacity of the plants planned for rehabilitation is 69MW. The investment cost is estimated at 31 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 4. In addition to the 69 MW of rehabilitated units, 1,746 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 132 MW that is already under construction or fully committed by the utility, as shown in Table 3. In addition, 217 MW of hydro power plants, 258 MW of CHP plants, and 1,271 MW of combined cycle gas-fired generation are added to the system.

The results show that, in the system, there is some deficit of existing capacity in the first 5 years (2005-2009) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2010 and thereafter.

In addition to the plants shown in Table 3, WASP results show that, for the period 2005-2010, the following new capacity are added to the power system of Albania:

- Vlora combined cycle Unit 1;
- Vlora combined cycle Unit 2;
- One 300 MW and one 150 MW combine cycle plant; and
- One 100 MW CHP plant.

In the period 2011-2015, the following units would be added:

- HPP Kalivaci (90 MW) and HPP Bushati (47 MW);
- One 150 MW combined cycle plant; and
- One 100 MW CHP plant.

In the period 2016-2020, the following units would be added:

- HPP Bratila (80 MW);
- One 100 MW CHP plant;
- One 150 MW combined cycle plant;
- Vlora combined cycle Unit 3; and
- One 100 MW simple cycle plant;

The total net present value of the total system investment and operating costs amounts to 1,953 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 33 million Euros.

Table 4: Albania Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	1,484			1,447	570	0.223
2006	1,518			1,447	600	0.142
2007	1,565	Fierza (58 MW) Balsh (11MW)		1,515	580	0.094
2008	1,585			1,515	590	0.225
2009	1,618		Vlora 1 (132 MW)	1,647	560	0.005
2010	1,652		Vlora 2 (132 MW) Combined cycle (288 MW) Combined cycle (144 MW) CCHP (86 MW)	2,297		0.012
2011	1,719		HPP Kalivaci (90MW)	2,387		0.269
2012	1,775		CCHP (86 MW)	2,473		0.009
2013	1,842		HPP Bushati (47MW)	2,520		0.009
2014	1,922		Combined cycle (144 MW)	2,664		0.007
2015	1,989			2,664		0.010
2016	2,099		HPP Bratila (80MW) CCHP (86 MW)	2,830		0.008
2017	2,220		Combined cycle (144 MW)	2,974		0.007
2018	2,352			2,974		0.019
2019	2,493		Vlora 3 (191 MW)	3,165		0.014
2020	2,645		Simple cycle (96 MW)	3,261		0.071
Total		**69 MW**	**1,746 MW**			

Note: The CCHP units selected by WASP could be replaced by Simple or Combined Cycle units if the demand for combined heat (steam) is not required. The impacts on the results would be negligible.

A12.1.3 Bosnia & Herzegovina

The resulting screening curves of selected candidate plants for Bosnia & Herzegovina are shown in Figure 2.

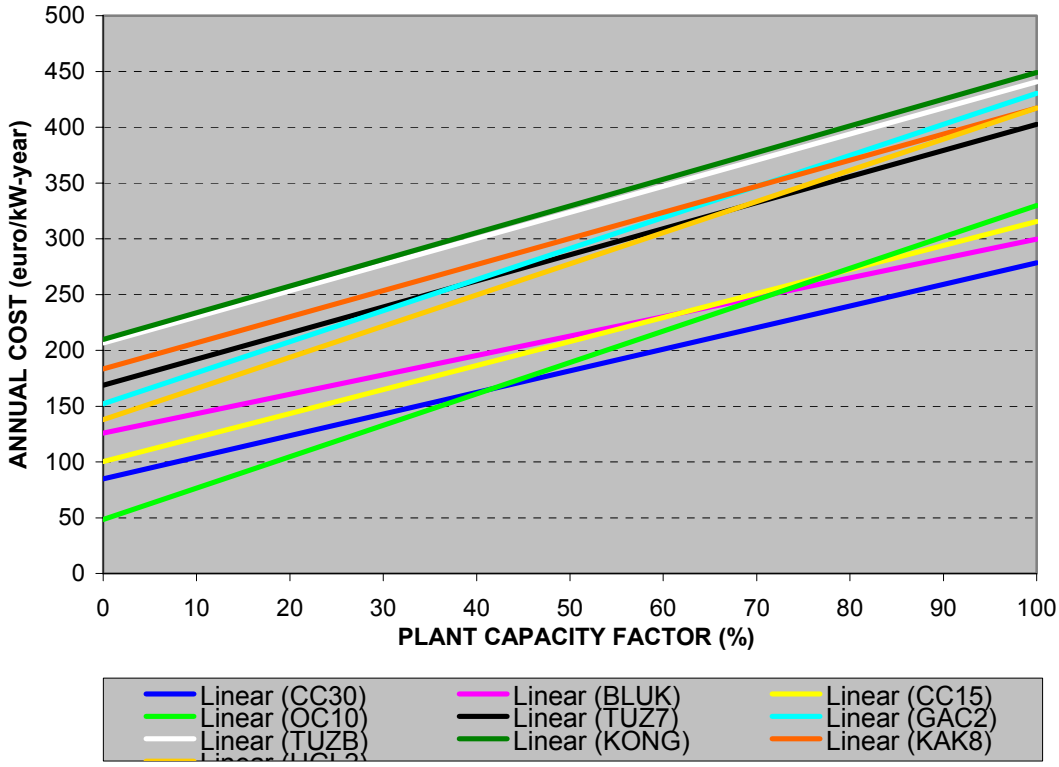

Figure 2: Bosnia & Herzegovina Screening Curves

The total capacity of the plants planned for rehabilitation is 1,035MW. The investment cost is estimated at 450 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 5. In addition to the 1,035 MW of rehabilitated units, 818 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new capacity additions include, 462 MW of lignite plants, 212 MW of brown coal plant, and 144 MW of combined cycle gas-fired plant.

The results show that there is some deficit of existing capacity in the period (2006-2008) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2010 and thereafter.

WASP results show that, for the period 2010-2015, the following new capacity is added to the power system of Bosnia & Herzegovina:

- One 150 MW combined cycle plant.

In the period 2016-2020, the following units are added:

- Banja Luka, lignite unit 135 MW;
- Tuzla 7, lignite unit 370 MW; and
- Kakanj 8, brown coal unit 230 MW.

The total net present value of the total system investment and operating costs amounts to 2,427 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 354 million Euros.

Table 5: Bosnia & Herzegovina Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	1,863			3,494		0.000
2006	1,881			3,296	40	0.138
2007	1,902	Tuzla 5 (182 MW)		3,378	40	0.204
2008	1,952	Tuzla 6 (198 MW) Kakanj 6 (100 MW)		3,400	20	0.271
2009	2,006	Gacko (276 MW)		3,676		0.005
2010	2,076		Combined cycle (144 MW)	3,541		0.005
2011	2,114	Ugljevik (279 MW)		3,820		0.005
2012	2,178			3,820		0.005
2013	2,247			3,820		0.005
2014	2,321			3,820		0.005
2015	2,410			3,820		0.099
2016	2,481		Banja Luka (122 MW)	3,942		0.005
2017	2,568			3,942		0.005
2018	2,659		Tuzla 7 (340 MW)	4,009		0.124
2019	2,766		Kakanj8 (212 MW)	4,221		0.005
2020	2,855			4,221		0.143
Total		**1,035 MW**	**818 MW**			

A12.1.4 Bulgaria

The resulting screening curves of selected candidate plants for Bulgaria are shown in Figure 3.

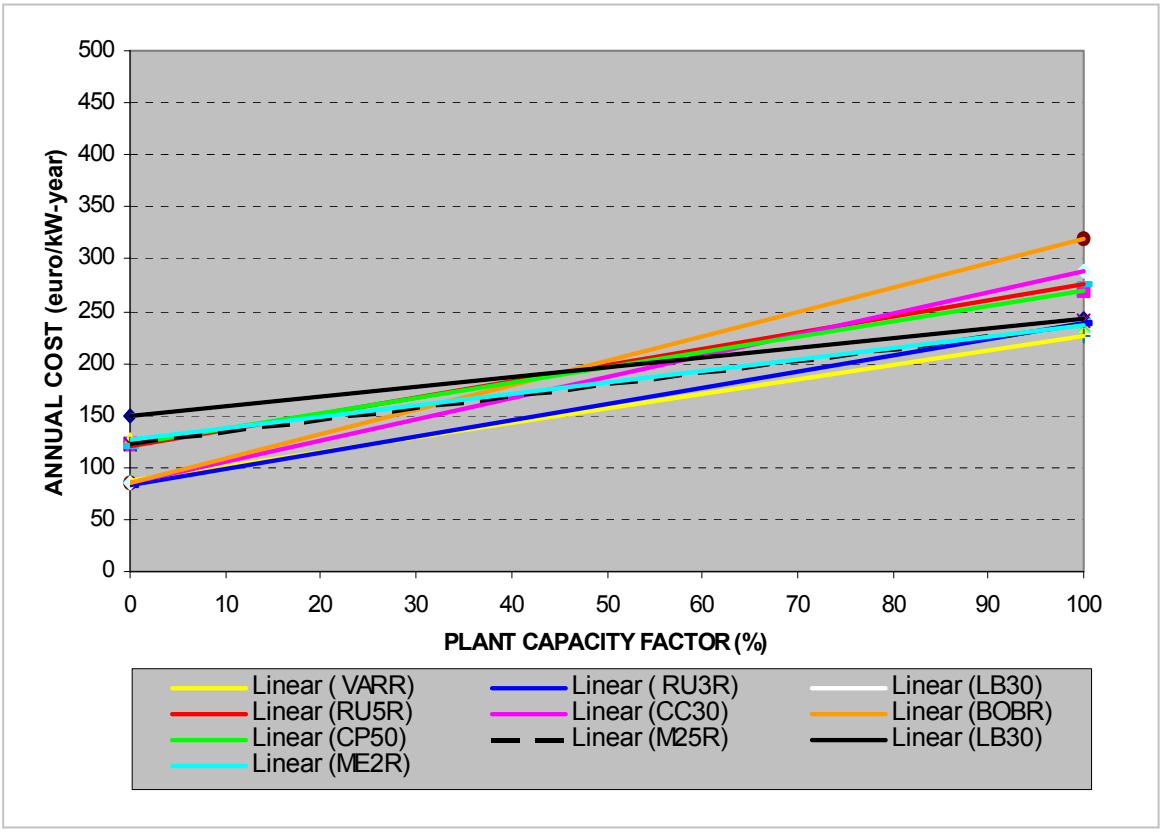

Figure 3: Bulgaria Screening Curves

The total capacity of the plants planned for rehabilitation is 3,811 MW. The investment cost is estimated at 2,156 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 6. In addition to the 3,811 MW of rehabilitated units, 550 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 2x275 MW that is already under construction or fully committed by the utility, as shown in Table 3.

In addition to the plants shown in Table 3, WASP results show that, for the period 2005-2020, there is no need for new capacity.

The total net present value of the total system investment and operating costs amounts to 1,981 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 1,791 million Euros.

Table 6: Bulgaria Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	6,383			9,376		0.000
2006	6,452	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW)		9,708		0.000
2007	6,497	Maritsa East 3 (189 MW) Maritsa East 2 (148 MW)		9,005		0.001
2008	6,517	Maritsa East 3 (189 MW) Maritsa East 2 (148 MW)		8,962		0.001
2009	6,518	Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW)	Maritsa East 1 (275 MW)x2	9,383		0.000
2010	6,482	Maritsa East 2 (185 MW) Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW)		9,403		0.000
2011	6,591	Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW)		9,444		0.000
2012	6,699	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW)		9,672		0.000
2013	6,752	Varna 4 (200 MW) Ruse 6 (25 MW)		9,728		0.000
2014	6,861	Varna 5 (200 MW)		9,744		0.000
2015	7,025	Varna 6 (200 MW)		9,944		0.000
2016	7,162			9,944		0.000
2017	7,256			9,944		0.000
2018	7,301			9,944		0.001
2019	7,351			9,944		0.001
2020	7,340			9,944		0.001
Total		**3,811 MW**	**550 MW**			

A12.1.5 Croatia

The resulting screening curves of selected candidate plants for Croatia are shown in Figure 4.

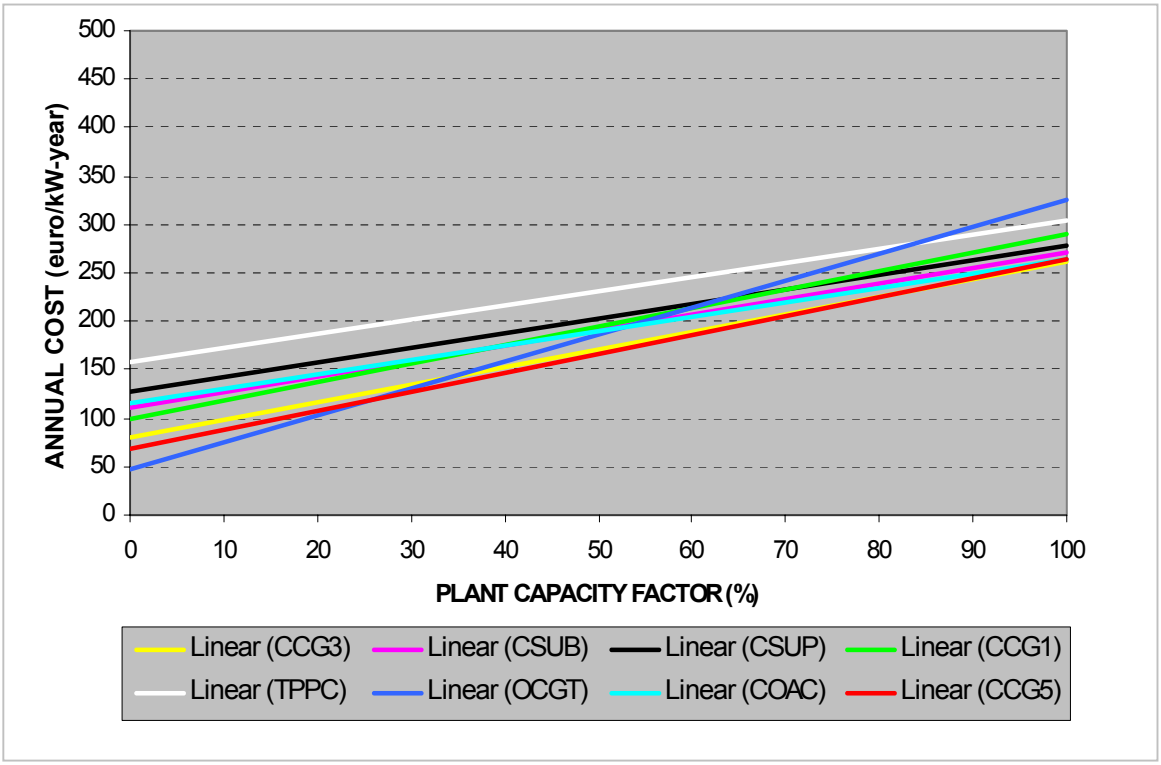

Figure 4: Croatia Screening Curves

The results of the 2005-2020 expansion plan are shown in Table 7. The 2,364 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include, 540 MW of coal subcritical plants, 192 MW simple cycle plants, and 1,632 MW of combined cycle gas-fired generation.

The results show that, in the system there is some deficit of existing capacity in the first 4 years (2005-2008) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2009 and thereafter.

In addition to the plants shown in Table 3, WASP results show that, for the period 2005-2010, the following new capacity would be added to the power system of Croatia:

- Two 300 MW combined cycle plant.

In the period 2011-2015, the following units would be added:

- One 300 MW combined cycle plant;
- One 500 MW combined cycle plant;

- One 100 MW simple cycle plant; and
- One 300 MW coal sub critical plant.

In the period 2016-2020, the following units would be added:

- One 300 MW coal sub critical plant;
- One 300 MW combined cycle plant; and
- One 100 MW simple cycle plant.

The total net present value of the total system investment and operating costs amounts to 4,242million Euros.

Table 7: Croatia Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	2,817			3,745	200	0.000
2006	2,912			3,745	200	0.000
2007	3,007			3,745	200	0.000
2008	3,101			3,745	200	0.398
2009	3,196		Combined cycle (288 MW)x2	4,399		0.000
2010	3,290			4,273		0.001
2011	3,400		Simple cycle (96 MW)	4,322		0.228
2012	3,510		Coal Subcritical (270 MW)	4,592		0.001
2013	3,619		Combined cycle (288 MW)	4,598		0.002
2014	3,729			4,598		0.005
2015	3,838		Combined cycle (480 MW)	4,623		0.015
2016	3,960			4,623		0.036
2017	4,082		Coal Subcritical (270 MW)	4,695		0.249
2018	4,204		Combined cycle (288 MW)	4,936		0.028
2019	4,326			4,936		0.063
2020	4,448		Simple cycle (96 MW)	5,032		0.173
Total			**2,364 MW**			

A12.1.6 Macedonia

The resulting screening curves of selected candidate plants for Macedonia are shown in Figure 5.

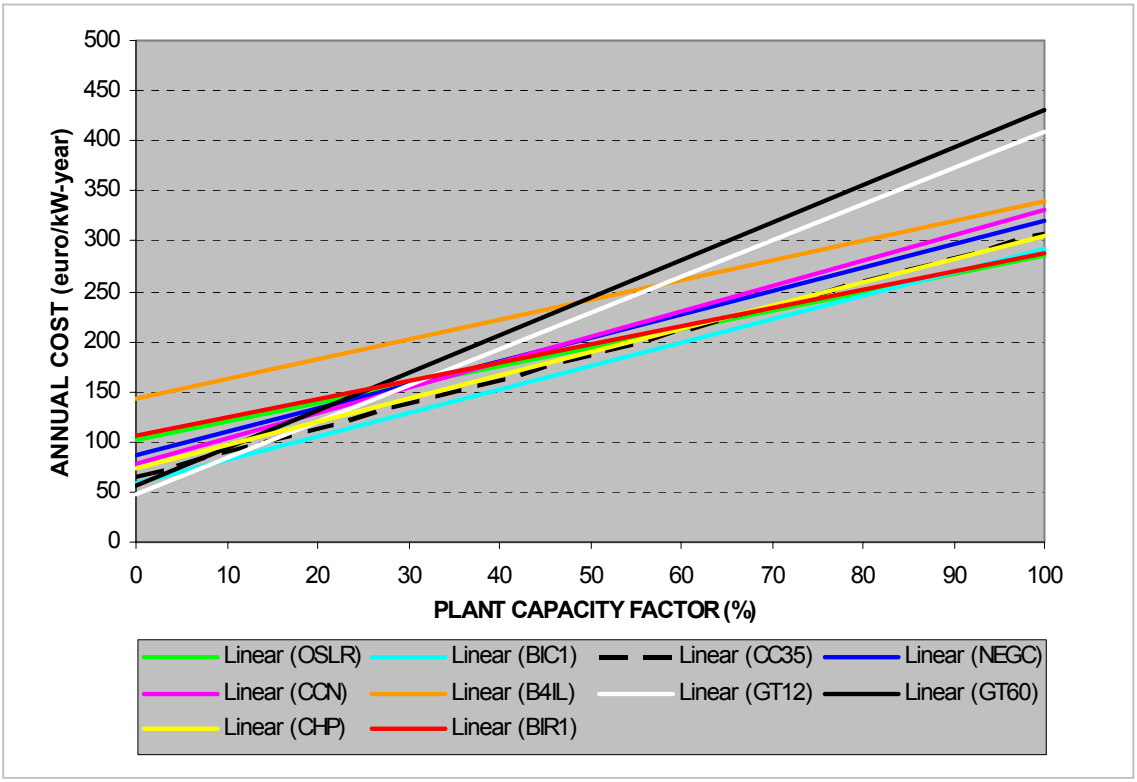

Figure 5: Macedonia Screening Curves

The list of rehabilitated plants, timing of rehabilitation and costs are shown in Appendix 9. The total capacity of the plants planned for rehabilitation is 927 MW. The investment cost is estimated at 441.1 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 8. In addition to the 927 MW of rehabilitated units, 1,331MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 584 MW of hydro power plants, 203 MW of lignite plant, 174 MW of CHP plants, and 370 MW of combined cycle gas-fired generation are added to the system.

The results show that, in the system, there is some deficit of existing capacity in the first 5 years (2005-2009) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2010 and thereafter.

WASP results show that, for the period 2005-2010, the following new capacity is added to the power system of Macedonia:

- Bitola 225-MW lignite unit 4;
- One 200 MW CHP plant; and

- One 70 MW combined cycle plant.

In the period 2011-2015, the following units would be added:

- One 150 MW combined cycle plant; and
- HPP Lukovo polje (25 MW).

In the period 2016-2020, the following units would be added:

- HPP Matka2 (35 MW);
- HPP Boskov most (45 MW);
- HPP Gradec (55 MW);
- HPP Cebren (157 MW);
- HPP Spilje (73 MW);
- HPP Galiste (194 MW);
- One 150 MW combined cycle plant; and
- One 70 MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 1,880 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 140 million Euros.

Table 8:. Macedonia Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	1,360			1,459	200	0.048
2006	1,418			1,459	200	0.115
2007	1,401			1,459	200	0.102
2008	1,389			1,459	200	0.095
2009	1,379			1,459	200	0.094
2010	1,373		Bitola 4 (203 MW) CCHP (174 MW) Gas Turbine (63 MW)	1,702		0.159
2011	1,405	Negotino (197 MW)		1,790		0.088
2012	1,455			1,790		0.142
2013	1,501	Oslomej (109 MW)		1,899		0.077
2014	1,552		Gas Turbine (122 MW) Lukovo Polje (25 MW)	1,839		0.257
2015	1,607	Bitola 1 (207 MW)		2,046		0.057
2016	1,667		Gas Turbine (63 MW) HPP Matka 2 (35 MW) HPP Boskov Most (45 MW)	1,982		0.208
2017	1,730	Bitola 2 (207 MW)		2,189		0.039
2018	1,797			2,189		0.084
2019	1,870		Gas Turbine (122 MW) HPP Gradec (55 MW) HPP Cebren (157 MW) HPP Spilje (73 MW) HPP Galiste (194 MW)	2,583		0.254
2020	1,946	Bitola 3 (207 MW)		2,790		0.004
Total		**927 MW**	**1,331 MW**			

A12.1.7 Montenegro

The resulting screening curves of selected candidate plants for Montenegro are shown in Figure 6.

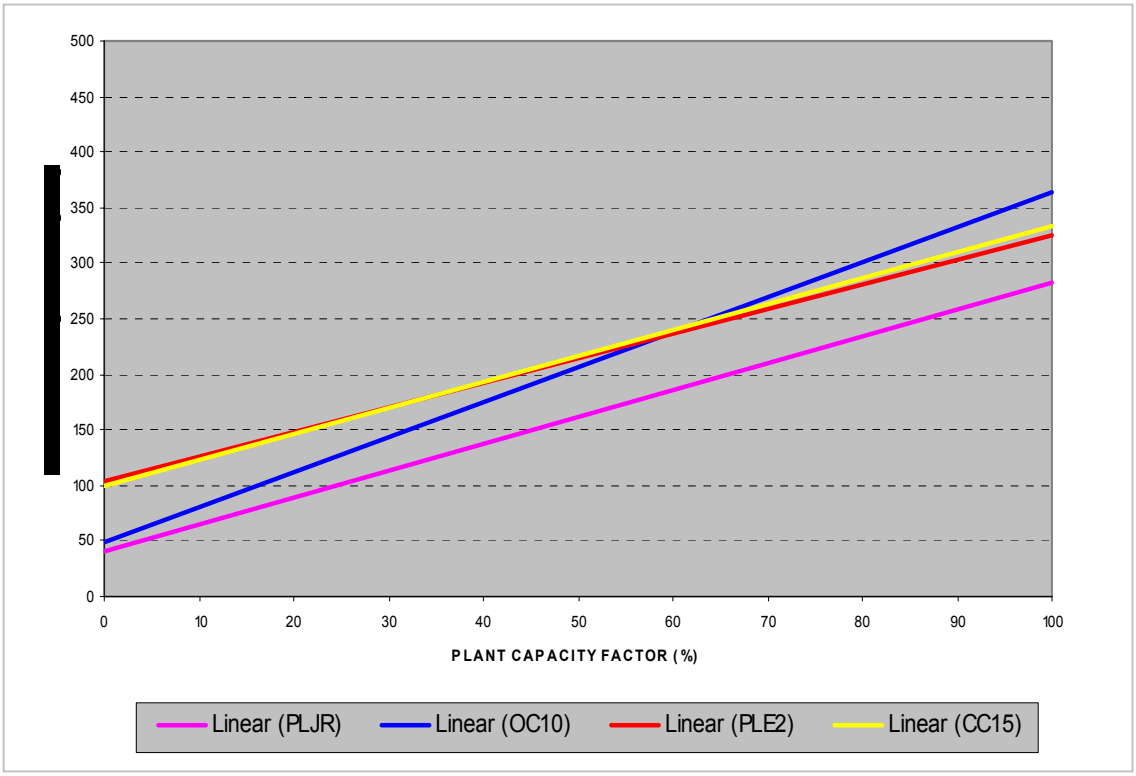

Figure 6: Montenegro Screening Curves

The list of rehabilitated plants, timing of rehabilitation and costs are shown in Appendix 9. The total capacity of the plants planned for rehabilitation is 191MW. The investment cost is estimated at 80.1 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 9. In addition to the 191 MW of rehabilitated unit, 906 MW of new capacity was added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 552 MW of hydro power plants, 258 MW of CHP plants and 96 MW of simple cycle gas-fired.

The results show that, in the system there is some deficit of existing capacity in the first 6 years (2005-2010) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2010 and thereafter.

WASP results show that, for the period 2005-2015, the following new capacity would be added to the power system of Montenegro:

- HPP Kostanica (552 MW);
- One 100 MW simple cycle plant; and

- Three 100 MW CHP plant.

The total net present value of the total system investment and operating costs amounts to 947 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 44 million Euros.

Table 9: Montenegro Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	616			449	360	0.189
2006	609			449	360	0.112
2007	612			449	360	0.155
2008	615			449	360	0.181
2009	617			449	360	0.197
2010	620		HPP Kostanica (552 MW)	860	360	0.000
2011	623	Pljevlja (191 MW)	CCHP (86 MW)x2 Simple cycle (96 MW)	1,319		0.172
2012	625			1,319		0.206
2013	627			1,319		0.244
2014	629		CCHP (86 MW)	1,405		0.001
2015	632			1,405		0.001
2016	642			1,405		0.002
2017	652			1,405		0.003
2018	662			1,405		0.004
2019	672			1,405		0.005
2020	682			1,405		0.006
Total		**191 MW**	**906 MW**			

Note: The CCHP units selected by WASP could be replaced by Simple or Combined Cycle units if the demand for combined heat (steam) is not required. The impacts on the results would be negligible.

A12.1.8 Romania

The resulting screening curves of selected candidate plants for Romania are shown in Figure 7.

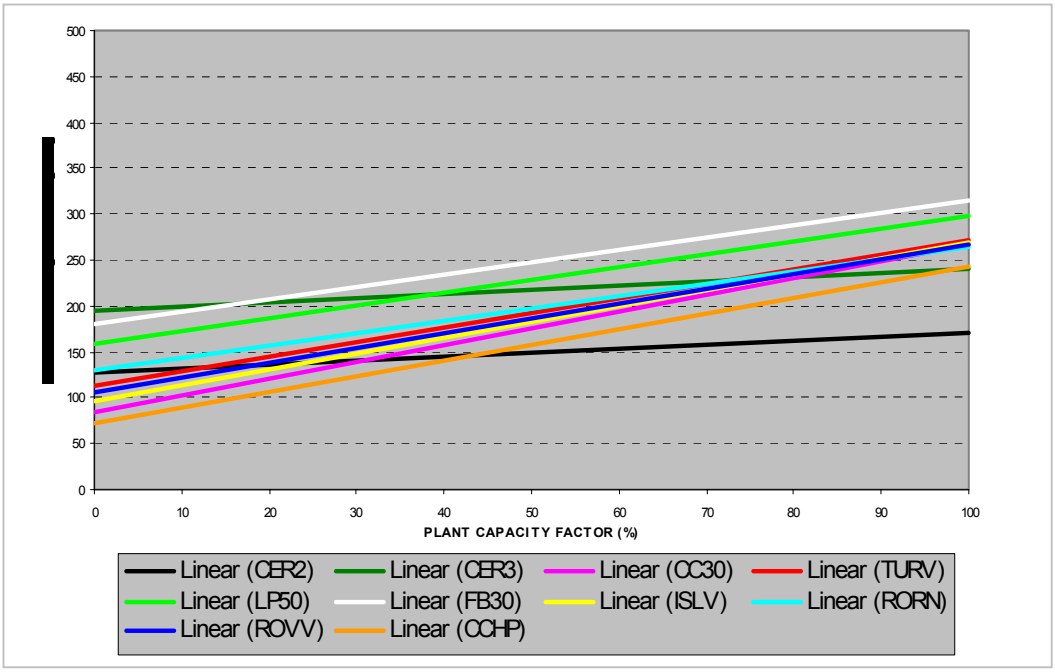

Figure 7: Romania Screening Curves

The list of rehabilitated plants, timing of rehabilitation and costs are shown in Appendix 9. The total capacity of the plants planned for rehabilitation is 2585MW. The investment cost is estimated at 1443.1 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 10. In addition to the 2,585 MW of rehabilitated units, 5,356 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 400 MW that is already under construction or fully committed by the utilities, as shown in Table 3. In addition, 1,328 MW of nuclear power plants, 602 MW of CHP plants, 1,010 MW of lignite power plant, and 2,016 MW of combined cycle gas-fired generation were added to the system.

The WASP model starts bringing new capacity from the candidate plants in year 2007 and thereafter.

In addition to the plants shown in Table 3, WASP results show that, for the period 2005-2010, the following new capacity would be added to the power system of Romania:

- Bucuresti Sud 100 MW gas plant, unit 1 and 2;
- Bucuresti West 100 MW gas plant unit 1 and 2 ;
- Cerna voda 2 700 MW nuclear plant;

- Two 300 MW combined cycle plant; and
- One 100 MW CHP plant.

In the period 2011-2015, the following units would be added:

- Four 300 MW combined cycle plant; and
- Three 100 MW CHP plant.

In the period 2016-2020, the following units would be added:

- 700-MW Cerna voda 3 nuclear plant;
- New Rovinari site 300 MW lignite plant;
- Three 100 MW CHP plant;
- One 300 MW combined cycle plant;
- One 300 MW sub critical lignite plant; and
- One 500 MW super critical lignite cycle plant.

The total net present value of the total system investment and operating costs amounts to 10,476 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 1,086 million Euros.

Table 10: **Romania Scenario A Capacity Expansion Plan and LOLP**

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	7,372			14,035		0.000
2006	7,414		Bucuresti Sud (100MW)	13,538		0.000
2007	7,500	Turceni 5 (272 MW) Deva 1 (167 MW)	Bucuresti Sud (100MW) Cerna Voda 2 (664 MW)	13,255		0.000
2008	7,623	Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW)	Bucuresti Vest (100MW) CCHP (86 MW) Combined cycle (288 MW)	13,200		0.037
2009	7,768	Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Combined cycle (288 MW)	13,485		0.000
2010	7,950	Turceni 3 (272 MW) Galati 4 (50 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW)	13,416		0.000
2011	8,148	Rovinari 5 (278 MW)		13,686		0.000
2012	8,382		Combined cycle (288 MW)	13,758		0.066
2013	8,639	Galati 5 (92 MW)	CCHP (86 MW)x2 Combined cycle (288 MW)	14,008		0.000
2014	8,918	Galati 6 (92 MW)	Combined cycle (288 MW)	14,330		0.000
2015	9,234		CCHP (86 MW) Combined cycle (288 MW)	14,528		0.000
2016	9,604		Combined cycle (288 MW)	14,816		0.097
2017	10,011		Cerna Voda 3 (664 MW)	15,304		0.000
2018	10,448		CCHP (86 MW) New Rovinari site (285 MW)	15,675		0.000
2019	10,915		CCHP (86 MW)x2 Lignite Subcritical (275 MW)	16,122		0.000
2020	11,418		Lignite Supercritical (450 MW)	16,572		0.119
Total		**2,585 MW**	**5,356 MW**			

A12.1.9 Serbia

The resulting screening curves of selected candidate plants for Serbia are shown in Figure 8.

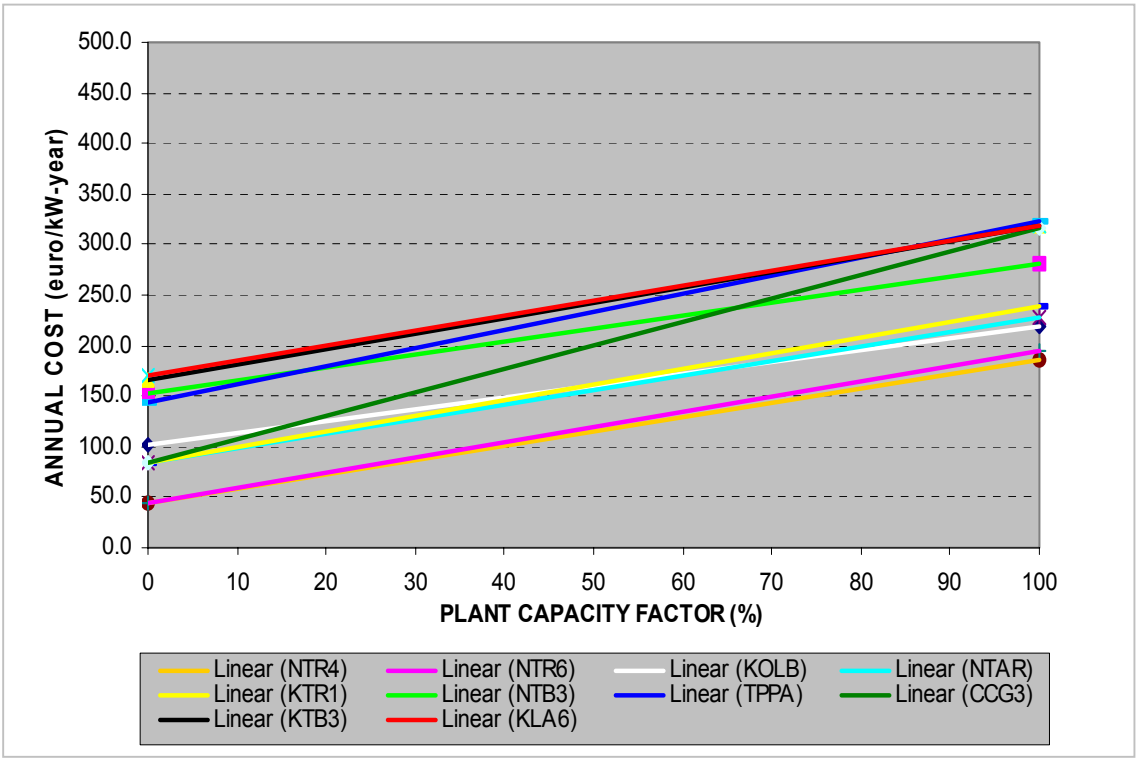

Figure 8: Serbia Screening Curves

The list of rehabilitated plants, timing of rehabilitation and costs are shown in Appendix 9. The total capacity of the plants planned for rehabilitation is 3,140 MW. The investment cost is estimated at 1,257.8 million Euros (2005 price level).

The results of the 2005-2020 expansion plan are shown in Table 11. In addition to the 3,140 MW of rehabilitated units, 928 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 640 MW of lignite power plant, and 288 MW of combined cycle gas-fired.

The results show that, in the system, there is some deficit of existing capacity in the first 3 years (2005-2007) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2009 and thereafter.

WASP results show that, for the period 2005-2010, the following new capacity would be added to the power system of Serbia:

- Kolubara B 320 MW lignite, unit 1; and
- One 300 MW combined cycle plant.

In the period 2011-2020, the following units would be added:

- Kolubara B 320 MW lignite, unit 2.

The total net present value of the total system investment and operating costs amounts to 5,621 million Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 673 million Euros.

Table 11: Serbia Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	6,062			7,202	200	0.345
2006	6,033	Novi Sad 1 (100 MW) Zrenjanin (100 MW)		6,998	350	0.278
2007	6,028	Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)		7,188	200	0.336
2008	6,084	Nikola Tesla A6 (280 MW)		7,468		0.447
2009	6,091		Combined cycle (288 MW)	7,536		0.074
2010	6,098	Nikola Tesla A1 (191 MW)	Kolubara B (320 MW)	7,827		0.027
2011	6,178	Nikola Tesla A2 (191 MW)	Kolubara B (320 MW)	7,729		0.036
2012	6,258	Nikola Tesla B1 (580 MW)		8,309		0.010
2013	6,338			7,729		0.240
2014	6,418	Nikola Tesla B2 (580 MW)		8,309		0.017
2015	6,498			7,989		0.055
2016	6,569	Kostolac B1 (320 MW)		8,309		0.032
2017	6,639			7,989		0.220
2018	6,709	Kostolac B1 (320 MW)		8,309		0.058
2019	6,779			8,309		0.077
2020	6,850			8,309		0.102
Total		**3,140 MW**	**928 MW**			

A12.1.10 UNMIK

The resulting screening curves of selected candidate plants for UNMIK are shown in Figure 9.

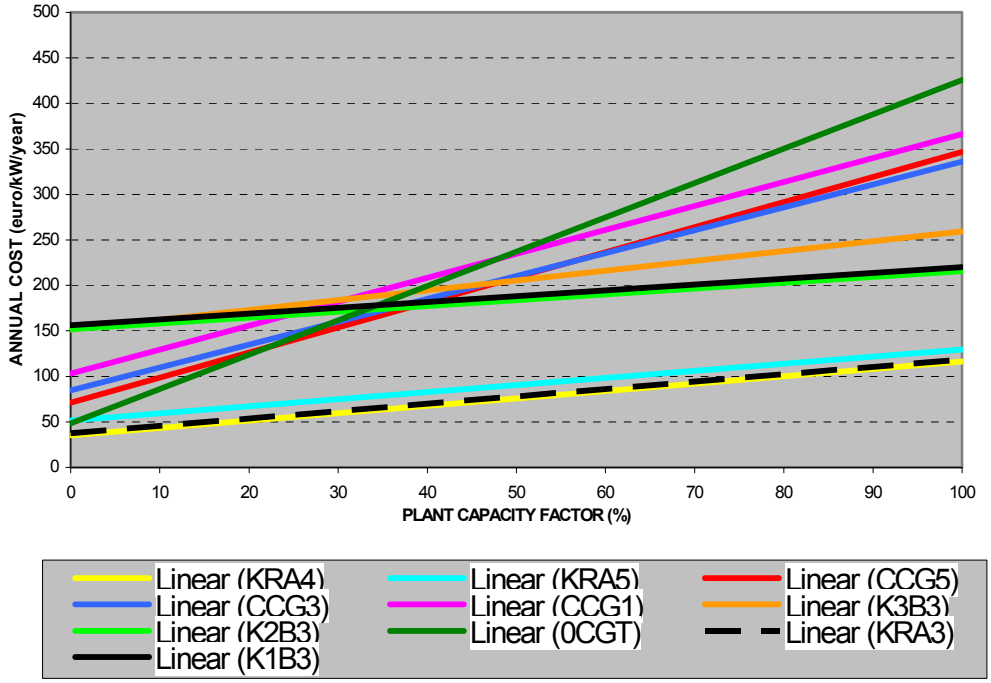

Figure 9: UNMIK Screening Curves

The results of the 2005-2020 expansion plan are shown in Table 12. A total of 1,489 MW of new capacity was added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,489 MW of lignite plants.

The results show that, in the system there is some deficit of existing capacity in the first 6 years (2005-2010) as indicated by required imports to maintain a LOLP value lower than one day per year. The WASP model starts bringing new capacity from the candidate plants in year 2010 and thereafter.

WASP results show that, for the period 2005-2010, the following new capacity would be added to the power system of UNMIK:

- Kosovo 135 MW lignite unit 1 and 2

In the period 2011-2015, the following units would be added:

- Three 300 MW lignite sub critical
- Kosovo B3 300 MW lignite

In the period 2016-2020, the following units would be added:

- Kosovo 135 MW lignite unit 3

The total net present value of the total system investment and operating costs amounts to 1,533 million Euros.

Table 12: UNMIK Scenario A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	Import (MW)	LOLP (%)
		Rehabilitation	New Plants			
2005	1,179			1,070	600	0.186
2006	1,196			1,035	600	0.260
2007	1,280			1,035	700	0.187
2008	1,279			1,035	700	0.194
2009	1,278			1,035	700	0.205
2010	1,265		Kosovo (135 MW)x2	905	700	0.225
2011	1,262		Lignite Subcritical (270 MW)x3 Kosovo B3 (274 MW)	1,989		0.123
2012	1,247			1,989		0.137
2013	1,240			1,989		0.146
2014	1,235			1,989		0.156
2015	1,247			1,989		0.171
2016	1,277			1,989		0.206
2017	1,302			1,989		0.249
2018	1,329		Kosovo (135 MW)	2,124		0.109
2019	1,356			2,124		0.134
2020	1,384			2,124		0.161
Total			**1,489 MW**			

A12.2 Scenario B Results

A12.2.1 Introduction

In the previous section, Scenario A results were presented. Each jurisdiction was expected to meet its own demand, based on supplies within the jurisdiction. A representative least-cost plan was developed for each jurisdiction. As an opposite alternative, Scenario B analyses all jurisdictions in a fully integrated regional power system. Scenario B corresponds to an ideal scenario with no transmission interconnection constraints or limits in optimal unit dispatch to meet regional demand.

Scenario B analysis was performed for the medium load forecast. The regional load forecast is expected to increase from 29,136 MW in 2005 to 30,806 MW in 2010 and 39,568 MW in 2020.

Due to constraints in the limited number of candidate plants that can be analysed in WASP, all candidate plants used in each jurisdiction are compared to each other through the use of the screening curves method to select the most competitive candidates on a regional basis. The screening curve method expresses the total annualised electricity production cost for a generating unit, including all capital and operating expenses, as a function of the unit capacity factor. This approach is especially useful for comparative analyses of relative costs of different electricity generation technologies. Details of the methodology and results are presented in Appendix 9. The following candidate plants were retained for Scenario B:

- Belene nuclear unit 1 (1,000 MW)
- Cernavoda nuclear units 2 and 3 (700 MW)
- Kolubara lignite units 1 and 2 (320 MW each)
- Kosovo lignite, 300 MW units
- Generic Kosovo lignite, 500-MW sub-critical units
- Generic imported coal, 500-MW super-critical units
- Generic combined cycle gas turbine, 300- and 500-MW units
- Generic open cycle gas turbine, 100-MW units
- Generic CHP gas turbine, 100-MW units

The resulting screening curves of these selected candidate plants are shown in Figure 10.

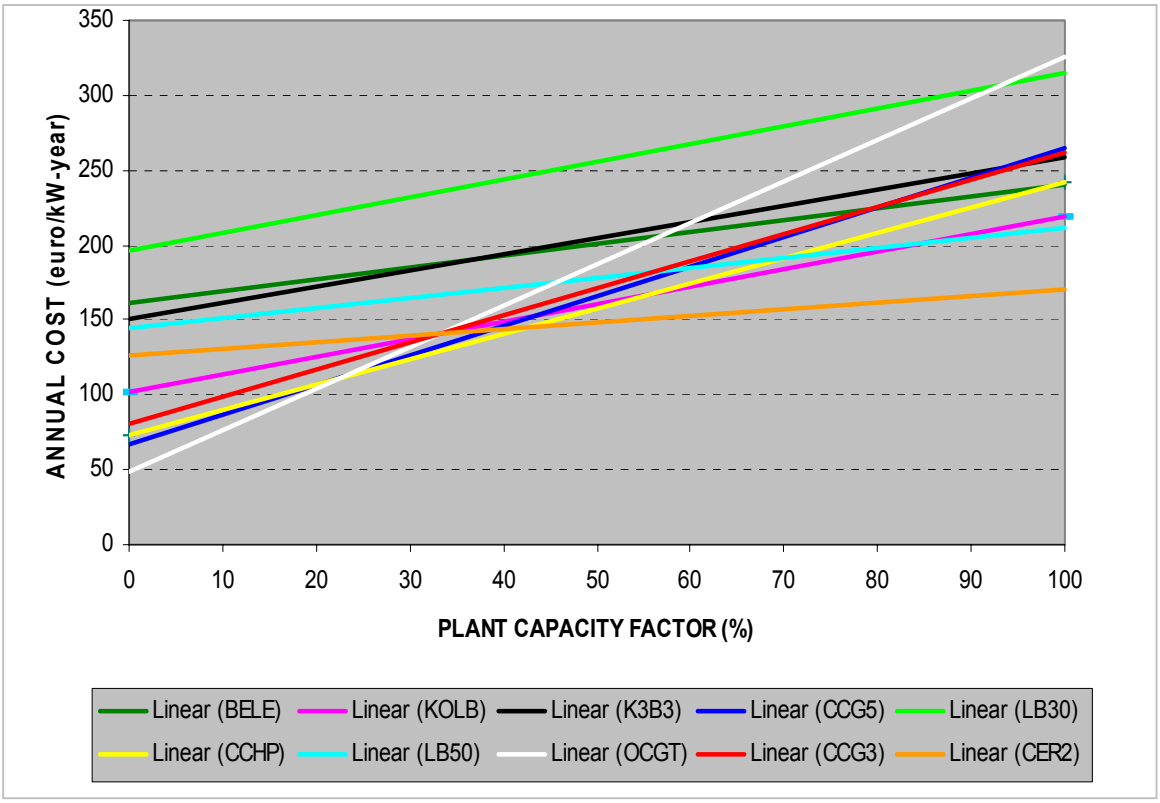

Figure 10: SEE Region Screening Curves

Since a large number of units are expected to be rehabilitated in the next 5-10 years, a similar screening-curve analysis was performed to evaluate the economic attractiveness of rehabilitation. The details are presented in Appendix 9 and the results are summarised in the following paragraphs.

To assess the economic impacts of various rehabilitation scenarios, several cases are analysed, using the WASP model. Case 1 uses the rehabilitation program given by the utilities. No analysis was performed to test the economic viability of the proposed rehabilitation programs before running the WASP model.

For Case 2, the economics of the rehabilitation programs are first tested through the use of screening curves. Screening curves are constructed for all rehabilitated units to provide an assessment of their annualised costs of electricity generation. Each curve is compared to a composite screening curve for new capacity to estimate the attractiveness of the rehabilitated plant.

For all cases, units already under construction or fully committed by the utilities are maintained in the regional expansion plans. These units are shown in Table 13.

Jurisdiction	Unit Name	Net Capacity (MW)	First Year of Operation
Romania	Bucuresti Sud	100	2006
Romania	Bucuresti Sud	100	2007
Romania	Bucuresti West	100	2008
Romania	Bucuresti West	100	2010
Bulgaria	Maritsa East 1	2x275	2009
Albania	Vlora	132	2009
Total		**1,082**	

Table 13: Units under Construction or Committed By Utilities

A12.2.2 Scenario B Cases 1A

Case 1A reflects the rehabilitation program as given by the utilities. No adjustments are made to the planned timing of rehabilitation. Rehabilitation costs were obtained from the utilities and reviewed and updated by the SEEC Environmental Team. Details of these costs are shown in Appendix 9 and in SEEC's report entitled "GIS – Implications for Investments in Environmental Protection".

Under Case 1A, rehabilitation includes technical rehabilitation (life extension) and full environmental compliance (particulate, NOx and SOx controls) with EC regulations (Directive 2001/80/EC) for Romania and Bulgaria. For the other jurisdictions, rehabilitation includes technical rehabilitation and partial environmental compliance (particulate and NOx) for plants planned for rehabilitation.

The list of rehabilitated plants, timing of rehabilitation and costs are shown in Appendix 9. The total capacity of the plants planned for rehabilitation is 11,574 MW. The investment cost is estimated at 5.9 billion Euros (2005 price level) for Case 1A.

Case 1A results of the 2005-2020 expansion plan are shown in Table 14. In addition to the 11,574 MW of rehabilitated units, 11,000 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear (Cernavoda 2 in 2010, Cernavoda 3 in 2013, and Belene 1 in 2017), 3,796 MW of Kosovo lignite, 640 MW of Kolubara lignite, 344 MW of CHP plants, and 2,880 MW of combined cycle gas-fired generation are added to the regional system.

The results show that, on a regional level, there is some excess of existing capacity in the first 3 years (2005-2007) as shown by LOLPs equal to 0.0. The WASP model starts bringing new capacity from the candidate plants in year 2008 and thereafter.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite unit #1; and

- One 500-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Cernavoda nuclear unit #3;
- Kolubara lignite unit #2;
- One 300-MW and two 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Two 300-MW and one 500-MW combined cycle plants.

In the period 2016-2020, the following units would be added:

- Belene nuclear unit #1;
- Three 300-MW and three 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Three 300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 34.09 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 14: Case 1A Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW) x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Case 1A Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW) x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kolubara B (320 MW)	41,423	0.116
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW)	42,096	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Combined cycle (288 MW)	42,897	0.000

Case 1A Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Cernavoda 3 (664 MW) CCHP (86 MW) Kosovo B3 (274 MW) Lignite Subcritical (450 MW)	43,053	0.224
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	CCHP (86 MW)	43,917	0.037
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	44,425	0.233
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,311	0.225
2017	35,026	Bitola 2 (207 MW)	Belene (930MW) Combined cycle (480 MW)	46,194	0.149
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (288 MW) Kosovo B4 (274 MW) Lignite Subcritical (450 MW)	47,225	0.064
2019	37,024		CCHP (86 MW) Combined cycle (288 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	48,116	0.132
2020	38,049	Bitola 3 (207 MW)	Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	49,128	0.113
Total		**11,574 MW**	**11,000 MW**		

A12.2.3 Scenario B Cases 2A1 and 2A2

For Case 2A, the justification of the rehabilitation programs is first tested through the use of screening curves. The cost of rehabilitation is compared to the cost of the most competitive regional candidate units. Figure 11 shows the screening curves for these selected regional candidates. The nuclear units are eliminated from this Figure as they are very site specific. A composite curve following the lower points (REFER1) of the screening curves was added to serve as a benchmark for evaluating the attractiveness of the rehabilitation plants. The REFER1 curve can be considered as a very strict benchmark for selection of units to be rehabilitated. For example, it includes the two Kolubara units that have low investment costs due to prior investments.

For this reason, another composite curve (REFER2) is computed to reflect a greater range of costs for assessment of the most competitive candidate plants that can be used in the region. The costs associated with the second curve (REFER2) are 25% higher than the costs of the first composite curve (REFER1). Details of the analysis and results are presented in Appendix 9.

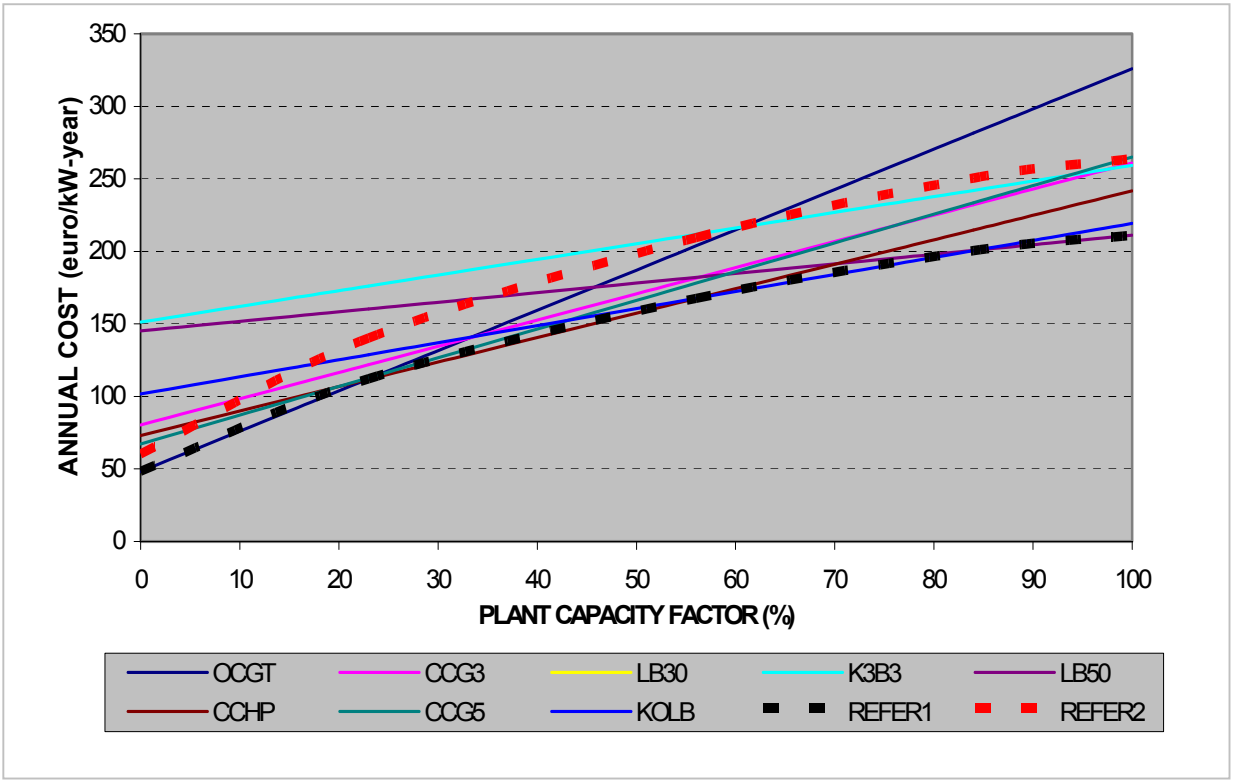

Figure 11: Screening Curves for Rehabilitation Benchmark

Case 2A1 uses the results based on composite curve REFER1. Using this method, rehabilitation of many existing units is not considered to be attractive and justified, when compared to new regional units. The total rehabilitation capacity of 11,574 MW used in Case 1A is reduced to 6,105 MW.

The results of the 2005-2020 expansion plan are shown in Table 15. In addition to the 6,105 MW of rehabilitated units, 15,202 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year in each year of the planning

horizon. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear (Cernavoda 2 in 2009, Cernavoda 3 in 2010, and Belene 1 in 2011), 5,244 MW of Kosovo lignite, 640 MW of Kolubara lignite, 602 MW of CHP plants, and 5,376 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear units #2 and 3;
- One 100-MW CHP plant;
- Kolubara lignite units #1 and 2;
- One 300-MW and one 500-MW combined cycle plants; and
- Two 300-MW and two 500-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Belene nuclear unit #1;
- Two 300-MW and three 500-MW Kosovo lignite plants;
- Three 100-MW CHP plants; and
- Three 300-MW and two 500-MW combined cycle plants;

In the period 2016-2020, the following units would be added:

- Two 300-MW and three 500-MW Kosovo lignite plants;
- Three 100-MW CHP plants; and
- Three 300-MW and four 500-MW combined cycle plants.

The total net present value of the total system investment and operating costs amounts to 31.89 billion Euros, with the net present value of the rehabilitation investment equals to 0.84 billion Euros.

Table 15: Case 2A1 Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202		Bucuresti Sud (100MW)	41,774	0.000
2007	28,553	Turceni 5 (272 MW) Nikola Tesla A4 (280 MW) Maritsa East 2 (148 MW) Tuzla 5 (182 MW)	Bucuresti Sud (100MW) Kolubara B (320 MW)	40,248	0.165
2008	28,927	Nikola Tesla A6 (280 MW) Maritsa East 2 (148 MW)	Bucuresti Vest (100MW) Maritsa East 1 (275 MW)x2 Kolubara B (320 MW) Kosovo B3 (274 MW)	40,570	0.161
2009	29,234	Ruse 4 (100 MW) Maritsa East 2 (148 MW) Turceni 6 (272 MW)	Vlora (132 MW) Cernavoda 2 ((664 MW) Lignite Subcritical (450 MW)x2	41,075	0.000
2010	29,649	Nikola Tesla A1 (191 MW) Varna 1 (200 MW) Turceni 3 (272 MW)	Bucuresti Vest (100MW) Cernavoda 3 ((664 MW) CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B4 (274 MW)	41,027	0.176
2011	30,242	Nikola Tesla A2 (191 MW) Varna 2 (200 MW)	Belene (930MW) Kosovo B5 (274 MW)	41,649	0.159
2012	30,864	Varna 3 (200 MW) Nikola Tesla B1 (580 MW)	CCHP (86 MW) Combined cycle (288 MW)	42,338	0.000

Case 2A1 Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW)	CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW)x2 Lignite Subcritical (450 MW)	42,662	0.157
2014	32,282	Varna 5 (200 MW) Nikola Tesla B2 (580 MW)	Combined cycle (288 MW)	43,530	0.000
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)x2	44,080	0.257
2016	34,072	Kostolac B1 (320 MW)	Combined cycle (288MW) Lignite Subcritical (450 MW)	45,138	0.014
2017	35,026	Bitola 2 (207 MW)	Combined cycle (480 MW)x2 Kosovo B7 (274 MW)	45,845	0.015
2018	36,002	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (288 MW) Lignite Subcritical (450 MW)	46,688	0.233
2019	37,024		CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B8 (274 MW)	47,609	0.140
/2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	48,625	0.001
Total		**6,105 MW**	**15,202 MW**		

Case 2A2 uses the results based on composite curve REFER2. Using this curve, rehabilitation of many existing units is considered to be attractive and justified, when compared to new regional units. Only a few units are not found to be competitive. The total rehabilitation capacity of 11,574 MW used in Case 1A is reduced to 9,916 MW.

The results of the 2005-2020 expansion plan are shown in Table 16. In addition to the 9,916 MW of rehabilitated units, 11,884 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year in each year of the planning horizon. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear (Cernavoda 2 in 2010, Cernavoda 3 in 2013, and Belene 1 in 2013), 3,346 MW of Kosovo lignite, 640 MW of Kolubara lignite, 430 MW of CHP plants, and 4,128 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite units #1 and 2;
- Two 300-MW combined cycle plants; and
- One 300-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Cernavoda nuclear unit #3;
- Belene nuclear unit #1;
- Two 300-MW and two 500-MW Kosovo lignite plants;
- One 100-MW CHP plant; and
- One 300-MW and one 500-MW combined cycle plants.

In the period 2016-2020, the following units would be added:

- One 300-MW and three 500-MW Kosovo lignite plants;
- Four 100-MW CHP plants; and
- Three 300-MW and four 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 33.76 billion Euros, with the net present value of the rehabilitation investment equals to 3.58 billion Euros.

Table 16:. Case 2A2 Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,394	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW) Maritsa East 1 (275 MW)x2	40,726	0.000
2009	29,234	Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Combined cycle (288 MW) Kolubara B (320 MW)	40,981	0.148

Case 2A2 Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Turceni 3 (272 MW) Nikola Tesla A1 (191 MW)	Bucuresti Vest (100 MW) Cernavoda 2 ((664 MW) Combined cycle (288 MW) Kolubara B (320 MW) Kosovo B3 (274 MW)	41,217	0.147
2011	30,242	Bobov Dol 2 (198 MW) Varna 2 (200 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Combined cycle (288 MW) Kosovo B4 (274 MW)	41,821	0.065
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Lignite Subcritical (450 MW)	42,784	0.000
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (34 MW)	Belene (930MW) Cernavoda 3 (664 MW)	43,060	0.000
2014	32,282	Varna 5 (200 MW) Nikola Tesla B2 (580 MW)		43,802	0.053
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	44,382	0.168
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,268	0.173
2017	35,026	Bitola 2 (207 MW)	CCHP (86 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW) Combined Cycle (480 MW)	46,030	0.238

Case 2A2 Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (480 MW) Lignite Subcritical (450 MW)	46,979	0.165
2019	37,024		CCHP (86 MW) Combined cycle (288 MW)x2 Lignite Subcritical (450 MW)	47,884	0.194
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Combined cycle (288MW)	48,738	0.210
Total		**9,916 MW**	**11,884 MW**		

A12.2.4 Scenario B Case 2B

Since Case 1 and Case 2A show a low level of LOLP in the first years (2005-2007), the WASP model is first run without any of the units planned for rehabilitation to assess the year when LOLP would become greater than one day per year. It is found to be 2007. WASP is then re-run with rehabilitation planned for 2005-2007 postponed by one or two years The run is made using the rehabilitated units selected under Case 2A2 (using the more relaxed benchmark criteria REFER2).

The results of the 2005-2020 expansion plan are shown in Table 17. In addition to the 9,916 MW of rehabilitated units, 11,884 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear (Cernavoda 2 in 2010, Cernavoda 3 in 2013, and Belene 1 in 2013), 3,346 MW of Kosovo lignite, 640 MW of Kolubara lignite, 430 MW of CHP plants, and 4,128 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite units #1 and 2;
- Two 300-MW combined cycle plants; and
- One 300-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Cernavoda nuclear unit #3;
- Belene nuclear unit #1;
- Two 300-MW and two 500-MW Kosovo lignite plants; and
- One 300-MW and one 500-MW combined cycle plants.

In the period 2016-2020, the following units would be added:

- One 300-MW and three 500-MW Kosovo lignite plants;
- Five 100-MW CHP plants; and
- Three 300-MW and four 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 33.64 billion Euros, with the net present value of the rehabilitation investment equals to 3.49 billion Euros.

Table 17:. Case 2B Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202		Bucuresti Sud (100MW)	41,915	0.000
2007	28,553	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Nikola Tesla A4 (280 MW)	Bucuresti Sud (100MW)	40,201	0.253
2008	28,927	Kostolac A1 (90 MW) Novi Sad 2 (108 MW) Tuzla 5 (182 MW) Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW) Maritsa East 1 (275 MW)x2	40,564	0.151
2009	29,234	Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Combined cycle (288 MW) Kolubara B (320 MW)	41,009	0.059

Case 2B Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Turceni 3 (272 MW) Nikola Tesla A1 (191 MW)	Bucuresti Vest (100MW) Cernavoda 2 ((664 MW) Combined cycle (288 MW) Kolubara B (320 MW) Kosovo B3 (274 MW)	41,244	0.050
2011	30,242	Bobov Dol 2 (198 MW) Varna 2 (200 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Cernavoda 3 (664 MW)	41,951	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)		42,464	0.000
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (34 MW)	Belene (930MW) Combined cycle (288 MW) Kosovo B4 (274 MW) Lignite Subcritical (450 MW)	43,088	0.000
2014	32,282	Varna 5 (200 MW) Nikola Tesla B2 (580 MW)		43,829	0.000
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Combined cycle (480 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	44,323	0.265
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW)x2 Combined cycle (480 MW)x2	45,295	0.097

Case 2B Capacity Expansion Plan and LOLP (continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2017	35,026	Bitola 2 (207 MW)	CCHP (86 MW) Kosovo B6 (274 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	46,058	0.172
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (480 MW) Lignite Subcritical (450 MW)	47,007	0.100
2019	37,024		CCHP (86 MW) Combined cycle (288 MW)x2 Lignite Subcritical (450 MW)	47,912	0.117
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Combined cycle (288MW)	48,766	0.195
Total		**9,916 MW**	**11,884 MW**		

A12.3 Scenario C Sensitivities

A12.3.1 Introduction

To reflect existing constraints in the regional electricity market, Scenario C is studied based on the results of Scenario B (unconstrained regional market), and a detailed hourly market simulation for two years (2010 and 2015) using the GTMax model. Actual operating conditions are determined, based on the candidate capacity projects identified as regional priorities in Scenario B, as well as the proposed regional transmission interconnections.

Scenario B "Case 1A", presented previously, is selected as the Reference Case for Scenario C. It includes the life extension and rehabilitation programs as scheduled by the utilities. A series of sensitivity cases is run. Table 18 summarises the cases analysed.

Table 18: List of Scenario C Cases

Scenario C Cases	Load Forecast	Gas Price Forecast	Rehab Plan	"Forced" Hydro
Reference Case	Medium	Medium	Utility	NO
Forced Hydro	Medium	Medium	Utility	YES
High Gas Price	Medium	High	Utility	YES
High Demand	High	Medium	Utility	YES
Low Demand	Low	Medium	Utility	NO
Full Rehab	Medium	Medium	Utility + Full Rehab	NO
Nuclear	Medium	Medium	Utility	NO
Increase Construction Cost	Medium	Medium	Utility	NO
Discount Rate	Medium	Medium	Utility	NO

The Scenario C analysis is performed mostly for the medium load forecast with a sensitivity analysis performed for the low and high demand forecasts. The expected regional load forecasts are presented in Table 19 and Table 20.

Table 19: Regional Annual Peak Load Forecast (MW)

	Year 2005	**Year 2010**	**Year 2020**
Medium Demand	27,882	29,649	38,049
High Demand	28,117	31,022	43,359
Low Demand	26,927	26,573	32,604

The average annual growth rate is 2.1% for the medium forecast, 2.9% for the high forecast and 1.3% for the low demand forecast.

Table 20: Regional Annual Energy Forecast (GWh)

Jurisdiction	Year 2005	Year 2010	Year 2020
Medium Demand	166,451	182,606	235,727
High Demand	167,815	191,259	269,155
Low Demand	160,837	163,763	201,389

Results for the Reference Case are presented in the Main report (Volume 3). Results of the sensitivity cases are presented in the following pages.

A12.3.2 Sensitivity – Forced Hydro

Since there are a large number of potential hydro plants to be developed in the SEE region, a WASP sensitivity run (Case 3A) is performed to include several hydro projects. Candidate plants proposed by the utilities and greater than 100 MW are considered in this analysis. Case 3A uses the same rehabilitation program as the one used in Case 1A (rehabilitation program given by the utilities). Appendix 10 describes the methodology used for ranking the different hydro projects. Table 21 summarises the results.

Table 21: Ranking of Hydro Power Plants

Plant Name	Installed Capacity (MW)	Average Annual Energy (GWh)	Total Investment Euro x million	Construction Cost Euro/kW	Rang B/C
KOST	552	1,120	266.1	482	**2.039**
ZUR	293	398	172.9	590	**1.987**
KOMA	168	232	95.6	569	**1.641**
ANDR	255.5	717	227.9	892	**1.275**[1/]
GLAV	172	313	188.3	1,094	**1.156**
DABA	160	303	171.7	1,073	**1.137**
BUKB	511.5	1119	482.2	943	**1.020**[2/]
GALI	194	257	200.7	1,035	**0.958**
CBRL	157	164	159.5	1,016	**0.878**
KONJ	122	292	134.9	1,106	**0.850**
GARD	170	434	196.1	1,153	**0.783**
LJUT	250	528	231.2	925	**0.640**

1/ - with HPP Zlatica

2/ - with HPP Srbinje

The top ranked hydro power plants with a priority index greater than 1.0 are considered for inclusion in the WASP sensitivity case. These plants have been forced into the regional expansion plan between year 2010 and 2015, according to the following schedule:

2010: Žhur

2011: Komarnica

2012: Buk Bijela + Srbinje

2013: Koštanica

2014: Glavatičevo + Dabar

2015: Andrijevo + Zlatica

The total capacity of these hydro plants is 2,112 MW. By comparison the total net capacity of new additions added in Case 1A between 2010 and 2015 is 4,920 MW.

A.3.2.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 22. In addition to the 11,574 MW of rehabilitated units, 12, 996 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,112 MW of hydro, 2,258 MW of nuclear (Cernavoda 2 in 2010, Cernavoda 3 in 2013, and Belene 1 in 2013), 3,796 MW of Kosovo lignite, 640 MW of Kolubara lignite, 516 MW of CHP plants, and 2,592 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- HPP Zhur;
- Cernavoda nuclear unit #2;
- Two 300-MW combined cycle plants; and
- One 300-MW and one 500-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- HPP Komarnica, Buk Bijela + Srbinje, Koštanica, Glavatičevo, Dabar, Andrijevo, and Zlatica;
- Kolubara lignite units #1 and 2;
- Cernavoda nuclear unit #3;
- One 100-MW CHP plant;
- Two 500-MW Kosovo lignite plants; and
- Two 300-MW and one 500-MW combined cycle plants.

In the period 2016-2020, the following units would be added:

- Belene nuclear unit #1;
- Three 300-MW and three 500-MW Kosovo lignite plants;
- Four 100-MW CHP plants; and

- Two 300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 34.46 billion Euros, with the net present value of the rehabilitation investment equal to 4.12 billion Euros.

Table 22: Scenario C- Forced Hydro - Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C- Forced Hydro - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kosovo B3 (274 MW) HPP Zhur (293 MW)	41,670	0.100
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW) HPP Komarnica (168 MW)	42,511	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Kolubara B (320 MW) HPP Buk Bijela (456 MW) HPP Srbinje (55.5 MW)	43,856	0.000

Scenario C- Forced Hydro - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Cernavoda 3 (664 MW) CCHP (86 MW) Combined cycle (288 MW) Lignite Subcritical (450 MW) HPP Kostanica (552 MW)	44,578	0.151
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	HPP Glavaticevo (172 MW) HPP Dabar (160 MW)	45,688	0.114
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW) HPP Andrijevo (200 MW) HPP Zlatica (55.5 MW)	46,538	0.205
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	47,424	0.179
2017	35,026	Bitola 2 (207 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	48,114	0.259
2018	36,002	Kostolac B1 (320 MW)	Belene (930MW) CCHP (86 MW)	49,149	0.259
2019	37,024		Combined cycle (288 MW) Kosovo B5 (274 MW)x2 Lignite Subcritical (450 MW)	50,228	0.106
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW)x2 Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	51,124	0.191
Total		**11,574 MW**	**12,996 MW**		

A.3.2.2 GTMax Results

For this Sensitivity Case, the GTMax model was run for the peak week of 2015, under average, dry and wet hydrological conditions. The 2010 results would be similar to the one presented in the previous section (Reference Case). The 2015 results are shown in Table 23.

The expected hydro generation for the peak week increases from 750 GWh under a dry year to 1,018 GWh in an average year and 1,273 GWh under a wet year. The corresponding generation costs decrease from €62.0 million to €54.2 million and €48.7 million. By comparison, the corresponding peak week generation costs of the Reference case are €63.5 million, €55.9 million and €52.2 million respectively for the dry, average and wet conditions. The Forced Hydro case reduces the peak week generation costs by €1.5 million under wet hydrologic conditions, €1.7 million under average conditions, and €3.5 million under dry conditions.

For that same 2015 peak week, the average LMPs vary between €19.0/MWh and €25.2/MWh. Under the Reference Case, the LMPs vary between €22.6/MWh and €27.2/MWh. The important role of hydro is clearly demonstrated by these values.

Table 23: GTMax Results – Forced Hydro Case

Regional Market Operation - 2015 – Dry Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	209.8	72.4	23.5	95.9	113.9	0.0	681	25.2
B&H	312.5	150.6	208.0	358.6	0.0	53.3	5,373	25.2
Bulgaria	979.7	41.4	1144.4	1185.9	0.0	206.2	17,679	25.2
Croatia	505.8	118.7	256.7	375.4	130.4	0.0	4,348	25.2
Macedonia	201.5	14.4	119.4	133.8	67.7	0.0	1,725	25.2
Montenegro	101.9	65.2	32.1	97.3	15.2	0.0	884	25.2
Romania	1330.3	160.2	1073.2	1233.5	96.8	0.0	16,654	25.2
Serbia	875.6	120.9	691.9	812.8	59.4	0.0	11,570	25.2
UNMIK	156.3	6.5	373.6	380.2	0.0	223.9	3,122	25.2
Total	**4673.3**	**750.3**	**3923.0**	**4673.3**	**483.4**	**483.4**	**62,035**	**-**

Regional Market Operation – 2015 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	209.8	86.9	23.5	110.4	99.4	0.0	681	20.0
B&H	312.5	177.4	105.8	283.2	22.9	0.0	2,497	20.0
Bulgaria	968.7	52.3	1129.0	1181.3	0.0	212.7	17,315	20.0
Croatia	502.9	130.0	236.7	366.7	136.2	0.0	3,939	20.0
Macedonia	201.5	18.7	116.8	135.5	66.1	0.0	1,669	20.0
Montenegro	101.9	90.5	32.1	122.6	0.0	11.3	884	20.0
Romania	1330.3	240.1	919.2	1159.3	171.0	0.0	12,494	20.0
Serbia	864.6	213.9	693.2	907.1	0.0	45.4	11,586	20.0
UNMIK	156.3	8.8	373.6	382.4	0.0	226.2	3,122	20.0
Total	**4648.4**	**1018.5**	**3629.9**	**4648.4**	**495.5**	**495.5**	**54,187**	**-**

Regional Market Operation – 2015 – Wet Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	209.8	98.3	23.5	121.8	88.0	0.0	681	19.0
B&H	312.5	208.1	72.2	280.3	23.2	0.0	1,642	19.0
Bulgaria	967.0	56.9	1064.3	1121.1	0.0	154.1	15,933	19.0
Croatia	502.9	154.8	179.8	334.6	168.3	0.0	2,614	19.0
Macedonia	201.5	36.0	87.8	123.8	77.8	0.0	1,015	19.0
Montenegro	101.9	151.6	32.1	183.7	0.0	64.8	884	19.0
Romania	1330.3	303.0	896.5	1199.5	130.8	0.0	12,042	19.0
Serbia	866.4	243.5	646.1	889.7	0.0	31.3	10,738	19.0
UNMIK	156.3	20.4	373.6	394.1	0.0	237.8	3,122	19.0
Total	**4648.6**	**1272.6**	**3376.0**	**4648.6**	**488.1**	**488.1**	**48,671**	**-**

Note: LMP = fuel + variable O&M Costs

A12.3.3 Sensitivity – High Demand Forecast

The WASP model is re-run under the high load forecast. Peak and energy demand of the high forecast are shown in Table 19 and Table 20. The rehabilitation program given by the utilities is used. To maintain a good balance of new capacity to be added into the regional system, the forced hydro units are maintained in the expansion plan.

A.3.3.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 24. In addition to the 11,574 MW of rehabilitated units, 17,632 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear, 5,434 MW of lignite, 602 MW of CHP plants, and 6144 MW of combined cycle gas-fired generation, as well as 2112 MW of HPPs are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite unit #1;
- Two 500-MW Kosovo lignite plant;
- One 300-MW and one 500-MW combined cycle plants; and
- HPP Zhur.

In the period 2011-2015, the following units would be added:

- Cernavoda nuclear unit #3;
- Belene nuclear unit #1;
- Kolubara lignite unit #2;
- Three 300-MW and three 500-MW Kosovo lignite plants;
- One 100-MW CHP plants;
- One 300-MW and one 500-MW combined cycle plants; and
- HPP Komarnica, Buk Bijela + Srbinje, Koštanica, Glavatičevo, Dabar, Andrijevo, and Zlatica.

In the period 2016-2020, the following units would be added:

- Three 300-MW and two 500-MW Kosovo lignite plants;
- Four 100-MW CHP plants; and

- Six 300-MW and six 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 37.56 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 24: Scenario C – High Demand - Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System NetCapacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	28,117			42,817	0.000
2006	28,541	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	29,810	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	41,234	0.269
2008	29,765	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	41,222	0.214
2009	30,361	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,898	0.138

Scenario C – High Demand - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2010	31,022	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)x2 Kolubara B (320 MW) HPP Zhur (293 MW)	42,935	0.000
2011	31,926	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW) Kosovo B3 (274 MW) HPP Komarnica (168 MW)	44,051	0.000
2012	32,844	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Kosovo B4 (274 MW) HPP Buk Bijela (456 MW) HPP Srbinje (55.5 MW)	45,350	0.086
2013	33,887	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Cernavoda 3 (664 MW) Belene (930MW) HPP Kostanica (552 MW CCHP (86 MW)x2 Lignite Subcritical (450 MW)	46,799	0.203
2014	34,940	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	Combined cycle (288 MW) HPP Glavaticevo (172 MW) HPP Dabar (160 MW)	48,198	0.000

Scenario C – High Demand - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2015	36,188	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)x2 HPP Andrijevo (200 MW) HPP Zlatica (55.5 MW)	49,483	0.099
2016	37,548	Kostolac B1 (320 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B6 (274 MW)	50,845	0.000
2017	38,926	Bitola 2 (207 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B7 (274 MW) Lignite Subcritical (450 MW)	51,133	0.247
2018	40,358	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW) Combined cycle (288 MW) Lignite Subcritical (450 MW)	53,133	0.239
2019	41,870		Combined cycle (480 MW)x2 Combined cycle (288 MW)x2	54,462	0.150
2020	43,359	Bitola 3 (207 MW)	CCHP (86 MW)x3 Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B8 (274 MW)	55,762	0.210
Total		**11,574 MW**	**17,632 MW**		

A.3.3.2 GTMax Results

For this Sensitivity Case, the GTMax model is run for 2010 and 2015 under average hydrologic conditions for the peak week only. The results are shown in Table 25.

Table 25: GTMax Results – High Demand Forecast

Regional Market Operation - 2010 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	183.8	86.9	23.5	110.4	73.4	0.0	681	21.3
B&H	274.0	151.7	110.5	262.1	11.9	0.0	2,598	21.3
Bulgaria	941.0	52.7	1143.5	1196.2	0.0	255.2	17,645	21.3
Croatia	451.8	130.0	241.4	371.4	80.4	0.0	4,211	21.3
Macedonia	176.8	18.7	122.3	141.0	35.8	0.0	1,408	21.3
Montenegro	103.3	49.1	0.0	49.1	57.2	0.0	0	21.3
Romania	1222.2	240.1	825.6	1065.7	156.4	0.0	12,020	21.3
Serbia	836.9	215.2	659.7	874.9	0.0	41.0	11,243	21.3
UNMIK	165.4	8.8	275.5	284.3	0.0	118.9	2,241	21.3
Total	**4355.2**	**953.1**	**3402.0**	**4355.2**	**415.1**	**415.1**	**52,046**	**-**

Regional Market Operation – 2015 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	231.4	86.9	23.5	110.4	121.1	0.0	681	19.8
B&H	324.5	177.4	105.8	283.2	41.3	0.0	2,497	19.8
Bulgaria	1064.9	55.0	1282.6	1337.6	0.0	272.7	18,679	19.8
Croatia	545.2	130.0	268.7	398.8	146.4	0.0	4,757	19.8
Macedonia	212.4	18.7	115.5	134.1	78.3	0.0	1,646	19.8
Montenegro	108.0	90.5	32.1	122.6	0.0	11.6	884	19.8
Romania	1503.1	240.1	912.4	1152.6	350.5	0.0	12,375	19.8
Serbia	917.4	214.1	703.7	917.8	0.0	3.4	11,790	19.8
UNMIK	175.7	8.8	616.9	625.7	0.0	450.0	5,402	19.8
Total	**5082.8**	**1021.4**	**4061.3**	**5082.7**	**737.6**	**737.6**	**58,710**	**-**

Note: LMP = fuel + variable O&M Costs

A.3.3.3 PSS/E Results

The GTMax output for the peak hour in 2010 and 2015 were used in the PSS/E model to analyse the behaviour of the regional network under a high load demand case. The detailed results of these studies are presented in Appendix 13.

Table 26 summarises the regional losses. The high load demand, 2010 losses increase from 737 MW under the Reference Case to 914 MW under the High Load Demand. There is also an increase in 2015. The additional lines planned for commissioning between 2010 and 2015 have a positive impact on reducing losses by 39 MW. These

changes are a consequence of better voltage profile in the region, especially in areas directly influenced by the new lines. For example, the new interconnection line Nis-Leskovac-Vranje-Skopje greatly improves the voltage profile in southern part of Serbia and the new interconnection lines Podgorica – V.Dejes – Kashar – Elbasan and Kosovo B – V.Dejes – Kashar – Elbasan greatly improve voltage profile in Albania.

Table **26**: Peak Hour - Regional Losses (MW) under Average Hydrologic Conditions

Case	Year 2010	Year 2015	
	2010*	2010*	2015*
Reference Case	737.1	1,035.1	1,006.4
High Load Forecast	913.9	1,296.9	1,257.8

*topogy

Table 27 summarises the transmission lines and transformers that are loaded over 80% of their thermal limits. This is an indication on what parts of the transmission network show weak spots and what network reinforcements would be necessary. For 2010, some 220 kV lines in Albania, Romania and Serbia are loaded over 80%. Also, most of the elements loaded over 80% are transformers in some substations, again, in Albania, Romania and Serbia. Results of n-1 analysis show that all identified insecure situations are also located in Albania, Romania and Serbia. The most critical elements are located in Romania: the 220 kV lines Targu Jiu – Paroseni and Urechesti-Targu Jiu and the 400/220 kV transformer in Urechesti substation.

For year 2015 under the 2010 topology, there is a large number of 220 kV lines in Albania, Romania and Serbia that are loaded over 80%: Targu Jiu – Paroseni and Urechesti – Targu Jiu in Romania, as well as 220/110 kV transformers in Fierza and Elbasan 1 substations in Albania, and 400/220 kV and 220/110 kV transformers in Kosovo B and Kosovo A substations in UNMIK. This leads to the conclusion that the 2010 transmission topology is not able to sustain the 2015 load-demand level and production dispatch. Results of n-1 analysis show many insecure states. Almost all elements that are loaded over 80% under normal operating conditions are now critical elements in n-1 analyses. Furthermore, for lot of contingency cases (losing of major interconnection and internal lines), the results could not be presented because of mathematical instability of the model. This indicates that all these cases are not feasible in reality, and that these contingencies can lead to voltage collapse and partial black outs in some parts of the monitored network.

For year 2015 under the 2015 topology, there is still a large number of 220 kV lines in Albania, Romania and Serbia that are loaded over 80%. The proposed network topology for 2015, as compared to the 2010 topology, has only a small influence in overall load level of the transmission network. Almost the same elements are found critical, especially in parts of the network that supply major consumption areas (Tirana in Albania, Bucharest and Timisoara in Romania, Belgrade in Serbia and Pristina in Serbia-UNMIK). Results of n-1 analysis show that all identified insecure situations are located in internal networks that belong to Albania, Romania and Serbia. The planned network reinforcements for 2015 resolve some of the critical contingencies, especially in southern part of Serbia. Additional network reinforcements are necessary to make this regime more secure.

Table 27 Overview of high loaded elements in High Load Demand sensitivity cases

year			2010		2015			
regime			high load		high load			
topology					2010		2015	
AREA	ELEMENT	RATING MVA	LOAD MVA	%	LOAD MVA	%	LOAD MVA	%
ALB	HL 220kV AKASHA2-ARRAZH2 1	270			288	107	290	108
BUL	HL 220 kV M.EAST-ST.ZAGORA	228.6						
ROM	HL 220kV BRADU-TIRGOVI 1	302.6			285	94.3	284	93.8
	HL 220kV BUC.S-B-FUNDENI 1	320			309	96.7	308	96.1
	HL 220kV FILESTI-BARBOSI 1	277.4			248	89.5	246	88.6
	HL 220kV L.SARAT-FILESTI 1	277.4			241	86.9	239	86.2
	HL 220kV LOTRU-SIBIU 1	277.4					281	101
	HL 220kV LOTRU-SIBIU 2	277.4					281	101
	HL 220kV P.D.F.A-CETATE1 1	208.1			207	99.6	206	99.1
	HL 220kV P.D.F.A-RESITA 1	277.4	227	81.7	267	96.2	262	94.5
	HL 220kV P.D.F.A-RESITA 2	277.4	227	81.7	267	96.2	262	94.5
	HL 220kV P.D.F.II-CETATE1 1	277.4			271	97.7	270	97.3
	HL 220kV PAROSEN-BARU M 1	277.4			228	82		
	HL 220kV RESITA-TIMIS 1	277.4			230	82.8	225	81.1
	HL 220kV RESITA-TIMIS 2	277.4			230	82.8	225	81.1
	HL 220kV TG.JIU-PAROSEN 1	208.1	278	134	321	154	314	151
	HL 220kV URECHESI-TG.JIU 1	277.4	278	100	320	116	314	113
	HL 220 kV MINTIA-SIBIU	381.1						
SRB	HL 220kV JBGD3 21-JOBREN2 1	301			291	96.7	292	97
ALB	TR 220/110 kV ABURRE 1	60			49.5	82.5	52.2	87
	TR 220/110 kV ABURRE 2	60			49.5	82.5	52.2	87
	TR 220/110 kV ABURRE 3	60			49.5	82.5	52.2	87
	TR 220/110 kV AELBS1 1	90			87.7	97.5	87.8	97.6
	TR 220/110 kV AELBS1 2	90			87.7	97.5	87.8	97.6
	TR 220/110 kV AELBS1 3	90	122	102	94.2	105	94.4	105
	TR 220/110 kV AFIER 1	120	100	111	149	124	152	126
	TR 220/110 kV AFIER 2	90	95.6	106	122	136	124	138
	TR 220/110 kV AFIER 3	90			117	130	119	132
	TR 220/110 kV AFIERZ 1	60			58	96.7	59.9	99.8
	TR 220/110 kV AFIERZ 2	60			58	96.7	59.9	99.8
	TR 220/110 kV AKASHA 1	100			93.4	93.4	94.7	94.7
	TR 220/110 kV AKASHA 2	100			93.4	93.4	94.7	94.7
	TR 220/110 kV ARRAZH 1	100			87.7	87.7	87.5	87.5
	TR 220/110 kV ARRAZH 2	100			87.7	87.7	87.5	87.5
	TR 220/110 kV ATIRAN 2	120			97.5	81.3	96.4	80.3
	TR 220/110 kV ATIRAN 3	120			102	85.2	101	83.9
BIH	TR 220/110 kV MO-4 3	150					124	83
	TR 400/110 kV UGLJEV 1	300			259	86.3	256	85.4
CRO	TR 220/110 kV TESISA 1	200			179	89.4	179	89.7
ROM	TR 220/110 kV BARBOS 1	200			167	83.6	167	83.3
	TR 220/110 kV FUNDE2 1	200	179	89.3	241	120	240	120
	TR 220/110 kV FUNDEN 1	200			204	102	203	102
	TR 220/110 kV TIMIS 1	200			172	85.9	170	85.2
	TR 400/110 kV BRASOV 1	250			232	92.6	230	92.1
	TR 400/110 kV CLUJ E 1	250			208	83.4	206	82.6
	TR 400/110 kV DIRSTE 1	250			221	88.4	220	87.8
	TR 400/220 kV BUC.S 1	400			378	94.6	377	94.1
	TR 400/220 kV BUC.S 2	400			378	94.6	377	94.1
	TR 400/220 kV IERNUT 1	400			408	102	405	101
	TR 400/220 kV URECHE 1	400	344	86.1	487	122	480	120
	TR 400/220 kV MINTIA	400						
SRB	TR 220/110 kV JBGD3 1	200			175	87.5	175	87.4
	TR 220/110 kV JBGD3 2	150			137	91.4	138	91.7
	TR 220/110 kV JPRIS4 1	150			137	91.3		
	TR 220/110 kV JPRIS4 2	150			137	91.3		
	TR 220/110 kV JTKOSA 2	150	132	87.7	151	101	134	89
	TR 220/110 kV JTKOSA 3	150	134	89.3	154	103	136	90.6
	TR 220/110 kV JZREN2 2	150	120	80.1	134	89.2	134	89.2
	TR 400/110 kV JJAGO4 A	300			246	81.9		
	TR 400/220 kV JBGD8 1	400	326	81.6	332	83	330	82.6
	TR 400/220 kV JTKOSB 1	400			412	103	352	88
	TR 400/220 kV JTKOSB 2	400			430	108	368	91.9
	TR 400/220 kV JTKOSB 3	400			430	108	368	91.9
MNG	TR 220/110 kV JTPLJE 1	125					102	82

A12.3.4 Sensitivity – Low Demand Forecast

Similarly, the WASP model is re-run under the low load forecast. Peak and energy demands of the high forecast are shown in Table 19 and Table 20. The rehabilitation program given by the utilities is used.

A.3.4.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 28. In addition to the 11,574 MW of rehabilitated units, 6,176 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 1,328 MW of nuclear, 2,088 MW of lignite, 430 MW of CHP plants, and 1,248 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2.

In the period 2011-2015, the following units would be added:

- Two Kolubara lignite units.

In the period 2016-2020, the following units would be added:

- Cernavoda nuclear unit #3;
- Two 300-MW and two 500-MW Kosovo lignite plants;
- Five 100-MW CHP plants; and
- One 300-MW and two 500-MW combined cycle plants.

The total net present value of the total system investment and operating costs amounts to 29.5 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 28: *Scenario C – Low Demand - Capacity Expansion Plan and LOLP*

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	26,927			42,817	0.000
2006	26,789	Maritsa East 3 (189 MW) x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	26,708	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	26,617	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.000

Scenario C – Low Demand - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	26,574	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.000
2010	26,573	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW)	40,653	0.000
2011	26,823	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)		41,006	0.000
2012	27,080	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)		41,519	0.000

Scenario C – Low Demand - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	27,502	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)		40,201	0.000
2014	28,000	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)		40,979	0.000
2015	28,511	Varna 6 (200 MW) Bitola 1 (207 MW)	Kolubara B (320 MW)x2	40,909	0.000
2016	29,245	Kostolac B1 (320 MW)		41,229	0.000
2017	30,047	Bitola 2 (207 MW)	CCHP (86 MW) Kosovo B3 (274 MW)x2 Lignite Subcritical (450 MW)	41,786	0.104
2018	30,872	Kostolac B1 (320 MW)	Cernavoda 3 (664 MW) CCHP (86 MW)	42,555	0.131
2019	31,732		Combined cycle (480 MW) Lignite Subcritical (450 MW)	43,278	0.131
2020	32,604	Bitola 3 (207 MW)	CCHP (86 MW)x3 Combined cycle (288 MW) Combined cycle (480 MW)	44,304	0.000
Total		**11,574 MW**	**6,176 MW**		

A.3.4.2 GTMax Results

The GTMax model is run for 2010 and 2015 under average hydrologic conditions for the peak week only. The results are shown in Table 29.

Table 29: GTMax Results – Low Demand Forecast

Regional Market Operation - 2010 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	154.7	86.9	23.5	110.4	44.3	0.0	681	20.3
B&H	257.2	151.7	81.5	233.2	24.1	0.0	1,903	20.3
Bulgaria	734.0	51.1	1061.7	1112.8	0.0	378.8	15,980	20.3
Croatia	412.7	130.0	125.5	255.6	157.1	0.0	1,716	20.3
Macedonia	162.7	18.7	122.5	141.1	21.6	0.0	1,409	20.3
Montenegro	80.1	49.1	0.0	49.1	34.0	0.0	0	20.3
Romania	1055.6	240.1	689.6	929.8	125.9	0.0	9,356	20.3
Serbia	729.6	215.2	576.0	791.2	0.0	64.6	9,984	20.3
UNMIK	136.9	1.8	98.7	100.5	36.4	0.0	818	20.3
Total	**3723.6**	**944.6**	**2779.0**	**3723.6**	**443.4**	**443.4**	**41,846**	**-**

Regional Market Operation – 2015 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	168.6	86.9	23.5	110.4	58.3	0.0	681	22.6
B&H	286.5	151.7	86.2	237.9	48.7	0.0	2,017	22.6
Bulgaria	749.1	51.2	1129.3	1180.5	0.0	431.4	17,319	22.6
Croatia	463.7	130.0	90.0	220.0	243.7	0.0	785	22.6
Macedonia	181.7	18.7	117.1	135.8	45.9	0.0	1,675	22.6
Montenegro	74.8	49.1	32.1	81.2	0.0	3.4	884	22.6
Romania	1141.0	240.1	776.0	1016.1	124.9	0.0	11,320	22.6
Serbia	797.7	215.2	692.6	907.9	0.0	113.2	11,579	22.6
UNMIK	128.2	1.8	99.8	101.6	26.5	0.0	827	22.6
Total	**3991.4**	**944.7**	**3046.7**	**3991.4**	**548.0**	**548.0**	**47,087**	**-**

Note: LMP = fuel + variable O&M Costs

A12.3.5 Sensitivity – High Gas Price

Gas prices are doubled under this sensitivity scenario. Under the Reference Case, gas prices were expected to increase from €2.90/GJ in 2005 to €3.00/GJ in 2010, and €3.23/GJ in 2020. Under this sensitivity case, gas prices are expected to increase from €5.80/GJ in 2005 to €6.00/GJ in 2010 and €6.46/GJ in 2020.

A.3.5.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 30. In addition to the 11,574 MW of rehabilitated units, 13,082 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear, 4,436 MW of lignite, 940 MW of imported coal, 430 MW of CHP plants, and 1,824 MW of combined cycle gas-fired generation, as well as 2,112 MW in HPPs are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- One 300-MW and one 500-MW Kosovo lignite plants; and
- HPP Zhur.

In the period 2011-2015, the following units would be added:

- Cernavoda nuclear unit #3;
- Belene nuclear unit #1;
- Kolubara lignite unit #1 and #2;
- Two 500-MW Kosovo lignite plants;
- One 500-MW Imported Coal plant; and
- HPP Komarnica, Buk Bijela + Srbinje, Koštanica, Glavatičevo, Dabar, Andrijevo, and Zlatica.

In the period 2016-2020, the following units would be added:

- Four 300-MW and three 500-MW Kosovo lignite plants;
- One 500-MW Imported Coal plant;
- Five 100-MW CHP plants; and

- Three300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 35.9 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 30: Scenario C - High Gas Price - Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C - High Gas Price - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kosovo B3 (274 MW) HPP Zhur (293 MW)	41,670	0.100
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW) HPP Komarnica (168 MW)	42,511	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Kolubara B (320 MW) HPP Buk Bijela (456 MW) HPP Srbinje (55.5 MW)	43,856	0.000

Scenario C - High Gas Price - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Cernavoda 3 (664 MW) Belene (930MW) HPP Kostanica (552 MW)	44,684	0.158
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	HPP Glavaticevo (172 MW) HPP Dabar (160 MW)	45,794	0.079
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Lignite Subcritical (450 MW)x2 HPP Andrijevo (200 MW) HPP Zlatica (55.5 MW) Imported Coal (470 MW)	46,710	0.263
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (288 MW) Kosovo B4 (274 MW)	47,678	0.105
2017	35,026	Bitola 2 (207 MW)	CCHP (86 MW) Combined cycle (480 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	48,440	0.172
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (480 MW) Imported Coal (470 MW)	49,409	0.114
2019	37,024		CCHP (86 MW)x2 Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	50,386	0.031
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Combined cycle (288 MW) Lignite Subcritical (450 MW)	51,210	0.177
Total		**11,574 MW**	**13,082 MW**		

A.3.5.2 GTMax Results

The GTMax model is run for 2010 and 2015 under average hydrologic conditions for the peak week only. The results are shown in Table 31.

Table 31: GTMax Results – High Gas Price Case

Regional Market Operation - 2010 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	173.8	86.9	23.2	110.1	63.7	0.0	1,248	25.7
B&H	269.2	151.7	131.9	283.6	0.0	14.3	3,105	25.7
Bulgaria	902.3	55.9	1146.1	1202.0	0.0	299.8	19,049	25.7
Croatia	431.3	130.1	108.1	238.2	193.1	0.0	1,118	25.7
Macedonia	172.2	18.7	122.1	140.8	31.4	0.0	1,406	25.7
Montenegro	100.9	49.1	0.0	49.1	54.8	0.0	0	25.7
Romania	1145.3	240.1	826.1	1066.2	79.1	0.0	12,838	25.7
Serbia	820.2	221.0	607.6	828.6	0.0	11.3	11,757	25.7
UNMIK	158.0	8.8	246.0	254.8	0.0	96.7	2,233	25.7
Total	**4173.4**	**962.2**	**3211.2**	**4173.4**	**422.1**	**422.1**	**52,752**	**-**

Regional Market Operation – 2015 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	209.8	86.9	21.5	108.4	101.4	0.0	1,213	18.5
B&H	312.5	177.4	81.5	258.9	53.6	0.0	1,914	18.5
Bulgaria	969.7	53.0	1283.2	1336.2	0.0	366.5	20,983	18.5
Croatia	502.9	130.0	167.2	297.3	205.6	0.0	2,078	18.5
Macedonia	201.5	18.7	115.3	133.9	67.6	0.0	1,642	18.5
Montenegro	101.9	90.5	32.1	122.6	0.0	17.7	884	18.5
Romania	1330.3	240.1	865.5	1105.6	224.6	0.0	13,455	18.5
Serbia	864.6	213.9	690.3	904.2	0.0	42.5	12,747	18.5
UNMIK	156.3	8.8	373.6	382.4	0.0	226.2	3,122	18.5
Total	**4649.4**	**1019.2**	**3630.2**	**4649.4**	**652.9**	**652.9**	**58,039**	**-**

Note: LMP = fuel + variable O&M Costs

A12.3.6 Sensitivity – Imports/Exports

Currently, power imports and exports within the SEE region and with surrounding countries are based on short-term transactions and not on long-term agreements, except for a few cases of sharing power plant between jurisdictions. Historical data show great variations from year to year.

The impact of rejoining of UCTE 1 and 2 has increased the potential for major power transactions but there is no indication at this time of the timing and magnitude of these transactions.

This sensitivity run assumes a net import of 1,500 MW into the region, starting in 2010 until 2020. It includes a net import of 750 MW from Ukraine, 750 MW from the European UCTE network and 500 MW from Turkey, and a net export of 500 MW to Greece. All transactions are assumed to be base-load, i.e. 24 hours per day.

A.3.6.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 32. In addition to the 11,574 MW of rehabilitated units, 9,220 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear, 3,712 MW of lignite, 344 MW of CHP plants, and 1,824 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2.

In the period 2011-2015, the following units would be added:

- Kolubara lignite unit #1 and #2;
- Two 300-MW and one 500-MW Kosovo lignite plants;
- One 100-MW CHP plants; and
- One300-MW and one 500-MW combined cycle plant.

In the period 2016-2020, the following units would be added:

- Cernavoda nuclear unit #3;
- Belene nuclear unit #1;
- One 300-MW and four 500-MW Kosovo lignite plants;

- Three 100-MW CHP plants; and
- Two300-MW and one 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 32.42 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 32: Scenario C – Import / Export - Capacity Expansion Plan and LOLP

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW) x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C – Import / Export - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW)	40,653	0.000
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)		41,006	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)		41,519	0.000

Scenario C – Import / Export - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	CCHP (86 MW) Lignite Subcritical (450 MW) Kolubara B (320MW)x2	41,377	0.259
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)		42,155	0.221
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Kosovo B4 (274 MW)x2	42,761	0.198
2016	34,072	Kostolac B1 (320 MW)	Cernavoda 3 (664 MW)	43,745	0.000
2017	35,026	Bitola 2 (207 MW)	Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	44,436	0.130
2018	36,002	Kostolac B1 (320 MW)	Belene (930 MW) CCHP (86 MW)	45,471	0.112
2019	37,024		CCHP (86 MW) Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	46,362	0.206
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Lignite Subcritical (450 MW)x2	47,348	0.212
Total		**11,574 MW**	**9,220 MW**		

A.3.6.2 GTMax Results

The Case GTMax model is run for 2010 and 2015 under average hydrological conditions for the peak week only. The results are shown in Table 33.

Table 33: GTMax Results – Import/Export Case

Regional Market Operation - 2010 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	173.8	86.9	23.5	110.4	63.5	0.0	681	25.9
B&H	269.2	151.7	132.6	284.2	0.0	15.0	3,110	25.9
Bulgaria	899.1	53.7	1074.5	1128.2	**84.0**	229.1+84	16,272	25.9
Croatia	431.2	130.0	125.1	255.2	**185.3**	9.3	1,710	25.9
Macedonia	172.2	18.7	122.4	141.0	31.2	0.0	1,408	25.9
Montenegro	100.9	49.1	0.0	49.1	54.8	0.0	0	25.9
Romania	1145.3	240.1	765.2	1005.3	83.6**+56.4**	0.0	13,324	25.9
Serbia	817.3	218.9	620.3	839.1	**10.3**	35.0	10,817	25.9
UNMIK	158.0	1.8	100.8	102.6	55.4	0.0	834	25.9
Total	**4167.2**	**950.8**	**2964.4**	**3915.1**	**288.4+336**	**288.4+84**	**48,156**	**-**

Regional Market Operation – 2015 – Average Hydrology - week 3								
System	Total Demand (GWh)	Hydro Generation (GWh)	Thermal Generation (GWh)	Total Generation (GWh)	Import (GWh)	Export (GWh)	Generation Costs (€1000)	Average LMP (€/MWh)
Albania	209.8	86.9	23.5	110.4	99.4	0.0	681	25.4
B&H	312.5	151.7	130.4	282.1	30.4	0.0	3,070	25.4
Bulgaria	979.2	59.6	1145.5	1205.1	**84.0**	225.9+**84**	17,695	25.4
Croatia	503.9	130.8	209.7	340.5	4.1**+159.4**	0.0	3,394	25.4
Macedonia	201.5	18.7	120.0	138.7	62.8	0.0	1,733	25.4
Montenegro	101.9	49.1	32.1	81.2	23.7	0.0	884	25.4
Romania	1330.3	240.1	835.8	1075.9	164.2+**90.**	0.0	12,548	25.4
Serbia	874.6	221.1	692.7	913.8	**2.5**	44.7	11,583	25.4
UNMIK	156.3	1.8	268.4	270.2	0.0	114.0	2,539	25.4
Total	**4669.9**	**959.6**	**3458.1**	**4417.8**	**384.6+336**	**384.6+84**	**54,128**	**-**

Note: LMP = fuel + variable O&M Costs

A.3.6.3 PSS/E Results

The GTMax output for the peak hour in 2010 and 2015 were used in the PSS/E model to analyse the behaviour of the regional network under a Net Imports sensitivity case. The detailed results of these studies are presented in Appendix 12.

Table 34 summarises overview of regional losses. Net imports have a positive impact on regional losses, reducing the 2010 losses from 737 MW under the Reference Case to 685 MW under the Net Imports case. The same trend can be observed in 2015.

Table 34: Peak Hour - Regional Losses (MW) under Average Hydrologic Conditions

Case	Year 2010	Year 2015	
	2010*	2010*	2015*
Reference Case	737.1	1,035.1	1,006.4
Imports/Exports	684.8	NA	850.3

*topogy

In 2010, a significant increase of power flows is noticed along the Slovenian-Croatian, Ukrainian-Romanian and Bosnian-Montenegrin interfaces. However, interconnection lines are not jeopardised since they are loaded far below their thermal ratings. Power flows through the Bosnian-Croatian, Serbian-Bosnian, Serbian-Croatian, Serbian-Montenegrin and Grecian-Albanian interfaces are decreased at the same time.

Power losses, compared to the Reference Case, show an increase in the power systems of Bulgaria (7.9 %) and Montenegro (9 %), but a decrease in Romania (-16 %), Serbia and UNMIK (-10.1 %). Regional power losses are decreased (-7.1 %) when the situation includes additional power import.
In 2015, power losses show an increase only in the power system of Macedonia (5%). In the other power systems power losses decreased, the most significantly in the power systems of Romania (-26%) and Montenegro (-23%). Regional power losses decreased by 16% when compared to the Reference Case.

Table 35 summarises the transmission lines and transformers that are loaded over 80% of their thermal limits. This is an indication on what parts of the transmission network show weak spots and what network reinforcements would be necessary. Certain internal network reinforcements would be necessary to sustain given load-demand level and production pattern given by the GTMax model.

Table 35: Overview of high loaded elements in Net Imports sensitivity cases

year			2010		2015	
topology			2010*		2015*	
AREA	ELEMENT	RATING MVA	LOAD MVA	%	LOAD MVA	%
ALB	HL 220kV AKASHA2-ARRAZH2 1	270			236	87.3
BUL	HL 220 kV M.EAST-ST.ZAGORA	228.6	189	82.6	191	83.5
ROM	HL 220kV BRADU-TIRGOVI 1	302.6			247	81.6
	HL 220kV BUC.S-B-FUNDENI 1	320			266	83.1
	HL 220kV FILESTI-BARBOSI 1	277.4				
	HL 220kV L.SARAT-FILESTI 1	277.4				
	HL 220kV LOTRU-SIBIU 1	277.4				
	HL 220kV LOTRU-SIBIU 2	277.4				
	HL 220kV P.D.F.A-CETATE1 1	208.1			204	98.2
	HL 220kV P.D.F.A-RESITA 1	277.4				
	HL 220kV P.D.F.A-RESITA 2	277.4				
	HL 220kV P.D.F.II-CETATE1 1	277.4				
	HL 220kV PAROSEN-BARU M 1	277.4				
	HL 220kV RESITA-TIMIS 1	277.4				
	HL 220kV RESITA-TIMIS 2	277.4				
	HL 220kV TG.JIU-PAROSEN 1	208.1				
	HL 220kV URECHESI-TG.JIU 1	277.4				
	HL 220 kV MINTIA-SIBIU	381.1				
SRB	HL 220kV JBGD3 21-JOBREN2 1	301			277	92.2
ALB	TR 220/110 kV ABURRE 1	60			49.1	81.8
	TR 220/110 kV ABURRE 2	60			49.1	81.8
	TR 220/110 kV ABURRE 3	60			49.1	81.8
	TR 220/110 kV AELBS1 1	90			74	82.2
	TR 220/110 kV AELBS1 2	90			74	82.2
	TR 220/110 kV AELBS1 3	90	117	97.6	79.5	88.3
	TR 220/110 kV AFIER 1	120	96	107	131	109
	TR 220/110 kV AFIER 2	90	91.6	102	107	119
	TR 220/110 kV AFIER 3	90			102	114
	TR 220/110 kV AFIERZ 1	60			50.9	84.8
	TR 220/110 kV AFIERZ 2	60			50.9	84.8
	TR 220/110 kV AKASHA 1	100			82.9	82.9
	TR 220/110 kV AKASHA 2	100			82.9	82.9
	TR 220/110 kV ARRAZH 1	100				
	TR 220/110 kV ARRAZH 2	100				
	TR 220/110 kV ATIRAN 2	120				
	TR 220/110 kV ATIRAN 3	120				
BIH	TR 220/110 kV MO-4 3	150				
	TR 400/110 kV UGLJEV 1	300			256	85.4
CRO	TR 220/110 kV TESISA 1	200				
ROM	TR 220/110 kV BARBOS 1	200	174	86.9		
	TR 220/110 kV FUNDE2 1	200			214	107
	TR 220/110 kV FUNDEN 1	200			181	90.5
	TR 220/110 kV TIMIS 1	200				
	TR 400/110 kV BRASOV 1	250			203	81
	TR 400/110 kV CLUJ E 1	250				
	TR 400/110 kV DIRSTE 1	250				
	TR 400/220 kV BUC.S 1	400				
	TR 400/220 kV BUC.S 2	400				
	TR 400/220 kV IERNUT 1	400				
	TR 400/220 kV URECHE 1	400				
	TR 400/220 kV MINTIA	400				
SRB	TR 220/110 kV JBGD3 1	200			169	84.7
	TR 220/110 kV JBGD3 2	150			127	84.5
	TR 220/110 kV JPRIS4 1	150				
	TR 220/110 kV JPRIS4 2	150				
	TR 220/110 kV JTKOSA 2	150				
	TR 220/110 kV JTKOSA 3	150				
	TR 220/110 kV JZREN2 2	150			122	81
	TR 400/110 kV JJAGO4 A	300				
	TR 400/220 kV JBGD8 1	400				
	TR 400/220 kV JTKOSB 1	400				
	TR 400/220 kV JTKOSB 2	400				
	TR 400/220 kV JTKOSB 3	400				
MNG	TR 220/110 kV JTPLJE 1	125				

Results of n-1 analysis for 2010 show insecure system situations in Albania, Bulgaria, Romania and Serbia. Loss of the 220 kV line between the Rrashbul and Tirana substations can cause overloading of 220 kV line between the Elbassan and Fier substations in Albania.

The opposite case is also found critical. Loss of the 400 kV line in Bulgaria, Maritsa East 2-Bourgas can cause overloading of 400 kV line Plovdiv-Maritsa East 3. Loss of the 220 kV line M. East 2-G.Oryahovitsa can cause overloading of 220 kV line M. East 2-St. Zagora.

Single outages of 400/110 kV transformers in the stations Brasov and Dirste in Romania are also found critical.

Loss of the OHL 220 kV in the Belgrade area can cause overloading of the parallel line. Loss of the 220 kV line between pumped storage power plant Bajina Basta and SS Pozega is also found critical. Loss of one 400/110 kV transformer in the Nis substation is critical due to possible overloading of the other parallel one but this problem could be solved by dispatcher intervention.

Results of n-1 analysis for 2015 show insecure system situations in Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Romania and Serbia. Transformer overloadings in Zerjavinec (Croatia), Nis and Pancevo (Serbia) substations may be removed by system operator actions.

A12.3.7 Sensitivity – Full Environmental Compliance

Under the Reference Case, plans given by the utilities and ministries were followed for both rehabilitation and environmental controls that include full compliance (particulate, NOx and SOx controls) with EC regulations for Romania and Bulgaria. For the other jurisdictions, rehabilitation includes technical rehabilitation and partial environmental compliance (particulate and NOx) for plants planned for rehabilitation.

A sensitivity case is performed to analyse the impact of full environmental compliance in all jurisdictions. A detailed presentation of these results and analyses are presented in a separate report entitled "Generation Investment Study – Implications for Investments in Environmental Protection, Study by SEEC for World Bank, 2005."

A.3.7.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 36. In addition to the 11,574 MW of rehabilitated units, 11,000MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear, 4,436 MW of lignite, 344 MW of CHP plants, and 2,880 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite unit #1 and #2; and
- One 500-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Belene nuclear unit #1;
- One 300-MW and two 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Two300-MW and one 500-MW combined cycle plant.

In the period 2016-2020, the following units would be added:

- Cernavoda nuclear unit #3;
- Three 300-MW and three 500-MW Kosovo lignite plants;

- Two 100-MW CHP plants; and
- Three 300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 34.42 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 36: ***Scenario C – Full Environmental Compliance - Capacity Expansion Plan and LOLP***

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,654	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,078	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,499	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW) Maritsa East 1 (275 MW)x2	41,028	0.000

Scenario C – Full Environmental Compliance - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Kolubara B (320MW)	41,272	0.000
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Kolubara B (320MW) Lignite Subcritical (450 MW)	41,606	0.000
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)		41,962	0.188
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Combined cycle (288 MW)	42,748	0.000

Scenario C – Full Environmental Compliance - Capacity Expansion Plan and LOLP (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Belene (930 MW) CCHP (86 MW) Lignite Subcritical (450 MW) Kosovo B3 (274 MW)	43,191	0.124
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)		43,950	0.000
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	44,553	0.181
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,430	0.156
2017	35,026	Bitola 2 (207 MW)	Cernavoda 3 (664 MW) Combined cycle (288 MW) Combined cycle (480 MW)	46,338	0.00
2018	36,002	Kostolac B1 (320 MW)	Kosovo B4 (274 MW) Lignite Subcritical (450 MW)	47,078	0.2612
2019	37,024		Combined cycle (288 MW) Kosovo B5 (274 MW)x2 Lignite Subcritical (450 MW)	48,163	0.061
2020	38,049	Bitola 3 (207 MW)	CCHP (86 MW) Lignite Subcritical (450 MW) Combined cycle (288 MW)	48,987	0.252
Total		**11,574 MW**	**11,000MW**		

A12.3.8 Sensitivity – Nuclear

Under the Reference Case, the Belene nuclear plant in Bulgaria is expected to come on line in 2017. This sensitivity case considers the Belene nuclear plant coming on line in 2012.

A.3.8.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 37. In addition to the 11,574 MW of rehabilitated units, 11,000 MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW of nuclear, 4,436 MW of lignite, 344 MW of CHP plants, and 2,880 MW of combined cycle gas-fired generation are added to the regional system.
In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- Kolubara lignite unit #1; and
- One 500-MW Kosovo lignite plant.

In the period 2011-2015, the following units would be added:

- Belene nuclear unit #1;
- Kolubara lignite unit #2;
- One 300-MW and two 500-MW Kosovo lignite plants;
- One 100-MW CHP plants; and
- Two 300-MW and one 500-MW combined cycle plant.

In the period 2016-2020, the following units would be added:

- Cernavoda nuclear unit #3;
- Three 300-MW and three 500-MW Kosovo lignite plants;
- Three 100-MW CHP plants; and
- Three 300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 34.12 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 37: Scenario C - Alternative Nuclear Program

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C - Alternative Nuclear Program (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kolubara B (320 MW)	41,423	0.116
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW)	42,096	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Belene (930MW)	43,539	0.000

Scenario C - Alternative Nuclear Program (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Kosovo B3 (274 MW) Lignite Subcritical (450 MW) Combined cycle (288 MW)	43,233	0.129
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)		44,011	0.000
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	CCHP (86 MW) Combined cycle (288 MW) Combined cycle (480 MW) Lignite Subcritical (450 MW)	44,605	0.133
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,491	0.133
2017	35,026	Bitola 2 (207 MW)	Cernavoda 3 (664 MW) CCHP (86 MW) Combined cycle (480 MW)	46,194	0.149
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (288 MW) Kosovo B4 (274 MW) Lignite Subcritical (450 MW)	47,225	0.064
2019	37,024		CCHP (86 MW) Combined cycle (288 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	48,116	0.132
2020	38,049	Bitola 3 (207 MW)	Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	49,128	0.113
Total		**11,574 MW**	**11,000 MW**		

A12.3.9 Sensitivity – 15% Increase in Construction Cost

Under this scenario all construction costs for the construction of new plants were increased by 15%.

A.3.9.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 38. In addition to the 11,574 MW of rehabilitated units, 11,000MW of new capacity is added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13. In addition, 2,258 MW in nuclear, 4,436 MW of lignite, 344 MW of CHP plants, and 2,880 MW of combined cycle gas-fired generation, are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- One 500-MW Kosovo lignite plants; and
- Kolubara lignite unit #1.

In the period 2011-2015, the following units would be added:

- Kolubara lignite unit #2;
- Cernavoda nuclear unit #3;
- One 300 MW and Two 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Two 300-MW and one 500-MW combined cycle plant.

In the period 2016-2020, the following units would be added:

- Belene nuclear unit #1;
- Three 300-MW and three 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Three 300-MW and two 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 34.46 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 38: Scenario C 15% Increase in Construction Cost for New Candidate Plants

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C 15% Increase in Construction Cost for New Candidate Plants (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kolubara B (320 MW)	41,423	0.116
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Kolubara B (320 MW)	42.096	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)	Combined cycle (288 MW)	42,897	0.000

Scenario C 15% Increase in Construction Cost for New Candidate Plants (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	Cernavoda 3 (664 MW)CCHP (86 MW) Lignite Subcritical (450 MW) Kosovo B3 (274 MW)	43,053	0.224
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	CCHP (86 MW)	43,917	0.037
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Lignite Subcritical (450 MW) Combined cycle (288 MW) Combined cycle (480 MW)	44,425	0.233
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,311	0.225
2017	35,026	Bitola 2 (207 MW)	Belene (930MW) Combined cycle (480 MW)	46,194	0.149
2018	36,002	Kostolac B1 (320 MW)	Combined cycle (288 MW) Kosovo B5 (274 MW) Lignite Subcritical (450 MW)	47,225	0.064
2019	37,024		CCHP (86 MW) Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	48,116	0.132
2020	38,049	Bitola 3 (207 MW)	Combined cycle (288 MW) Lignite Subcritical (450 MW) Kosovo B7 (274 MW)	49,128	0.113
Total		**11,574 MW**	**11,000 MW**		

A12.3.10 Sensitivity – Discount Rate

A discount rate of 7% was used for this sensitivity case, instead of 10% used in the Reference Case.

A.3.10.1 WASP Results

The results of the 2005-2020 expansion plan are shown in Table 39. In addition to the 11,574 MW of rehabilitated units, 10,986 MW of new capacity was added during the study period to maintain a LOLP of less than one day per year. The new net capacity additions include 1,082 MW that is already under construction or fully committed by the utilities, as shown in Table 13 in addition, 2,258 MW of nuclear, 4,710 MW of lignite, 344 MW of CHP plants, and 2,592 MW of combined cycle gas-fired generation are added to the regional system.

In addition to the plants shown in Table 13, WASP results show that, for the period 2005-2010, the following new capacity would be added to the regional power system:

- Cernavoda nuclear unit #2;
- One 500-MW Kosovo lignite plants;
- Kolubara lignite unit #1.

In the period 2011-2015, the following units would be added:

- Belene nuclear unit #1;
- Cernavoda nuclear unit #3;
- Kolubara lignite unit #2;
- One 300-MW and two 500-MW combined cycle plant;
- Two 100-MW CHP plants; and
- One 300-MW combined cycle plant.

In the period 2016-2020, the following units would be added:

- Four 300-MW and two 500-MW Kosovo lignite plants;
- Two 100-MW CHP plants; and
- Four 300-MW and three 500-MW combined cycle plant.

The total net present value of the total system investment and operating costs amounts to 39.84 billion Euros. This includes the net present value of the capital costs for the planned rehabilitation of existing units. This is computed in a separate spreadsheet (see Appendix 9). The net present value of the investment for planned rehabilitation is 4.12 billion Euros.

Table 39: Scenario C 7% Discount Rate

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2005	27,882			42,817	0.000
2006	28,202	Maritsa East 3 (189 MW)x2 Maritsa East 2 (148 MW) Ruse 3 (100 MW) Novi Sad 1 (100 MW) Zrenjanin (100 MW)	Bucuresti Sud (100MW)	42,217	0.000
2007	28,553	Fierza (58 MW) Balsh (11MW) Tuzla 5 (182 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Turceni 5 (272 MW) Deva 1 (167 MW) Nikola Tesla A4 (280 MW) Kostolac A1 (90 MW) Novi Sad 2 (108 MW)	Bucuresti Sud (100MW)	40,632	0.000
2008	28,927	Tuzla 6 (198 MW) Kakanj 6 (100 MW) Maritsa East 3 (189 MW) Maritsa East 2 (148 MW) Rovinari 3 (278 MW) Galati 3 (92 MW) Deva 2 (167 MW) Nikola Tesla A6 (280 MW)	Bucuresti Vest (100MW)	40,621	0.118

Scenario C 7% Discount Rate *(Continued)*

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2009	29,234	Gacko (276 MW) Maritsa East 2 (148 MW) Maritsa East 2 (185 MW) Ruse 4 (100 MW) Turceni 6 (272 MW) Isalnita 7 (266 MW) Paroseni 4 (120 MW)	Vlora (132 MW) Maritsa East 1 (275 MW)x2	41,096	0.188
2010	29,649	Bobov Dol 1 (198 MW) Varna 1 (200 MW) Ruse 1 (25 MW) Turceni 3 (272 MW) Galati 4 (50 MW) Nikola Tesla A1 (191 MW) Deva 4 (167 MW)	Bucuresti Vest (100MW) Cernavoda 2 (664 MW) Lignite Subcritical (450 MW) Kolubara B (320 MW)	41,423	0.116
2011	30,242	Ugljevik (279 MW) Bobov Dol 2 (198 MW) Varna 2 (200 MW) Ruse 2 (25 MW) Pljevlja (191 MW) Negotino (197 MW) Rovinari 5 (278 MW) Nikola Tesla A2 (191 MW)	Cernavoda 3 (664 MW) Kolubara B (320 MW)	42,760	0.000
2012	30,864	Bobov Dol 3 (198 MW) Varna 3 (200 MW) Ruse 5 (25 MW) Nikola Tesla B1 (580 MW)		43,273	0.000

Scenario C 7% Discount Rate (Continued)

Year	Peak Load (MW)	Capacity Additions		Total System Net Capacity (MW)	LOLP (%)
		Rehabilitation	New Plants		
2013	31,535	Varna 4 (200 MW) Ruse 6 (25 MW) Oslomej (109 MW) Galati 5 (92 MW)	CCHP (86 MW) Kosovo B3 (274 MW) Lignite Subcritical (450 MW) Combined cycle (288 MW)	43,053	0.224
2014	32,282	Varna 5 (200 MW) Galati 6 (92 MW) Nikola Tesla B2 (580 MW)	CCHP (86 MW)	43,917	0.037
2015	33,151	Varna 6 (200 MW) Bitola 1 (207 MW)	Belene (930MW) Lignite Subcritical (450 MW)	44,587	0.245
2016	34,072	Kostolac B1 (320 MW)	CCHP (86 MW) Combined cycle (480 MW)	45,473	0.165
2017	35,026	Bitola 2 (207 MW)	Combined cycle (480 MW)x2 Kosovo B4 (274 MW)	46,180	0.210
2018	36,002	Kostolac B1 (320 MW)	CCHP (86 MW) Kosovo B5 (274 MW)x2 Lignite Subcritical (450 MW)	47,283	0.056
2019	37,024		Combined cycle (288 MW)x2 Lignite Subcritical (450 MW)	48,102	0.233
2020	38,049	Bitola 3 (207 MW)	Combined cycle (288 MW) Kosovo B6 (274 MW) Lignite Subcritical (450 MW)	49,114	0.197
Total		**11,574 MW**	**10,986 MW**		