WWF

BRIEFING PAPER

JULY 2013

Investments with no future:

an examination of the economic viability of two new lignite plants in Greece

SUMMARY

The present study by WWF Greece investigates the economic viability of the new lignite unit, owned by the Greek Public Power Corporation SA (PPC) **Ptolemaida-V**, the construction of which has already been approved, and unit **Meliti-II**, that is included in PPC's investment plans and is scheduled to come into operation in 2021.[1]

Both investments[2] are being promoted within a social, economic and regulatory context that simply does not favour continued dependence on the so-called 'national fuel', lignite. As a result, and as this study demonstrates, **the two projects prove to be unprofitable in economic terms**, while the Ptolemaida-V power plant, under certain circumstances, might even have negative cash flows over the coming decades.

Climate change impacts are transforming the power system

The **findings of the latest climate change assessments** concur with the consensus among scientists: average CO2 concentration in the atmosphere is rapidly increasing, rendering global warming an indisputable fact – indicatively, 2012 has been the 9th warmest year on record, while 9 out of the 10 warmest years in history have all occurred in the 21st century.[3] Especially for Greece, it is estimated that the country will suffer a wide range of climate change impacts (more heatwaves, increased risk of fire occurrence, reduced annual rainfall, increased risk of extreme weather events and floods etc.) with a direct effect on two of the country's most crucial economic sectors: agriculture and tourism. At the same time, and according to the Bank of Greece, the cost of inaction by 2100 will reach €701 bi., which is more than double the country's national debt as of 2009.[4]

Under these circumstances, the respective **policies and measures for the reduction of greenhouse gas emissions within the EU, and abroad**, are increasingly moving towards the path of decarbonisation. The European Commission's Energy Roadmap,[5] published in 2011, implies a 85% reduction of GHG emissions by 2050 from the power sector. Even more ambitious are national policies of countries such as Denmark, Germany and the United Kingdom. At the same time, the decline of renewable energy (RES) costs, which makes the deployment of distributed power generation, owned by the consumers an attractive option, is about to displace traditional utilities from their dominant role as known to date. The **signs of an "energy revolution" are already being witnessed in Germany**, where out of the 39 coal-fired power plants announced in 2007, only 2 are operational today, while another 20 have already been cancelled.

[1] The two units will be constructed in the prefecture of Western Macedonia, Northern Greece. Ptolemaida-V is a 660MWe unit, with the possibility of providing 140MWth for district heating, and has an efficiency rating of 40.5%. Meliti-II's capacity is 450MW.

[2] The total budget of the Ptolemaida unit is €1.4 billion (38% will be covered by own resources, 44% by the German export agency Hermes and bank KfW, while the rest will be covered by the European Investment Bank).

[3] NASA, "NASA Finds 2012 Sustained Long-Term Climate Warming Trend", 15.01.2013 http://www.nasa.gov/topics/earth/features/2012-temps.html

[4] Bank of Greece, "The environmental, economic and social impacts of climate change in Greece", June 2011, http://www.bankofgreece.gr/BogEkdoseis/ClimateChange_FullReport_bm.pdf

[5] European Commission, Energy Roadmap 2050, 15.11.2011 http://ec.europa.eu/energy/energy2020/roadmap/index_en.htm

Table 1. Projects of coal-fired power plants in Germany since 2007[6]

	Number of plants	Total power (MW)
Operating	2	2,900
Under construction	8	8,600
In planning process	3	2,700
Put on hold	6	5,400
Abandoned	20	19,400
Total	39	39,000

The **development of the Greek power system**, on the other hand, has been mapped in the "Energy Roadmap to 2050", published by the Ministry of Environment in March 2012.[7] The latter investigates scenarios that achieve GHG emissions reductions in the range of 49-62% by 2050 (compared to 1990 levels), while RES share projections in the energy mix seem to be already underestimated for certain technologies.[8] The need for moving to a low carbon power system is, in any case, dictated by the **external cost of lignite exploitation** with regards to both human health and the environment – a crucial factor that is rarely taken into account. The 'hidden cost' of atmospheric pollution caused by lignite plants in Greece has been estimated by the European Environment Agency in the range of €2.33-3.91 bi., only for 2009.[9] Concealing the aforementioned contributes to the widespread impression that lignite is the cheapest and most appropriate fuel for powering the country.

Table 2. External cost of lignite plants in Greece (2009)

	Emissions (tons)				Total cost (million €)	
Lignite Unit	CO_2	NO_x	SO_x	PM_{10}	Low 'VOLY'	High 'VSL'
Megalopoli A	4,460,000	3,090	184,000	5,590	692	1,609
Agios Dimitrios	12,900,000	24,800	58,000	471	629	944
Kardia	9,650,000	17,400	9,280	3,520	393	503
Ptolemaida	5,030,000	6,260	6,670	5,050	225	320
Amyntaio	4,400,000	4,270	20,200	1,230	216	330
Megalopoli B	2,910,000	2,220	1,260	59.2	105	115
Meliti	1,880,000	1,420	2,240	N,R,	71	84
TOTAL					2,332	3,906

[6] Deutsche Umwelthilfe, "Projects of coal-fired power plants in Germany since 2007", 11.2012 http://www.duh.de/uploads/media/New_coal_plants_Germany_2012_DUH.pdf

[7] Ministry of Environment, 2012, National Energy Planning, Roadmap for 2050

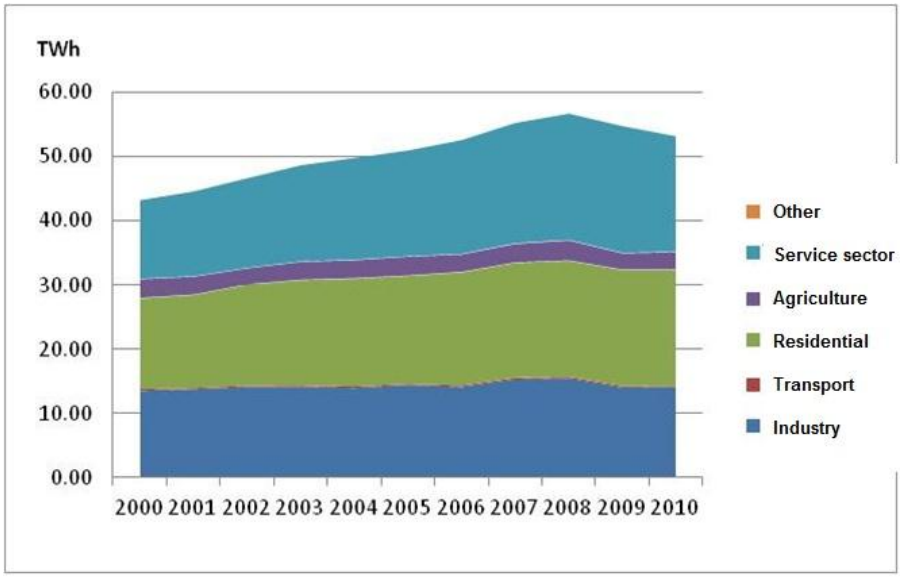
[8] PV installed capacity has already (February 2013) reached 1,838MW, while it is expected that the 2020 target will be surpassed already by 2014 (projected installed capacity 2,265MW).

[9] EEA, "Revealing the costs of air pollution from industrial facilities in Europe", 24.11.2012 http://www.eea.europa.eu/pressroom/newsreleases/industrial-air-pollution-cost-europe

The Greek power system

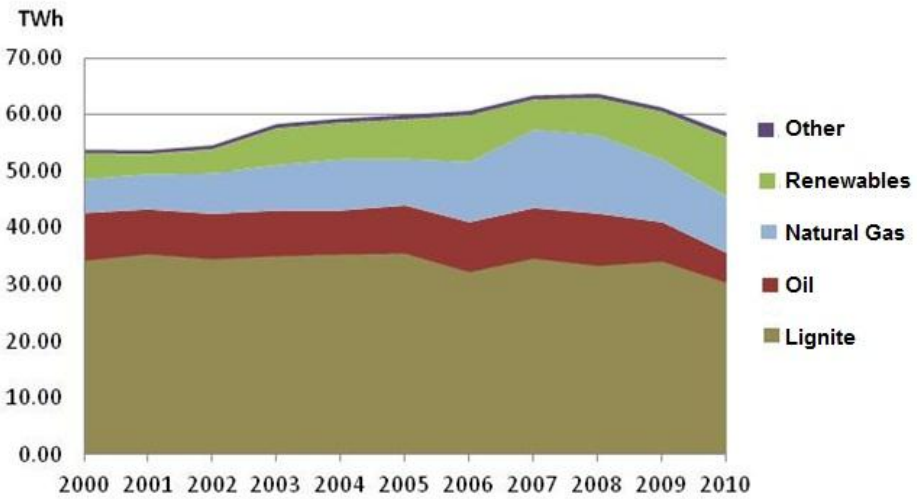
According to figures provided by EUROSTAT, final energy consumption in Greece has been increasing since 2000 and until 2008, while the recession that hit the country marked a twist in this trend. This was especially apparent for the transportation and agricultural sector (decrease in energy consumption during 2008-2010 was 12.3% and 7.4% respectively), while the industrial and household sectors were affected at a smaller level (decrease by 4,4%).

Chart 1. Final energy consumption (2000-2010) (EUROSTAT)



With regards to the power generation mix, the share of RES (including large hydro) and natural gas have significantly increased during the past decade at the expense of lignite – *see Chart 2*.

Chart 2. Gross electricity generation (EUROSTAT)



Modeling the performance of the two lignite units

For the needs of the present study, 4 different scenarios have been analyzed, all of which are based on the assumptions of the Greek "Energy Roadmap to 2050"[10] – *Table 3*.

Table 3. Main assumptions per scenario

Scenario	Assumptions
Scenario 1	Power demand and RES penetration, as in BAU scenario of Greek Energy Roadmap to 2050. CO_2 emissions prices as "alternative scenario" (*see table 4*). No CCS retrofit takes place.
Scenario 2	Power demand and RES penetration, as in "Maximization of RES" scenario of Greek Energy Roadmap to 2050. CO_2 emissions prices as in the European Commission's Energy Roadmap (*see table 4*). No CCS retrofit takes place.
Scenario 3	Energy demand and RES penetration, as in "Maximization of RES" scenario of Greek Energy Roadmap to 2050. CO_2 emissions prices as in EC's Energy Roadmap (*see table 4*). CCS is applied to both lignite units by 2030.
Scenario 4	Energy demand and RES penetration, as in "Minimum cost environmental policies" scenario of Greek Energy Roadmap to 2050. CO_2 emissions prices as in EC's Energy Roadmap (*see table 4*). CCS is applied to both lignite units by 2030.

Table 4. ETS prices in €'10/t CO2

	2020	2030	2040	2050	Scenarios
Energy Roadmap 2050 (reference scenario)	20	40	52	50	2,3,4
Alternative carbon values	20	25	30	35	1

It is important to note that, according to the European Commission, ETS carbon prices included in the reference scenario will lead to GHG emissions' reduction by only 40% in 2050 – far below the Union's commitment for reductions in the range of 80-95%. In case of higher CO2 prices, as those applied in the decarbonization scenarios of the Roadmap, the performance of the said lignite units would be significantly lower.

The following chart depicts the development of energy demand, according to the various scenarios of the Greek Energy Roadmap. In all scenarios, apart from the "Business as Usual" one, demand reaches 80—85TWh, mainly as a result of the electrification of transportation.

[10] The Roadmap presents 3 basic scenarios: the [1] "Business As Usual" scenario that assumes a conservative implementation of energy and environmental policies, the [2] "Maximization of RES" scenario and the [3] "Minimum cost environmental policies" scenario

Chart 3. Final electricity demand

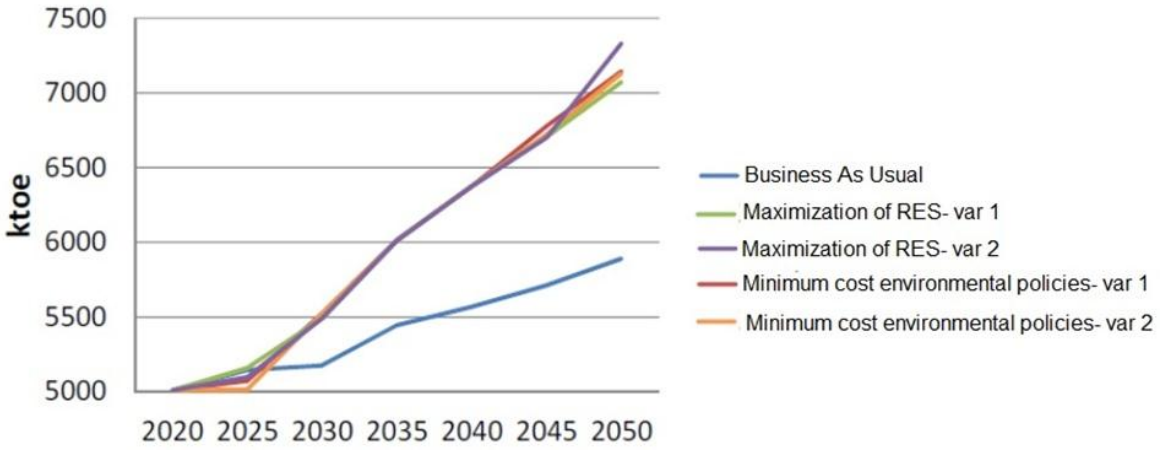
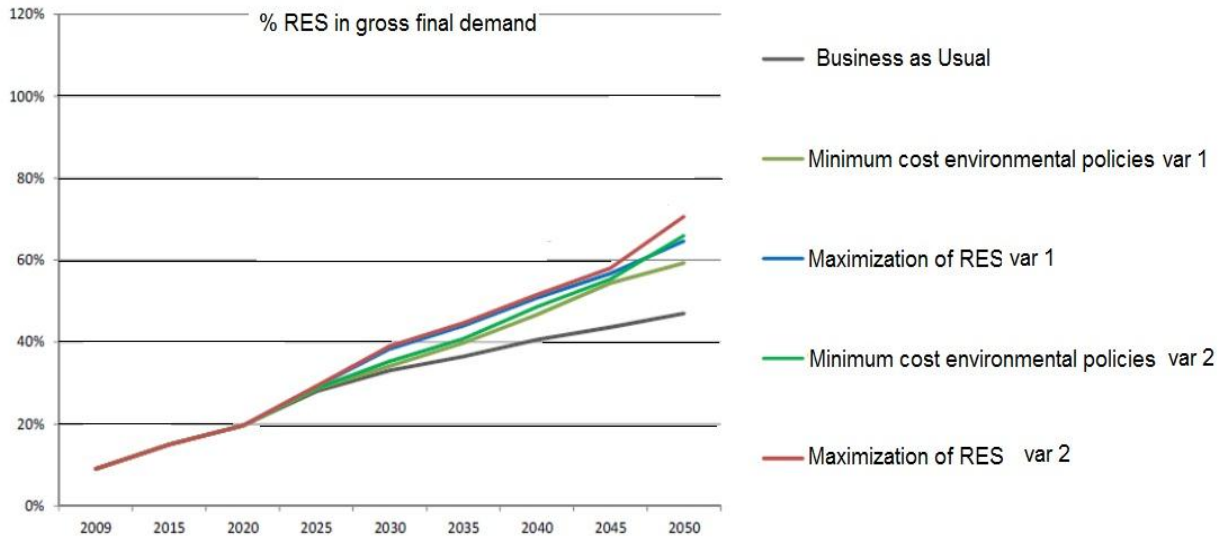


Chart 4, shows how RES penetration in gross final demand develops, according to the estimations of the Greek Energy Roadmap. As is demonstrated, RES share ranges between 45-70% in 2050.

Chart 4. Renewables share in gross final demand (%)



Results of simulation

Based on the above mentioned assumptions, the load duration curves were determined as well as the residual load duration curves (i.e. the load profile that needs to be provided by the thermal units). Following this, the cash flows for the two lignite units were calculated, allowing the determination of the investments' internal rate of return -IRR- (*see table 5*).

Table 5. Internal rate of return (IRR) for the two units for each scenario

Scenarios	Ptolemaida-V	Meliti-II
Scenario 1	4.9%	10.0%
Scenario 2	-5.4%	2.4%
Scenario 3	1.1%	6.0%
Scenario 4	6.75%	10.7%

The first conclusion that can be drawn, is the apparent **decrease that the combination of high share of RES and the implementation of energy management policies will bring to the operational hours of the lignite units**, the latter having zero residual loads for several hours (*see table 6*).

Table 6. Equivalent operating hours for the two units & development of the System Marginal Price (SMP) in 2050

	2050			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
SMP €/kWh	117.69	112.74	107.51	137.45
Equivalent operating hours				
Ptolemaida-V	4,143	2,861	2,861	5,643
Meliti-II	5,257	5,116	5,116	5,257

As was expected, the remarkable utilization level drop for the thermal power plants (even at a range of 20-30% in 2050), limits significantly their economic performance, especially for scenarios 2 and 3, that have the largest share of RES.

In addition, the **impact of ETS prices becomes apparent, in combination with the adoption or not- of CCS technology**. This is the case especially for Ptolemaida-V, as in scenario 2 (high share of RES, no CCS), where CO2 allowances are expensive, the investment's IRR is negative (-5.4%). This changes slightly for scenario 3 (units' conversion to CCS by 2030), as the reduced need for allowances lowers the respective generation costs. Even so, the IRR remains at extremely low levels (1.1%).

The combination of low RES shares (and, thus, increased residual loads for lignite plants), CCS implementation and high SMP prices (due to the increased operational hours of natural gas units) improves the performance of both Ptolemaida-V and Meliti-II – scenario 4.

Notably, Meliti-II, compared to Ptolemaida-V, performs much better in all scenarios which is attributed to the different quality of locally mined lignite. **CCS conversion of the unit, however, remains a sine qua non**, as in the opposite case ETS prices have a serious impact on the respective cash flows.

As part of the study a sensitivity analysis was also performed, main finding of which is the significant impact that construction costs, interest rates and the SMP have on the end performance of the two units.

Table 7. Impact of construction cost increase by 10% on the units' performance (IRR)

	Ptolemaida-V	Meliti-II
Scenario 1	3.7%	8.2%
Scenario 2	-6.4%	0.8%
Scenario 3	0.0%	4.5%
Scenario 4	5.7%	9.2%

Table 8. Impact of CCS costs variation (±10%) on the units' performance (IRR)

	Ptolemaida-V		Meliti-II	
	-10%	**+10%**	**-10%**	**+10%**
Scenario 3	1.4%	0.8%	6.3%	5.7%
Scenario 4	6.9%	6.5%	10.9%	10.5%

Table 9. Impact of interest rate variation by±2% on the units' performance (IRR)

	Ptolemaida-V		Meliti-II	
Interest rate	**5%**	**9%**	**5%**	**9%**
Scenario 1	6.48%	3.3%	12.2%	7.9%
Scenario 2	-3.8%	-6.8%	4.7%	0.3%
Scenario 3	3.2%	-0.9%	8.4%	3.7%
Scenario 4	8.3%	5.1%	12.9%	8.6%

Table 10. Impact of SMP variation (±10%) on the units' performance (IRR)

	Ptolemaida-V		Meliti-II	
	-10%	**+10%**	**-10%**	**+10%**
Scenario 1	0.3%	9.7%	4.7%	16.3%
Scenario 2	-13.3%	1.0%	-4.5%	9.9%
Scenario 3	-3.3%	5.7%	1.2%	11.8%
Scenario 4	3.0%	11.0%	6.2%	16.6%

In a nutshell, the core finding of the power-system simulation performed in this study is that the **economic performance of the two new lignite units, especially that of Ptolemaida-V, is extremely uncertain,** in spite of the favorable assumptions that have been used for both Ptolemaida-V and Meliti-II.[11]

[11] As such are mentioned the low CO_2 prices, low emissions reduction targets, absence of lignite use taxation, favorable financing conditions, while additional daily start/stop costs have not been taken into account

Epilogue

The new study by WWF Greece illustrates the threats that new lignite generation assets will face in Greece, within a context of thermal power overcapacity, strong role of RES and demand-side management measures. Under these circumstances, the long term viability of the Ptolemaida-V and Meliti-II units might require State support measures, such as tax exemptions, subsidies and tailor-made tariff schemes.

Investments in new lignite-fired units, that aim at doubtful short term profits, will lock Greece's power system into high-carbon infrastructure, and given the limited funding opportunities, are introducing competition for the much needed projects in energy efficiency, energy storage and grid upgrade plans. The latter will not only maximize profits for the entire society and the environment, but will also contribute to the security of energy supply and, additionally, offer the opportunity to PPC to place itself amongst the frontrunners of power utilities.

WWF Greece urges both the Greek State and investors to reconsider their intention of expanding the highly damaging lignite asset portfolio of PPC SA and instead, redirect the respective investments towards the clean energy industry, focusing at creating opportunities in the so-called energy centers of the country. Greece has, beyond any doubt, the necessary capacity to get back on the track of growth and financial stability in a socially, economically and environmentally wise and just manner.