Southeastern Europe Power Generation Investment Study (GIS) Update

Presented to the Athens Forum on ECSEE
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October 25, 2006

Topics Covered

- Objective and approach
- Key findings of original GIS
- Updating the GIS
- Overview of key results
- Key energy supply options
- Conclusion

Objective

Update the Original GIS (2004) to:

- Examine the impact of recent changes in fuel prices and CO2 prices
- Explore the case for electricity imports
- Explore expanded energy supply options for the region

Approach

- Maintain the same assumptions with GIS regarding methodology and models (screening curve analysis and WASP)
- Revise the fuel and CO2 prices in the model based on new forecasts
- Relax some constraints of the original GIS to explore broader energy supply options: e.g. imported coal, open cycle gas turbines and nuclear energy

Key Findings of Original GIS

- 11.6 GWs of existing capacity need to be rehabilitated and retrofitted with environmental controls
- 15.5 GWs of new capacity needed if the region is not interconnected
- But only 11 GWs of new capacity needed if regional optimization is pursued, saving €3 billion
- Key selections under regional optimization:
  - Kosovo lignite (4,200MWs)
  - Combined Cycle Gas Turbines (3,000MWs)
  - Complete partly completed and committed plants (Cernavoda 2 &3, Belene 1, Kolubara B, Maritsa East 1 and 4X100 CHPs)
  - 400 MW CHPs
  - Approx 2,000 MWs of hydro could be added at an additional cost (NPV) of €1.1 billion relative to least cost
  - Other renewables were not included as non-competitive

Updating the Original GIS
Key Changes Relative to Original GIS

- Revised fuel prices for Basecase
  - Oil : $37-53/bbl vs $23-26/bbl in original GIS
  - Natural gas : €4.4-6.2/GJ vs. €2.9-3.23/GJ
  - More recent estimates for:
    - Kosovo lignite (€0.92/GJ vs €0.62/GJ), and
    - Maritsa East lignite (€1.09/GJ vs €0.88/GJ)
- Alternative fuel price scenarios:
  - Low case: $23-48/bbl oil prices
  - High case: $70-100/bbl oil prices
- Higher CO2 values
  - Alternative scenarios: €20/ton and €30/ton vs €5/ton and €10/ton in the original GIS

Gas Prices for Generic Candidates (€/GJ)

	Scenario	2006	2010	2015	2020
Original GIS	Low	2.11	2.11	2.11	2.11
	Base	2.90	3.00	3.12	3.23
	High	3.87	4.14	4.26	4.31
Updated GIS	**Low**	**5.65**	**2.82**	**2.71**	**2.70**
	Base	**6.20**	**4.41**	**4.40**	**4.51**
	High	**8.28**	**11.73**	**11.77**	**11.74**

Additional Changes Relative to Original GIS

- Higher electricity imports
  - Alternative scenario: 3GWs in 2010-2014 and 5GWs in 2015-2020
  - Original GIS: 1.5GWs in 2010-2020
- Relax constraints for new candidates
  - Allow imported coal, nuclear and open cycle gas turbines to compete
- Maintain reasonable constraints (max)
  - 5,000MW Kosovo lignite starting after 2012
  - 8,000MW gas fired (CCGT) after 2010
  - 3,000MW imported coal
  - 3,000MW of nuclear (5,000MW in CO2 Scenarios)

Key Findings

Overview

- Higher fuel prices seem to reduce need for new capacity by correspondingly increasing the capacity stock to be rehabilitated (with environmental controls)
- But higher CO2 prices seem to do the opposite – more new gas fired capacity, and also more nuclear selected, unless more hydro and renewables are supported
- Importing electricity (from Ukraine, Russia) would reduce need for both new and rehab capacity – seems like a balanced scenario
- New gas capacity highly influenced by availability of gas and imported coal and/or electricity could be the next choice

  → *Diversification of energy supply is key*

Least-Cost Options

- Least-cost options under Baseline assumptions are biased towards coal
  - Kosovo lignite (maximum feasible capacity)
  - Imported coal
  - Natural gas-fired plants
- But, gas and CO2 prices could change this ranking (post-2012 uncertainty on CO2 is a constraining factor)
- More nuclear may not be practical; more imported coal/electricity could be alternate viable options
- The 2,112 MW of hydro candidates included are not only not sufficient to make a difference, but are also feasible only under high CO2 price scenario which is itself uncertain

SEE Region - Rehab and New Capacity Needs (2006-20)

Scenario	Rehab (MW)	New (MW)
Official plan:	11,574	11,000
Baseline Justified:	9,361	12,696
High electricity imports	9, 361	6,936
High oil/gas prices:	10,061	12,494
Low oil/gas prices:	6,814	14,712
€20/ton of CO2:	4,573	16,634
€30/ton of CO2:	Zero	21,259
High gas/CO2 prices	10,061	13,926

Key Energy Supply Options - 1

- *Local lignite*:
  - Kosovo: cheapest fuel; most scenarios indicate the need for 4,000-4,800 MWs; high CO2 prices may limit its use, but significant capacity (~2500MW) is still competitive
  - Other lignite mines are more expensive; most are non-competitive
- *Imported coal*: up to 3,000 MW selected; relatively stable price; plentiful and secure supply; but lack of infrastructure (ports; railroads); presently, available in Bulgaria, Croatia and Romania;
- *Natural gas*: up to 8,000 MW selected; cleanest fuel, but highly volatile price; multiple supply sources could enhance diversification and competition, but require significant investments

Key Energy Supply Options - 2

- *Nuclear*: competitive at €30/ton CO2, but serious obstacles remain (siting and financing)
- *Hydro:* 2,112 MW competitive under high gas prices or high CO2 prices; higher potential exists but more comprehensive assessment is needed
- *Renewables*: Renewables may be competitive at high gas or CO2 prices; more review needed
- *CHP*: District Heating could be modernized and expanded to generate electricity, too; high efficiency and small increments which are easier to finance are attractive features; more detail assessment is needed
- *Electricity imports* (from Ukraine and Russia): Viable option; depends on pricing and strengthening of transmission

In Conclusion…

- The case for regional trading through ECSEE supported by GIS is further strengthened
- SEE has the potential mix of energy resources to support a diversification strategy and thereby help reduce energy supply or security risks
- Ongoing study on SEE regional gasification could support and enhance the realization of the gas – coal capacity mix for the region with new technologies to reduce environmental impacts
- The option of importing significant amount of electricity over long-term deserves serious attention
- Periodic updating of GIS (say every 3 years or when significant events warrant) is recommended

Thank you

Annexes

Results of GIS Update
Updated vs Original GIS

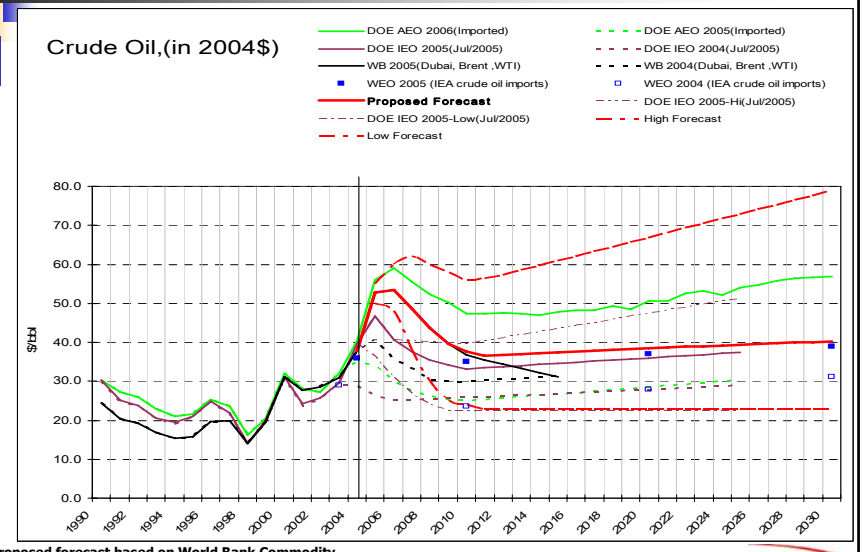
	Rehabs (MW)	New Plants (MW)	Key Selections of New Plants
Original GIS Base	11,574	11,000	Kosovo: 4,200MW (4x300, 6x500) CCGTs: 3,000MW (5x300, 3x500) OCGTs: None (constrained) Imported Coal: None (constrained) Nuclear: None (except Cernavoda 2/3 & Belene)
Updated GIS Base	11,574	11,022	Kosovo: 4,300MW (6x300, 5x500) CCGTs: 1,300MW (1x300, 2x500) OCGTs: 100MW Imported Coal: 1500MW (3x500 MW) Nuclear: None (except Cernavoda 2/3 & Belene)
Updated GIS Base w/ justified rehab	9,361	12,696	Kosovo: 4,800MW(6x300+6x500) [max] CCGTs: 2,100MW (2X300+3X500) OCGTs: None Imported Coal: 2,500MW (5x500) Nuclear: None (except Cernavoda 2/3 & Belene)

9,361MWs out of 11,574MWs are cost effective to be rehabilitated
Key options: Kosovo, CCGTs and imported coal

Rehabilitation and Environmental Control Investments for Full Compliance

Jurisdiction	Capacity Affected (MW)	Rehabilitation cost for life Extension € million	Environmental Control Costs € million				Grand Total € million
			ESP	NOx	SOx	TOTAL	
Albania	72	30	0.000	1.510	9.720	11.230	41.230
Bosnia and Herzegovina	1,765	391	25.810	57.780	215.500	299.090	690.090
Bulgaria	4,220	1,584	64.260	21.580	480.000	565.840	2149.84
Croatia	420	0	0.000	7.120	0.000	7.120	7.120
Montenegro	210	72	4.500	3.560	28.000	36.060	108.060
FYROM	1,110	438	2.000	1.120	95.000	98.120	536.120
Romania	4,114	1,038	56.700	72.680	415.500	544.880	1582.88
Serbia	4,672	1,160	66.240	66.120	491.000	623.360	1783.36
UNMIK	678	0	15.800	23.080	41.000	79.880	79.880
TOTAL	17,261	4,713	235.3	254.6	1775.7	2,265.58	6,978.58

Oil prices forecasts considered



Proposed forecast based on World Bank Commodity Forecasts up to 2015; after 2015, the trend is based on the IEA World Energy Outlook 2005

Results: Alternative Fuel Prices

	Rehabs (MW)	New Plants (MW)	Key Selections of New Plants
Updated GIS Base w/ justified rehab	9,361	12,696	Kosovo: 4,800MW(6x300+6x500) [max] CCGTs: 2,100MW (2X300+3X500) OCGTs: None Imported Coal: 2,500MW (5x500) Nuclear: None (except Cernavoda 2/3 & Belene)
High Fuel Prices	10,061	12,494	Kosovo: 4,800MW (6x300+6x500)[max] CCGTs: 1,300MW (1X300+2X500) OCGTs: 1x100 MW Imported Coal: 3,000MW (6X500) [max] Nuclear: None (except Cernavoda 2/3 & Belene)
Low Fuel Prices	6,814	14,712	Kosovo: 4,800MW (6x300+6x500)[max] CCGTs: 4,000MW (5X300+ 5X500) OCGTs: 2X100 MW Imported Coal: 2,500MW (5X500) Nuclear: None (except Cernavoda 2/3 & Belene)

Cost-effectiveness of existing plants to be rehabilitated is affected significantly by gas prices
Key options remain: Kosovo, CCGTs and imported coal

Results: Alternative CO2 Prices

	Rehab (MW)	New Plants (MW)	Key Selections of New Plants
Update GIS Base w/ Justified Rehab	9,361	12,696	Kosovo: 4,800MW(6x300+6x500) [max] CCGTs: 2,100MW (2X300+3X500) OCGTs: None Imported Coal: 2,500MW (5x500) Nuclear: None (except Cernavoda 2/3 & Belene)
€20/to CO2	4,573	16,634	Kosovo: 2,500MW (5x500) CCGTs: 7,900MW (14x500 + 3x300) [max] OCGTs: None Imported Coal: 3,000MW (6X500) Nuclear: None (except Cernavoda 2/3 & Belene)
€30/to CO2	None	21,259	Kosovo: 2,500MW (5x500) CCGTs: 7,900MW (14x500 + 3x300) [max] OCGTs: None Imported Coal: 3,000MW (6X500)[max] Nuclear: 5x1000 MW (plus Cernavoda 2/3 & Belene)

None of the rehabilitations is cost-effective for €30/ton CO2; 4,573MWs under €20/ton CO2
Key options: Kosovo, CCGTs and imported coal; nuclear too for €30/ton CO2

Results: Alternative Hydro Scenarios

- 2,112 MWs of hydros (>100 MWs)
- Hydros are cost-effective under:
  - High gas price scenario
  - €20/ton of CO2
  - €30/ton of CO2
- 2,112 MW of hydros replace apprx. 500MW of the least cost plants (CCGT, lignite or imported coal depending on the scenario)
- Higher hydro potential exists (additional large hydro; run-of-river; rehabilitations); more comprehensive assessment is recommended

High Electricity Imports

[3GWs in 2010-2014 and 5GWs in 2015-2020]

	Rehabs (MW)	New Plants (MW)	Key Selections of New Plants
Updated GIS Base w/ justified rehab	**9,361**	**12,696**	**Kosovo: 4,800MW(6x300+6x500) [max] CCGTs: 2,100MW (2X300+3X500) OCGTs: None Imported Coal: 2,500MW (5x500) Nuclear: None (except Cernavoda 2/3 & Belene)**
High Electricity Imports	**9,361**	**6,936**	**Kosovo: 2,100MW (2x300+3x500) CCGTs: 1,000MW (2X500) OCGTs: 1X100 MW Imported Coal: None Nuclear: None (except Cernavoda 2/3 & Belene)**

Electricity imports replace mainly imported energy (gas and coal)