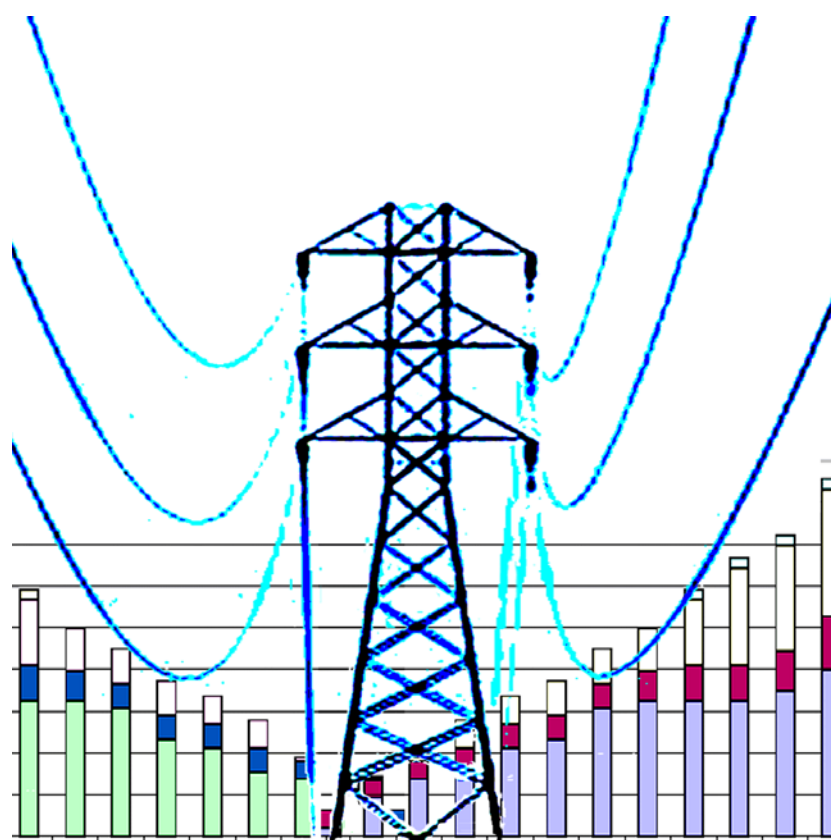


Projected Costs of Generating Electricity (2005 Update)

WADE's Response to the Report of the International Energy Agency and the Nuclear Energy Agency



August 2005



The IEA Report

This report was written by WADE as a response to the 2005 report entitled: “The Projected Costs of Generating Electricity – 2005 Update”, published by the International Energy Agency, the Nuclear Energy Agency and the Organisation for Economic Co-operation and Development, March 2005.

The IEA analysis presents CHP in a relatively favourable light. However, WADE has some potential concerns in the overall approach adopted and the assumptions made. These are summarised below.

1. The generation costs calculated by the IEA are the busbar costs at the station, rather than delivered costs. This is main feature of the analysis that makes its comparisons of limited value. As far as consumers are concerned, the generation costs are only a part of the overall cost equation; the other major part is the network costs, which are excluded from the report. WADE’s analysis, given in this report, includes these costs to give a more meaningful figure.
2. The economic lifetime of nuclear and coal plants is given as 40 years; for gas and CHP it is 20 years. This assumption appears to unreasonably favour coal and nuclear and does not necessarily reflect commercial realities. The first 10 - 15 years are usually the crucial period for power plant economics.
3. The discount rates used are 5% and 10%. The use of the lower discount rate favours high capital cost systems. As an example, and based on WADE’s own analyses, the levelised costs of a small CHP plant vary by 8% between the 5% and 15% discount rates. For nuclear plants, the variance is at least 50%.
4. The methodology does not take into account any business risks associated with competitive energy markets. Yet, this is increasingly an important issue. As the private sector takes an ever growing role in the generation sector, expected returns will increase, putting pressure on those technologies that have high capital costs and various perceived risks. This is already putting some forms of central generation at a significant disadvantage.

WADE Comments

In terms of some of the specific assumptions in the report, WADE has the following comments:

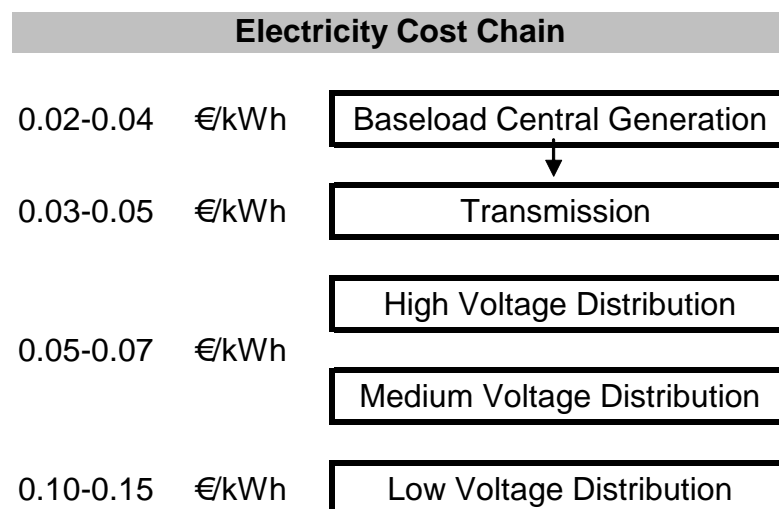
1. Coal. Construction costs are given as \$1,000 – 1,500 / kWe. These appear to be low and perhaps ignore the use of FGD. In addition, waste disposal costs appear not to have been included and power plant efficiencies do not appear to have taken into account the in-house loads.

2. Nuclear. Construction costs given as \$1,000 – 2,000 / kWe for most plants. This range appears to be an underestimate. WADE believes that around \$2,750 is a more reasonable figure. Crucially, waste disposal and decommissioning costs appear to have been significantly under-estimated, reducing overall costs¹. Power plant efficiencies also appear not to take account of in-house loads.

WADE has developed a levelised cost methodology in order to attempt to make a fair comparison between the delivered costs of centralised generation and decentralised CHP. The methodology used is a conventional levelised cost approach. The analysis is based on a range of assumptions, all of which are given in the main report or the attached Annex. WADE has aimed to be as balanced as possible about these assumptions.

In particular, network costs have been included. Typically, network costs make up around 30-50% of the average cost of electricity. However, when CHP or on-site renewable systems are installed into the network, they displace central generation and the associated network costs of delivering the electricity to that site. As an illustration of this, Figure 1 below illustrates the cost chain, based on a recent analysis for the European Commission.

Figure 1. The Electricity Network Cost Chain.



Source: Professor Nikos Hatziargyriou, National Technical University of Athens, 2005 (for the EU Microgrids project)

¹ In August 2005, the UK Nuclear Decommissioning Authority projected a cost of £56 billion (\$100 billion) to decommission the country's nuclear sites; UK nuclear generating capacity is around 13 GWe.

For example, the network cost savings from a small residential CHP system will be higher than a larger industrial CHP plant connected to the high or medium voltage system. These important differentials are reflected in the WADE assumptions.

WADE assumptions.

A summary of the main assumptions underlying WADE's methodology are given in Table 1 below (all are given in the attached Annex), and the levelised delivered costs that it has arrived at are shown in Figure 2 on p.5. Note that renewable energies have not been included in this analysis.

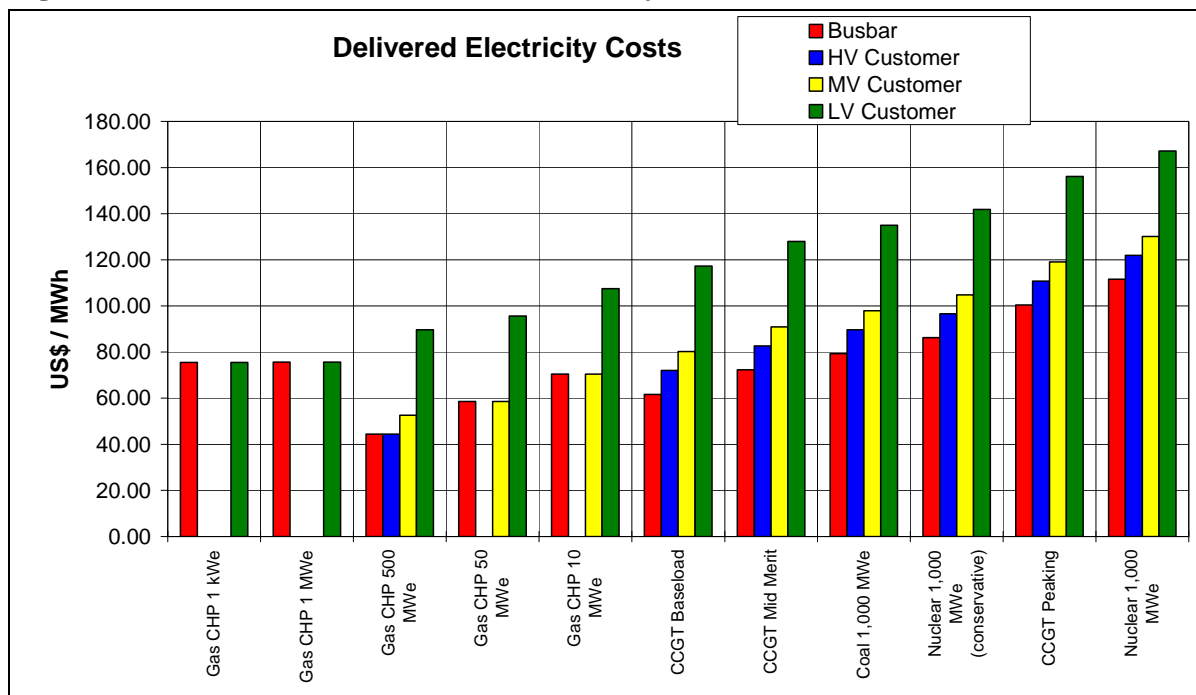
Table 1. Assumptions underlying WADE levelised cost methodology.

	Full installed cost (US\$ / kWe)	Fuel price (USc / kWh)	Load factor (%)	Electric efficiency (% , HHV)	Heat efficiency (% , HHV)	Self-consumption (%)	O&M costs (USc / kWh)
CCGT 410 MWe baseload	725	2.1	86	48.7	-	2.4	0.55
CCGT 410 MWe mid merit	725	2.1	51	46.2	-	2.4	0.55
CCGT 410 MWe peak	725	2.1	23	43.8	-	2.4	0.55
Gas CHP 1 kWe	823 (marginal)	3.5	34	12	79	80	\$311 / year
Gas CHP 1 MWe	677 (marginal)	3.5	63	35	43	100	1.02
Gas CHP 10 MWe	1,227 (marginal)	2.9	80	29.1	45.5	100	0.82
Gas CHP 50 MWe	1,205 (marginal)	2.4	94	33.7	39.7	75	0.73
Gas CHP 500 MWe	930	2.1	96	41	37	10	0.55
Coal 1,000 MWe (WADE assumptions)	2,330	0.82	80	41	-	4.0	0.86
Nuclear 1,000 MWe (WADE assumptions)	2,750	0.75	78	34	-	6.0	0.88
Nuclear 1,000 MWe (WADE conservative assumptions)	2,000	0.75	90	34	-	6.0	0.88

Table notes:

1. A 6% discount rate is used throughout.
2. The levelised costs are calculated on the basis of 10 year operation in all cases, except nuclear and coal (15 years). Construction times have been taken into account, and capital spend has been spread over the construction periods. CHP construction times are shorter than that for most centralised plants.
3. CCGT efficiencies are based on design LHV efficiency of 57.7% (HHV 52.5%) and include allowance for in-house loads and degradation.
4. The CHP installed costs are marginal to boiler costs (CHP systems are usually acquired to replace old boilers).
5. For CHP plants, the delivered costs include the generation costs and any cost for transport of electrical energy to lower voltage consumers. Thus if an MV connected CHP plant delivers electricity to the MV network and this energy is then transported to an LV customer, the additional cost for transfer between MV and LV is included in the levelised cost.
6. Coal plant waste disposal costs are assumed to be around \$21 million / year for a 1,000 MWe plant.
7. Nuclear plant waste treatment costs are assumed to be around \$20.5 million / year for a 1,000 MWe plant. Decommissioning set aside is assumed to be \$2,500 / kWe and this cost is spread over 40 years.
8. No environmental costs are included in the analysis. Inclusion of carbon prices would favour CHP over all options other than nuclear.

Figure 2. Levelised delivered costs of electricity.



Source, WADE 2005

It is clear that these results give a quite different range of values, and a different hierarchy, than the IEA / NEA analysis. Even with conservative assumptions (\$2,000 / kWe capital costs; 90% load factor), nuclear generation appears to be extremely uncompetitive.

Conclusions

In conclusion, therefore:

1. The most important omission from the IEA/NEA report is that it compares costs for centralised generation options with those of decentralised generation options without incorporating the grid costs into the comparison.
2. The data for centralised technologies tends to adopt more favourable assumptions and options, including high load factors, no market risk factors, low capital costs and no waste treatment costs. In comparison, the CHP and renewable options are presented without such favourable approaches.

Overall, therefore, the modelling of the IEA data and comparison with data used by WADE indicates that the IEA report is disposed towards favouring nuclear and coal generating options and has ignored some of the most important cost benefits of high efficiency CHP generation.

Annex of Assumptions

INSTALLATION DATA FOR CHP PLANTS

SIZE CASE	1 kWe	1 MWe	10 MWe	50 MWe	500 MWe
Description of the CHP Installation					
CHP Description	Domestic CHP	Gas Engine CHP	Gas Turbine CHP	Gas Turbine CHP	CCGT CHP
Prime Mover Type	Stirling Engine	Gas Engine	Gas Turbine	Gas Turbine	Gas Turbine
Heat Recovery Type	Heat Exchanger	Heat Exchanger	Unfired-WHB	Fired HRSG	Fired HRSG
Additional Prime Mover	No	No	No	Steam Turbine	Steam Turbine
Heat Provision Grade	Hot Water	Hot Water	10 bar Steam	7 bar & 2 bar	40 bar & 10 bar
Primary Fuel	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Secondary Fuel	None	None	Gas Oil	Gas Oil	Refinery Wastes
Gas supply pressure	Atmosphere	Atmosphere	Atmosphere	Medium Pressure	NTS
Compression of Fuel	No	No	Yes	Yes	No
Connection Voltage	230 V	440 V	6.6 kV	11 kV	132 kV

Location and use					
Top Sector	Residential	Public	Industry	Industry	Industry
Branch	Family House	Hospital	Food	Chemicals	Oil Refining

Technical characteristics of the CHP Installation						
Electrical output capacity	MW	0.001	1.2	9.6	54.0	500.0
Gas Compression and in-house loads	MW	0.000	0.0	0.7	3.3	10.0
Net Electrical Output	MW	0.001	1.2	8.9	50.7	490.0
Thermal output capacity	Tonnes				85.0	600.0
Thermal output capacity	MW	0.006	1.4	15.0	63.8	450.0
Electrical efficiency (LHV)	%	13.0%	38.5%	32.0%	37.0%	45.0%
Thermal efficiency (LHV)	%	86.7%	47.8%	50.0%	43.7%	40.5%
Total efficiency (LHV)	%	99.7%	86.3%	82.0%	80.7%	85.5%
Electrical efficiency (HHV)	%	11.8%	35.0%	29.1%	33.7%	41.0%
Thermal efficiency (HHV)	%	78.9%	43.5%	45.5%	39.7%	36.9%
Total efficiency (HHV)	%	90.7%	78.5%	74.6%	73.4%	77.8%
Power to heat ratio		0.15	0.81	0.64	0.85	1.11
Heat to power ratio		6.67	1.24	1.56	1.18	0.90
Fuel Consumption per hour	MW	0.0076	3.31	32.97	160.38	1221.00
Share of Primary Fuel	%	100%	100%	98%	98%	75%
Primary Fuel Consumption	MW	0.0076	3.31	32.31	157.17	915.75
Share of Secondary Fuel	%	0%	0%	2%	2%	25%
Secondary Fuel Consumption	MW	0.0000	0	0.65	3.14	228.94

Operational data						
Hours of operation per year	hr/yr	3000	5500	7000	8200	8400
Full load load factor	%	34.25%	62.79%	79.91%	93.61%	95.89%
Electricity on-site consumption	%	80%	100%	100%	75%	10%
Electricity Production	MWh	2.700	6353	62300	415740	4116000
Heat Production	MWh	18.000	7920	105000	522750	3780000
Primary Fuel Consumption	MWh	22.823	18210	226154	1288815	7692308
Secondary Fuel Consumption	MWh	0.000	0	4523	25776	1923077
Total Fuel Consumption	MWh	22.823	18210	230677	1314591	9615385
Electricity Used on-site	MWh	2.160	6353	62300	311805	411600
Electricity Exported	MWh	0.540	0	0	103935	3704400

Capital Costs						
Total Cost of Equipment	US\$/kWe	2470.5	732	1464	1281	823.5
Installation Fixed Cost	US\$	2562	109800	183000	4575000	91500000
Connection Cost	US\$					
Installation Variable Cost	US\$/kWe	0	183	91.5	91.5	91.5

Operational Costs						
Variable Maintenance Costs	USc/kWh	0	1.0248	0.8235	0.732	0.549
Fixed Maintenance Costs	US\$	311.1	1830	9150	18300	91500

Carbon Emissions						
Primary Fuel	tC	1.14	908.86	11287.13	64323.58	383916.08
Secondary Fuel	tC	0.00	0.00	308.39	1757.47	79038.46
Total	tC	1.14	908.86	11595.52	66081.06	462954.55

REFERENCE POWER PLANT DATA

Reference Power Plant for Avoided Investment

Combined Cycle Gas Turbine		Siemens SCC5 4000F
Size of Station	MW	410
Primary Fuel		Natural Gas
Secondary Fuel		Gas Oil
Gas supply pressure		High Pressure
Compression of Fuel		Yes
Connection Voltage		200 kV

Reference Power Plant Capital Investment

CCGT Capital Cost	US\$/kWe	640.5	
CCGT Capital Cost	US\$ million	262.605	
Installation cost	US\$ million	26.3	10%
Grid Connection - shallow	US\$ million	9.2	
Total Costs	US\$ million	298.0	

Technical characteristics CCGT

Design electrical efficiency LHV	%	57.70%	
Design electrical efficiency HHV	%	52.51%	
Design electrical output capacity	MW	410.0	
Thermal output capacity	MW	0.0	0%
Fuel Consumption at full load	MW	780.8	
Actual best electrical output at generator te	MW	397.7	50.9%
Inhouse loads	MW	9.7	2.4%
Degradation of CCGT over year	MW	8.0	2.0%
Net electrical output	MW	380.0	
Net electrical efficiency (HHV)	%	48.7%	
Annual electrical efficiency - baseload		48.7%	
Annual electrical efficiency - mid-merit		46.2%	95%
Annual electrical efficiency - peaking		43.8%	90%
Share of Primary Fuel	%	100%	
Primary Fuel Consumption	MW	780.8	
Share of Secondary Fuel	%	0%	
Secondary Fuel Consumption	MW	0.0	

Operational Data

Variable operation and maintenance cost	US\$/kWh	0.5
Fixed O&M	US\$/a	91500

Labour used on CCGT power station

Staff Employed for Baseload	N°	45
Staff Employed for Mid-Merit	N°	40
Staff Employed for Peaking	N°	30
Cost per person	US\$/yr	91500
Total Cost for Baseload	US\$/yr	4117500
Total Cost for Mid-Merit	US\$/yr	3660000
Total Cost for Peaking	US\$/yr	2745000

Power Generation Statistics

Average Efficiency of CCGTs excluding ow	%	46.40%	2003 Data
Average Efficiency of Thermal Power Plant	%	38.80%	2003 Data
Share of Coal	%	49.56%	2003 Data
Efficiency of Coal Generation including own	%	34.34%	2003 Data
Share of Gas	%	49.69%	2003 Data
Efficiency of Gas Generation including own	%	44.98%	2003 Data
Share of Oil	%	0.76%	2003 Data
Efficiency of Oil Generation including own t	%	25.62%	2003 Data

Grid Losses

Average Grid Losses Reported by DUKES	%	8.70%	2003 Data
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Theoretical Calculations

Transformation losses	%	0.8%	per transformation
Power Station to High Voltage Grid	N°	1	
High Voltage to Medium Voltage	N°	1	
Medium to Low Voltage	N°	1	
Low Voltage to Consumer	N°	1	
Heating losses HV	%	1.0%	
Heating losses MV	%	3.0%	
Heating losses LV	%	5.0%	
T&D Losses for HV connected customers	%	2.6%	
T&D Losses for MV connected customers	%	6.4%	
T&D Losses for LV connected customers	%	12.2%	

REFERENCE BOILER PLANT

SIZE CASE		1 kWe	1 MWe	10 MWe	50 MWe	500 MWe
Description of the Boiler Installation						
Type of Boiler		Condensing	Shell Boiler	Shell Boilers	Water Tube Boilers	Water Tube Boilers
Primary Fuel		Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
Secondary Fuel		None	None	Gas Oil	Gas Oil	Refinery Wastes
Technical characteristics of the Replacement Boiler Installation						
Thermal output capacity	Tonnes				85.0	600.0
Thermal output capacity of CHP plant	MW	0.0060	1.4	15.0	63.8	450.0
Thermal output capacity of Reference Boiler plant	MW	0.0260	2.0	20.0	75.0	540.0
Full Load Efficiency (LHV)	%	102.0%	92.0%	88.0%	86.0%	86.0%
Full Load Efficiency (HHV)	%	92.8%	83.7%	80.1%	78.3%	78.3%
Fuel Consumption per hour at full load	MW	0.0059	1.6	17.0	74.1	523.3
Share of Primary Fuel	%	100%	100%	98%	98%	75%
Primary Fuel Consumption	MW	0.0059	1.57	16.70	72.65	392.44
Share of Secondary Fuel	%	0%	0%	2%	2%	25%
Secondary Fuel Consumption	MW	0.0000	0	0.33	1.45	98.11
Reference Boiler Installation Costs						
Capital Costs	US\$/kW	64.05	146.4	109.8	128.1	118.95
Installation Costs	US\$/kW	91.5	45.75	45.75	45.75	36.6
Total Installation Cost	US\$	4044.3	384300	3111000	13038750	83997000
Fixed Maintenance Costs	US\$/a	274.5	1830	9150	36600	183000
Variable Maintenance Costs	USc/kWh	0	0.183	0.0915	0.0915	0.0915
Reference Boiler Operational Data						
Hours of operation	hrs	1800	4500	7000	8400	8400
Full Load Equivalent Hours	hrs	700	3240	5250	7014	7000
Heat Production	MWh	18.200	6480	105000	526050	3780000
Load factor of boilers	%	7.99%	36.99%	59.93%	80.07%	79.91%
Efficiency Loss due to Cycling	%	5.00%	12.00%	10.00%	10.00%	10.00%
Efficiency of boilers cycling	%	88.51%	75.31%	73.67%	72.14%	72.14%
Annual Consumption of Primary Fuel	MWh	20.562	8605	139682	714669	3930111
Annual Consumption of Secondary Fuel	MWh	0.000	0	2851	14585	1310037
Total Annual Fuel Consumption	MWh	20.562	8605	142533	729254	5240148
Check CHP Heat Output	MWh	18.000	7920	105000	522750	3780000
Old Boiler Operational Data						
Age of Boilers	Yr	15	20	30	30	35
Fuel Used		Same	Same	Same	Same	Same
Heat Output	MWh	18.200	6480	105000	526050	3780000
Boiler Plant Efficiency	%	60.00%	72.00%	70.00%	70.00%	70.00%
Annual Consumption of Primary Fuel	MWh	30.333	9000	147000	736470	4050000
Annual Consumption of Secondary Fuel	MWh	0.000	0	3000	15030	1350000
Total Annual Fuel Consumption	MWh	30.333	9000	150000	751500	5400000

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: 1 kWe CHP Scheme

Technology: 1 kWe CHP Scheme

INPUTS

Technical Specifications

Net Electrical Output	kWe	0.9
Thermal Output	kWt	6
Electrical Efficiency	%	12%
Heat Efficiency	%	79%
Total Efficiency	%	91%
Fuel Input	kWf	7.61

Capital Investment CHP

Total Cost of Equipment	US\$	2223.45
Installation Fixed Cost	US\$	2562
Installation Variable Cost	US\$	0
Total Installation Cost	US\$	4785.45
Marginal Equipment Cost	US\$	558.15
Marginal Installation Cost	US\$	183
Marginal Total Cost	US\$	741.15

Capital Investment Boiler

New Boiler Costs	US\$	1665.3
Installation Costs	US\$	2379
Total Avoided Boiler Costs	US\$	4044.3

Other Inputs

Operating Hours	hrs/yr	3000
Gas Price	US\$/kWh	3.48
Other Fuel Price	US\$/kWh	7.32
Composite Fuel Price	US\$/kWh	3.48
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	12.81
Electricity Export Price	US\$/kWh	5.92
Self Consumption %	%	80%
Boiler Efficiency	%	89%

Operational Performance

Variable O&M	US\$/kWh	0
Variable O&M	US\$/a	0
Fixed O&M	US\$/a	311.1
Total O&M	US\$/a	311.1
Boiler Fixed O&M Costs	US\$/a	274.5
Boiler Variable O&M Costs	US\$/a	0
Total Boiler O&M costs	US\$/a	274.5
CHP Fuel Consumption	kWh	22823
Boiler Fuel Consumption	kWh	20562
Net Consumption	kWh	2261
Heat Output	kWh	18000
Electricity Output	kWh	2700
Exported Electricity	kWh	540
Electricity Used On-Site	kWh	2160

OUTPUTS: MARGINAL ASSUMING BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5	6	7	8
Marginal Costs										
Capital cost	US\$	-558	-558							
Installation cost	US\$	-183	-183							
O&M	US\$	-403	-37	-37	-37	-37	-37	-37	-37	-37
Fuel input	US\$	-865	-79	-79	-79	-79	-79	-79	-79	-79
Total cost	US\$	-2009	-856	-115	-115	-115	-115	-115	-115	-115
Discounted	US\$	-1704	-856	-109	-103	-97	-91	-86	-81	-77
Production										
Electricity	kWh	29700	2700	2700	2700	2700	2700	2700	2700	2700
Electricity discounted	kWh	22572	2700	2547	2403	2267	2139	2018	1903	1796
Revenue										
Electricity revenue	US\$	3395	309	309	309	309	309	309	309	309
Discounted revenue	US\$	2580	309	291	275	259	244	231	218	205
Net Cost/Income (not discounted)	US\$	1387	-548	193	193	193	193	193	193	193
Net Cost/Income (discounted)	US\$	876	-548	182	172	162	153	145	136	129

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	7.55	€/kWh	6.15
Net Present Value	US\$	826		
Internal Rate of Return	%	33%		
Simple Payback Period	years	3.83		

OUTPUTS: ASSUMING NO BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5	6	7	8
Full Costs										
Capital cost	US\$	-2223	-2223							
Installation cost	US\$	-2562	-2562							
O&M	US\$	-403	-37	-37	-37	-37	-37	-37	-37	-37
Fuel input	US\$	-865	-79	-79	-79	-79	-79	-79	-79	-79
Total cost	US\$	-6053	-4901	-115	-115	-115	-115	-115	-115	-115
Discounted	US\$	-5749	-4901	-109	-103	-97	-91	-86	-81	-77
Production										
Electricity	kWh	29700	2700	2700	2700	2700	2700	2700	2700	2700
Electricity discounted	kWh	22572	2700	2547	2403	2267	2139	2018	1903	1796
Revenue										
Electricity revenue	US\$	3395	309	309	309	309	309	309	309	309
Discounted revenue	US\$	2580	309	291	275	259	244	231	218	205
Net Cost/Income (not discounted)	US\$	-2658	-4592	193	193	193	193	193	193	193
Net Cost/Income (discounted)	US\$	-3168	-4592	182	172	162	153	145	136	129

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	25.47	€/kWh	20.75
Net Present Value	US\$	-2,658		
Internal Rate of Return	%	-13%		
Simple Payback Period	years	24.74		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: 1 MWe CHP Scheme

INPUTS

Technical Specifications		
Net Electrical Output	kWe	1155
Thermal Output	kWt	1440
Electrical Efficiency	%	35%
Heat Efficiency	%	43%
Total Efficiency	%	79%
Fuel Input	kWf	3297

Capital Investment CHP		
Total Cost of Equipment	US\$	845460
Installation Fixed Cost	US\$	109800
Installation Variable Cost	US\$	211365
Total Installation Cost	US\$	1166625
Marginal Equipment Cost	US\$	552660
Marginal Installation Cost	US\$	229665
Marginal Total Cost	US\$	782325

Capital Investment Boiler		
New Boiler Costs	US\$	292800
Installation Costs	US\$	91500
Total Avoided Boiler Costs	US\$	384300

Other Inputs		
Operating Hours	hrs/yr	5500
Gas Price	US\$/kWh	3.48
Other Fuel Price	US\$/kWh	7.32
Composite Fuel Price	US\$/kWh	3.48
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	8.24
Electricity Export Price	US\$/kWh	5.92
Self Consumption %	%	100%
Boiler Efficiency	%	75%

Operational Performance		
Variable O&M	US\$/kWh	1.0248
Variable O&M	US\$/a	65100.42
Fixed O&M	US\$/a	1830
Total O&M	US\$/a	66930.42
Boiler Fixed O&M Costs	US\$/a	1830
Boiler Variable O&M Costs	US\$/a	11858.4
Total Boiler O&M costs	US\$/a	13688.4
CHP Fuel Consumption	kWh	18210361
Boiler Fuel Consumption	kWh	8604532
Net Consumption	kWh	9605829
Heat Output	kWh	7920000
Electricity Output	kWh	6352500
Exported Electricity	kWh	0
Electricity Used On-Site	kWh	6352500

OUTPUTS: MARGINAL ASSUMING BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5
Marginal Costs							
Capital cost	US\$	-552660	-552660				
Installation cost	US\$	-229665	-229665				
O&M	US\$	-585662	-53242	-53242	-53242	-53242	-53242
Fuel input	US\$	-3673942	-333995	-333995	-333995	-333995	-333995
Total cost	US\$	-5041929	-1169562	-387237	-387237	-387237	-387237
Discounted	US\$	-4019658	-1169562	-365318	-344639	-325131	-306728
Production							
Electricity	kWh	69877500	6352500	6352500	6352500	6352500	6352500
Electricity discounted	kWh	53107453	6352500	5992925	5653702	5333681	5031775
Revenue							
Electricity revenue	US\$	5754412	523128	523128	523128	523128	523128
Discounted revenue	US\$	4373399	523128	493517	465582	439229	414367
Net Cost/Income (not discounted)	US\$	712483	-646433	135892	135892	135892	135892
Net Cost/Income (discounted)	US\$	353741	-646433	128200	120943	114097	107639

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	7.57	€/kWh	6.17
Net Present Value	US\$	333,718		
Internal Rate of Return	%	16%		
Simple Payback Period	years	5.76		

OUTPUTS: ASSUMING NO BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5
Full Costs							
Capital cost	US\$	-845460	-845460				
Installation cost	US\$	-321165	-321165				
O&M	US\$	-585662	-53242	-53242	-53242	-53242	-53242
Fuel input	US\$	-3673942	-333995	-333995	-333995	-333995	-333995
Total cost	US\$	-5426229	-1553862	-387237	-387237	-387237	-387237
Discounted	US\$	-4403958	-1553862	-365318	-344639	-325131	-306728
Production							
Electricity	kWh	69877500	6352500	6352500	6352500	6352500	6352500
Electricity discounted	kWh	53107453	6352500	5992925	5653702	5333681	5031775
Revenue							
Electricity revenue	US\$	5754412	523128	523128	523128	523128	523128
Discounted revenue	US\$	4373399	523128	493517	465582	439229	414367
Net Cost/Income (not discounted)	US\$	328183	-1030733	135892	135892	135892	135892
Net Cost/Income (discounted)	US\$	-30559	-1030733	128200	120943	114097	107639

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	8.29	€/kWh	6.76
Net Present Value	US\$	328,183		
Internal Rate of Return	%	5%		
Simple Payback Period	years	8.58		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: 10 MWe CHP Scheme

INPUTS

Technical Specifications		
Net Electrical Output	MWe	8.9
Thermal Output	MWt	15.0
Electrical Efficiency	%	29.1%
Heat Efficiency	%	45.5%
Total Efficiency	%	74.6%
Fuel Input	MWf	31
Capital Investment		
Total Cost of Equipment	US\$	13029600
Installation Fixed Cost	US\$	183000
Variable Installation Cost	US\$	814350
Total Installation Cost	US\$	14026950
Marginal Equipment Cost	US\$	10833600
Marginal Installation Cost	US\$	82350
Marginal Total Cost	US\$	10915950
Capital Investment Boiler		
New Boiler Costs	US\$	2196000
Installation Costs	US\$	915000
Total Avoided Boiler Costs	US\$	3111000
Other Inputs		
Operating Hours	hrs/yr	7000
Gas Price	US\$/kWh	2.93
Other Fuel Price	US\$/kWh	7.32
Composite Fuel Price	US\$/kWh	3.02
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	7.23
Electricity Export Price	US\$/kWh	5.37
Self Consumption %	%	100%
Boiler Efficiency	%	74%
Operational Performance		
Variable O&M	US\$/kWh	0.8235
Variable O&M	US\$/a	513040.5
Fixed O&M	US\$/a	9150
Total O&M	US\$/a	522190.5
Boiler Fixed O&M Costs	US\$/a	274.5
Boiler Variable O&M Costs	US\$/a	96075
Total Boiler O&M costs	US\$/a	96349.5
CHP Fuel Consumption	MWh	230677
Boiler Fuel Consumption	MWh	142533
Net Consumption	MWh	88144
Heat Output	MWh	105000
Electricity Output	MWh	62300
Exported Electricity	MWh	0
Electricity Used On-Site	MWh	62300

OUTPUTS: MARGINAL ASSUMING BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5	6	7	8
Marginal Costs										
Capital cost	US\$ thousands	-10834	-10834							
Installation cost	US\$ thousands	-82	-82							
O&M	US\$ thousands	-4684	-426	-426	-426	-426	-426	-426	-426	-426
Fuel input	US\$ thousands	-29241	-2658	-2658	-2658	-2658	-2658	-2658	-2658	-2658
Total cost	US\$ thousands	-44841	-14000	-3084	-3084	-3084	-3084	-3084	-3084	-3084
Discounted	US\$ thousands	-36699	-14000	-2910	-2745	-2589	-2443	-2305	-2174	-2051
Production										
Electricity	MWh	685300	62300	62300	62300	62300	62300	62300	62300	62300
Electricity discounted	MWh	520833	62300	58774	55447	52308	49347	46554	43919	41433
Revenue										
Electricity revenue	US\$ thousands	49537	4503	4503	4503	4503	4503	4503	4503	4503
Discounted revenue	US\$ thousands	37648	4503	4248	4008	3781	3567	3365	3175	2995
Net Cost/Income (not discounted)	US\$ thousands	4696	-9497	1419	1419	1419	1419	1419	1419	1419
Net Cost/Income (discounted)	US\$ thousands	949	-9497	1339	1263	1192	1124	1061	1001	944
Economic Summary before subsidies										
Levelised Electricity Cost	US\$/kWh	7.05	€/kWh	5.74						
Net Present Value	US\$	895,241								
Internal Rate of Return	%	8%								
Simple Payback Period	years	7.69								

OUTPUTS: ASSUMING NO BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5	6	7	8
Full Costs										
Capital cost	US\$ thousands	-13030	-13030							
Installation cost	US\$ thousands	-997	-997							
O&M	US\$ thousands	-4684	-426	-426	-426	-426	-426	-426	-426	-426
Fuel input	US\$ thousands	-29241	-2658	-2658	-2658	-2658	-2658	-2658	-2658	-2658
Total cost	US\$ thousands	-47952	-17111	-3084	-3084	-3084	-3084	-3084	-3084	-3084
Discounted	US\$ thousands	-39810	-17111	-2910	-2745	-2589	-2443	-2305	-2174	-2051
Production										
Electricity	MWh	685300	62300	62300	62300	62300	62300	62300	62300	62300
Electricity discounted	MWh	520833	62300	58774	55447	52308	49347	46554	43919	41433
Revenue										
Electricity revenue	US\$ thousands	49537	4503	4503	4503	4503	4503	4503	4503	4503
Discounted revenue	US\$ thousands	37648	4503	4248	4008	3781	3567	3365	3175	2995
Net Cost/Income (not discounted)	US\$ thousands	1585	-12608	1419	1419	1419	1419	1419	1419	1419
Net Cost/Income (discounted)	US\$ thousands	-2162	-12608	1339	1263	1192	1124	1061	1001	944
Economic Summary before subsidies										
Levelised Electricity Cost	US\$/kWh	7.64	€/kWh	6.23						
Net Present Value	US\$ thousands	1,585								
Internal Rate of Return	%	2%								
Simple Payback Period	years	9.88								

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: 50 MWe CHP Scheme

INPUTS

Technical Specifications		
Net Electrical Output	MWe	50.7
Thermal Output	MWt	63.8
Electrical Efficiency	%	33.7%
Heat Efficiency	%	39.7%
Total Efficiency	%	73.4%
Fuel Input	MWf	151
Capital Investment		
Total Cost of Equipment	US\$	64946700
Installation Fixed Cost	US\$	4575000
Variable Installation Cost	US\$	4639050
Total Installation Cost	US\$	74160750
Marginal Equipment Cost	US\$	55339200
Marginal Installation Cost	US\$	5782800
Marginal Total Cost	US\$	61122000
Capital Investment Boiler		
New Boiler Costs	US\$	9607500
Installation Costs	US\$	3431250
Total Avoided Boiler Costs	US\$	13038750
Other Inputs		
Operating Hours	hrs/yr	8200
Gas Price	US\$/kWh	2.38
Other Fuel Price	US\$/kWh	7.32
Composite Fuel Price	US\$/kWh	2.48
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	6.77
Electricity Export Price	US\$/kWh	5.37
Self Consumption %	%	75%
Boiler Efficiency	%	72%
Operational Performance		
Variable O&M	US\$/kWh	0.732
Variable O&M	US\$/a	3043216.8
Fixed O&M	US\$/a	18300
Total O&M	US\$/a	3061516.8
Boiler Fixed O&M Costs	US\$/a	36600
Boiler Variable O&M Costs	US\$/a	481336
Total Boiler O&M costs	US\$/a	517936
CHP Fuel Consumption	MWh	1314591
Boiler Fuel Consumption	MWh	729254
Net Consumption	MWh	585337
Heat Output	MWh	522750
Electricity Output	MWh	415740
Exported Electricity	MWh	103935
Electricity Used On-Site	MWh	311805

OUTPUTS: MARGINAL ASSUMING BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5
Marginal Costs							
Capital cost	US\$ millions	-55	-55				
Installation cost	US\$ millions	-6	-6				
O&M	US\$ millions	-28	-3				
Fuel input	US\$ millions	-160	-15	-15	-15	-15	-15
Total cost	US\$ millions	-249	-78	-17	-17	-17	-17
Discounted	US\$ millions	-204	-78	-16	-15	-14	-13
Production							
Electricity	MWh	4573140	415740	415740	415740	415740	415740
Electricity discounted	MWh	3475623	415740	392208	370007	349063	329305
Revenue							
Electricity revenue	US\$ millions	323	29	29	29	29	29
Discounted revenue	US\$ millions	245	29	28	26	25	23
Net Cost/Income (not discounted)	US\$ millions	74	-49	12	12	12	12
Net Cost/Income (discounted)	US\$ millions	42	-49	12	11	10	9

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	5.86	€/kWh	4.77
Net Present Value	US\$	39,442,876		
Internal Rate of Return	%	22%		
Simple Payback Period	years	4.96		

OUTPUTS: ASSUMING NO BOILER REPLACEMENT

Year	Total	0	1	2	3	4	5
Full Costs							
Capital cost	US\$	-64946700	-64946700				
Installation cost	US\$	-9214050	-9214050				
O&M	US\$	-27979392	-2543581	-2543581	-2543581	-2543581	-2543581
Fuel input	US\$	-159540	-14504	-14504	-14504	-14504	-14504
Total cost	US\$	-102299681	-76718835	-2558085	-2558085	-2558085	-2558085
Discounted	US\$	-95546560	-76718835	-2413287	-2276686	-2147817	-2026243
Production							
Electricity	kWh	4573140	415740	415740	415740	415740	415740
Electricity discounted	kWh	3475623	415740	392208	370007	349063	329305
Revenue							
Electricity revenue	US\$	293621	26693	26693	26693	26693	26693
Discounted revenue	US\$	223154	26693	25182	23757	22412	21143
Net Cost/Income (not discounted)	US\$	-102006060	-76692142	-2531392	-2531392	-2531392	-2531392
Net Cost/Income (discounted)	US\$	-95323406	-76692142	-2388106	-2252930	-2125405	-2005099

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	2749.05	€/kWh	2239.80
Net Present Value	US\$	-102,006,060		
Internal Rate of Return	%	#DIV/0!		
Simple Payback Period	years	-29.30		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: 500 MWe CHP Scheme

INPUTS

Technical Specifications

Net Electrical Output	MWe	490
Thermal Output	MWt	450
Electrical Efficiency	%	41.0%
Heat Efficiency	%	36.9%
Total Efficiency	%	77.8%
Fuel Input	MWf	1197

Capital Investment

Total Cost of Equipment	US\$	403515000
Installation Fixed Cost	US\$	91500000
Variable Installation Cost	US\$	44835000
Total Installation Cost	US\$	539850000
Marginal Equipment Cost	US\$	339282000
Marginal Installation Cost	US\$	116571000
Marginal Total Cost	US\$	455853000

Capital Investment Boiler

New Boiler Costs	US\$	64233000
Installation Costs	US\$	19764000
Total Avoided Boiler Costs	US\$	83997000

Other Inputs

Operating Hours	hrs/yr	8400
Gas Price	US\$/kWh	2.10
Other Fuel Price	US\$/kWh	3.66
Composite Fuel Price	US\$/kWh	2.49
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	5.97
Electricity Export Price	US\$/kWh	5.37
Self Consumption %	%	10%
Boiler Efficiency	%	72%

Operational Performance

Variable O&M	US\$/kWh	0.549
Variable O&M	US\$/a	22596840
Fixed O&M	US\$/a	91500
Total O&M	US\$/a	22688340
Boiler Fixed O&M Costs	US\$/a	183000
Boiler Variable O&M Costs	US\$/a	3458700
Total Boiler O&M costs	US\$/a	3641700
CHP Fuel Consumption	MWh	9615385
Boiler Fuel Consumption	MWh	5240148
Net Consumption	MWh	4375237
Heat Output	MWh	3780000
Electricity Output	MWh	4116000
Exported Electricity	MWh	3704400
Electricity Used On-Site	MWh	411600

OUTPUTS: MARGINAL ASSUMING BOILER REPLACEMENT

Year	Total	0	1	2	3	4
Marginal Costs						
Capital cost	US\$ millions	-339	-339			
Installation cost	US\$ millions	-117	-117			
O&M	US\$ millions	-210	-19	-19	-19	-19
Fuel input	US\$ millions	-1200	-109	-109	-109	-109
Total cost	US\$ millions	-1865	-584	-128	-128	-128
Discounted	US\$ millions	-1527	-584	-121	-114	-108
Production						
Electricity	MWh	45276000	4116000	4116000	4116000	4116000
Electricity discounted	MWh	34410118	4116000	3883019	3663225	3455873
Revenue						
Electricity revenue	US\$ millions	4862	442	442	442	442
Discounted revenue	US\$ millions	3695	442	417	393	371
Net Cost/Income (not discounted)	US\$ millions	2997	-142	314	314	314
Net Cost/Income (discounted)	US\$ millions	2168	-142	296	279	264

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	4.44	€/kWh	3.62
Net Present Value	US\$ millions	2,045		
Internal Rate of Return	%	221%		
Simple Payback Period	years	1.45		

OUTPUTS: ASSUMING NO BOILER REPLACEMENT

Year	Total	0	1	2	3	4
Full Costs						
Capital cost	US\$	-403515000	-403515000			
Installation cost	US\$	-136335000	-136335000			
O&M	US\$	-209513040	-19046640	-19046640	-19046640	-19046640
Fuel input	US\$	-1200002	-109091	-109091	-109091	-109091
Total cost	US\$	-750563042	-559005731	-19155731	-19155731	-19155731
Discounted	US\$	-699993579	-559005731	-18071444	-17048532	-16083521
Production						
Electricity	kWh	45276000	4116000	4116000	4116000	4116000
Electricity discounted	kWh	34410118	4116000	3883019	3663225	3455873
Revenue						
Electricity revenue	US\$	2457979	223453	223453	223453	223453
Discounted revenue	US\$	1868083	223453	210804	198872	187615
Net Cost/Income (not discounted)	US\$	-748105063	-558782278	-18932278	-18932278	-18932278
Net Cost/Income (discounted)	US\$	-698125496	-558782278	-17860640	-16849660	-15895906

Economic Summary before subsidies

Levelised Electricity Cost	US\$/kWh	2034.27	€/kWh	1657.43
Net Present Value	US\$	-748,105,063		
Internal Rate of Return	%	#DIV/0!		
Simple Payback Period	years	-28.51		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: COAL

INPUTS

Technical Specifications

Electrical Output	MWe	1000
Thermal Output	MWt	0
Electrical Efficiency	%	41.0%
Heat Efficiency	%	0%
Total Efficiency	%	41.0%
Fuel Input	MWf	2441

Capital Investment

Total Cost of Equipment	US\$	2.196E+09
Installation Fixed Cost	US\$	128100000
Connection Cost	US\$	9150000
Total Installation Cost	US\$	2.333E+09
Marginal Equipment Cost	US\$	2.196E+09
Marginal Installation Cost	US\$	137250000
Marginal Total Cost	US\$	2.333E+09

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours	hrs/yr	7008
Coal Price	US\$/kWh	0.82
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	0
Electricity Export Price	US\$/kWh	5.97
Self Consumption %	%	4%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	US\$/kWh	0.86
Variable O&M	US\$/a	60000000
Fixed O&M	US\$/a	3660000
Waste Disposal	US\$/a	21024000
Total O&M	US\$/a	84684000
Boiler O&M costs	US\$/a	0
Fuel Consumption	MWh	17104030
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	17104030
Heat Output	MWh	0
Electricity Output	MWh	7008000
Exported Electricity	MWh	6727680
Electricity Used On-Site	MWh	280320

OUTPUTS

Year	Total	0	1	2	3	4	5	6	7	8
Marginal Costs										
Capital cost	US\$ millions	-2196	0	-329	-527	-922	-417			
Installation cost	US\$ millions	-137	0	-34	-34	-34	-34			
O&M	US\$ millions	-1016	0	0	0	-42	-42	-85	-85	-85
Fuel input	US\$ millions	-1533	0	0	0	0	0	-139	-139	-139
Total cost	US\$ millions	-4883	0	-364	-561	-999	-494	-224	-224	-224
Discounted	US\$ millions	-3473	0	-343	-500	-839	-391	-167	-158	-149
Production										
Electricity	MWh	77088000	0	0	0	0	0	7008000	7008000	7008000
Electricity discounted	MWh	43779981	0	0	0	0	0	5236785	4940363	4660720
Revenue										
Electricity revenue	US\$ millions	6422	401	401	401	401	401	401	401	401
Discounted revenue	US\$ millions	4299	401	379	357	337	318	300	283	267
Net Cost/Income (not discounted)	US\$ millions	1539	401	38	-160	-598	-93	177	177	177
Net Cost/Income (discounted)	US\$ millions	827	401	36	-142	-502	-73	132	125	118

Economic Summary

Levelised Electricity Cost	US\$/kWh	7.93	€/kWh 6.46
Net Present Value	US\$	386,711,013	
Internal Rate of Return	%	#NUM!	
Simple Payback Period	years	0.00	

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: NUCLEAR

INPUTS

Technical Specifications

Electrical Output	MWe	1000
Thermal Output	MWt	0
Electrical Efficiency	%	34.0%
Heat Efficiency	%	0%
Total Efficiency	%	34.0%
Fuel Input	MWf	2941

Capital Investment

Total Cost of Equipment	US\$	2745000000
Installation Fixed Cost	US\$	183000000
Connection Cost	US\$	9150000
Total Installation Cost	US\$	2937150000
Marginal Equipment Cost	US\$	2745000000
Marginal Installation Cost	US\$	192150000
Marginal Total Cost	US\$	2937150000

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours	hrs/yr	6833
Fuel Price	US\$/kWh	0.75
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	0
Electricity Export Price	US\$/kWh	5.97
Self Consumption %	%	6%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	US\$/kWh	0.88
Variable O&M	US\$/a	60000000
Fixed O&M	US\$/a	18300000
Waste treatment	US\$/a	20498400
Decommissioning set aside	US\$/a	62500000
Total O&M	US\$/a	161298400
Boiler O&M costs	US\$/a	0
Fuel Consumption	MWh	20096471
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	20096471
Heat Output	MWh	0
Electricity Output	MWh	6832800
Exported Electricity	MWh	6422832
Electricity Used On-Site	MWh	409968

OUTPUTS

Year	Total	0	1	2	3	4	5	6	7
Marginal Costs									
Capital cost	US\$ millions	-2745	-796	-604	-576	-494	-275		
Installation cost	US\$ millions	-192	-38	-38	-38	-38	-38		
O&M	US\$ millions	-1936	0	0	0	-81	-81	-161	-161
Fuel input	US\$ millions	-1658	0	0	0	0	0	-151	-151
Total cost	US\$ millions	-6531	-834	-642	-615	-613	-394	-312	-312
Discounted	US\$ millions	-4764	-834	-606	-547	-515	-312	-233	-220
Production									
Electricity	MWh	75160800	0	0	0	0	6832800	6832800	6832800
Electricity discounted	MWh	42685481	0	0	0	0	5105866	4816854	4544202
Revenue									
Electricity revenue	US\$ millions	4598	0	0	0	0	383	383	383
Discounted revenue	US\$ millions	2697	0	0	0	0	304	286	270
Net Cost/Income (not discounted)									
Net Cost/Income (not discounted)	US\$ millions	-1933	-834	-642	-615	-613	-10	71	71
Net Cost/Income (discounted)	US\$ millions	-2066	-834	-606	-547	-515	-8	53	50

Economic Summary

Levelised Electricity Cost	US\$/kWh	11.16
Net Present Value	US\$	-1,977,328,612
Internal Rate of Return	%	#DIV/0!
Simple Payback Period	years	41.28

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: NUCLEAR Delta Conservative Variant

INPUTS

Technical Specifications

Electrical Output	MWe	1000
Thermal Output	MWt	0
Electrical Efficiency	%	34.0%
Heat Efficiency	%	0%
Total Efficiency	%	34.0%
Fuel Input	MWf	2941

Capital Investment

Total Cost of Equipment*	US\$	2000000000
Installation Fixed Cost	US\$	183000000
Connection Cost	US\$	9150000
Total Installation Cost	US\$	2192150000
Marginal Equipment Cost	US\$	2000000000
Marginal Installation Cost	US\$	192150000
Marginal Total Cost	US\$	2192150000

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours**	hrs/yr	7884
Fuel Price	USc/kWh	0.75
Discount Rate	%	6%
Electricity Import Price	USc/kWh	0
Electricity Export Price	USc/kWh	5.97
Self Consumption %	%	6%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	USc/kWh	0.76
Variable O&M	US\$/a	60000000
Fixed O&M	US\$/a	18300000
Waste treatment	US\$/a	23652000
Decommissioning set aside	US\$/a	62500000
Total O&M	US\$/a	164452000
Boiler O&M costs	US\$/a	0
Fuel Consumption	MWh	23188235
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	23188235
Heat Output	MWh	0
Electricity Output	MWh	7884000
Exported Electricity	MWh	7410960
Electricity Used On-Site	MWh	473040

OUTPUTS

Year	Total	0	1	2	3	4	5	6	7
Marginal Costs									
Capital cost	US\$ millions	-2000	-580	-440	-420	-360	-200		
Installation cost	US\$ millions	-192	-38	-38	-38	-38	-38		
O&M	US\$ millions	-1973	0	0	0	-82	-82	-164	-164
Fuel input	US\$ millions	-1913	0	0	0	0	0	-174	-174
Total cost	US\$ millions	-6079	-618	-478	-458	-481	-321	-338	-338
Discounted	US\$ millions	-4249	-618	-451	-408	-404	-254	-253	-239
Production									
Electricity	MWh	86724000	0	0	0	0	0	7884000	7884000
Electricity discounted	MWh	49252478	0	0	0	0	0	5891383	5557909
Revenue									
Electricity revenue	US\$ millions	5305	0	0	0	0	442	442	442
Discounted revenue	US\$ millions	3112	0	0	0	0	350	330	312
Net Cost/Income (not discounted)	US\$ millions	-773	-618	-478	-458	-481	121	104	104
Net Cost/Income (discounted)	US\$ millions	-1137	-618	-451	-408	-404	96	78	73

* based on installed cost \$2000 / kW
 ** based on load factor of 90%

Economic Summary

Levelised Electricity Cost	USc/kWh	8.6272708464
Net Present Value	US\$	-1,113,425,351
Internal Rate of Return	%	#NUM!
Simple Payback Period	years	21.13

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: **CCGT Baseload**

INPUTS

Technical Specifications

Electrical Output	MWe	410
Thermal Output	MWt	0
Electrical Efficiency	%	48.7%
Heat Efficiency	%	0%
Total Efficiency	%	48.7%
Fuel Input	MWf	842

Capital Investment

Total Cost of Equipment	US\$	262605000
Installation Fixed Cost	US\$	26260500
Connection Cost	US\$	9150000
Total Installation Cost	US\$	298015500
Marginal Equipment Cost	US\$	262605000
Marginal Installation Cost	US\$	35410500
Marginal Total Cost	US\$	298015500

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours	hrs/yr	7500
Gas Price	US\$/kWh	2.10
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	0
Electricity Export Price	US\$/kWh	5.97
Self Consumption %	%	0%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	US\$/kWh	0.549
Variable O&M	US\$/a	16881750
Fixed O&M	US\$/a	91500
Labour	US\$/a	4117500
Total O&M	US\$/a	14141104
Boiler O&M costs	US\$/a	0
CCGT Gas Consumption	MWh	6317945
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	6317945
Heat Output	MWh	0
Electricity Output	MWh	3075000
Exported Electricity	MWh	3075000
Electricity Used On-Site	MWh	0

OUTPUTS

Year	Total	0	1	2	3	4	5
Marginal Costs							
Capital cost	US\$ millions	-263	-263				
Installation cost	US\$ millions	-35	-35				
O&M	US\$ millions	-232	-21	-21	-21	-21	-21
Fuel input	US\$ millions	-1463	-133	-133	-133	-133	-133
Total cost	US\$ millions	-1993	-452	-154	-154	-154	-154
Discounted	US\$ millions	-1586	-452	-145	-137	-129	-122
Production							
Electricity	MWh	33825000	3075000	3075000	3075000	3075000	3075000
Electricity discounted	MWh	25707268	3075000	2900943	2736739	2581829	2435688
Revenue							
Electricity revenue	US\$ millions	2018	183	183	183	183	183
Discounted revenue	US\$ millions	1534	183	173	163	154	145
Net Cost/Income (not discounted)	US\$ millions	25	-269	29	29	29	29
Net Cost/Income (discounted)	US\$ millions	-52	-269	28	26	25	23

Economic Summary

Levelised Electricity Cost	US\$/kWh	6.17	€/kWh	5.03
Net Present Value	US\$	-49,300,647		
Internal Rate of Return	%	2%		
Simple Payback Period	years	10.14		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: **CCGT Mid Merit**

INPUTS

Technical Specifications

Electrical Output	MWe	410
Thermal Output	MWt	0
Electrical Efficiency	%	46.2%
Heat Efficiency	%	0%
Total Efficiency	%	46.2%
Fuel Input	MWf	887

Capital Investment

Total Cost of Equipment	US\$	262605000
Installation Fixed Cost	US\$	26260500
Connection Cost	US\$	9150000
Total Installation Cost	US\$	298015500
Marginal Equipment Cost	US\$	262605000
Marginal Installation Cost	US\$	35410500
Marginal Total Cost	US\$	298015500

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours	hrs/yr	4500
Gas Price	US\$/kWh	2.10
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	0
Electricity Export Price	US\$/kWh	6.56
Self Consumption %	%	0%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	US\$/kWh	0.549
Variable O&M	US\$/a	10129050
Fixed O&M	US\$/a	91500
Labour	US\$/a	3660000
Total O&M	US\$/a	9306748
Boiler O&M costs	US\$/a	0
CCGT Gas Consumption	MWh	3990281
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	3990281
Heat Output	MWh	0
Electricity Output	MWh	1845000
Exported Electricity	MWh	1845000
Electricity Used On-Site	MWh	0

OUTPUTS

Year	Total	0	1	2	3	4	5
Marginal Costs							
Capital cost	US\$ millions	-263	-263				
Installation cost	US\$ millions	-35	-35				
O&M	US\$ millions	-153	-14	-14	-14	-14	-14
Fuel input	US\$ millions	-924	-84	-84	-84	-84	-84
Total cost	US\$ millions	-1374	-396	-98	-98	-98	-98
Discounted	US\$ millions	-1116	-396	-92	-87	-82	-78
Production							
Electricity	MWh	20295000	1845000	1845000	1845000	1845000	1845000
Electricity discounted	MWh	15424361	1845000	1740566	1642043	1549098	1461413
Revenue							
Electricity revenue	US\$ millions	1332	121	121	121	121	121
Discounted revenue	US\$ millions	1012	121	114	108	102	96
Net Cost/Income (not discounted)	US\$ millions	-43	-275	23	23	23	23
Net Cost/Income (discounted)	US\$ millions	-104	-275	22	21	19	17

Economic Summary

Levelised Electricity Cost	US\$/kWh	7.24	€/kWh	5.90
Net Present Value	US\$	-98,014,316		
Internal Rate of Return	%	-3%		
Simple Payback Period	years	12.83		

DELTA TECHNOLOGY ASSESSMENT MODEL

Technology: CCGT Peaking Plant

INPUTS

Technical Specifications

Electrical Output	MWe	410
Thermal Output	MWt	0
Electrical Efficiency	%	43.8%
Heat Efficiency	%	0%
Total Efficiency	%	43.8%
Fuel Input	MWf	936

Capital Investment

Total Cost of Equipment	US\$	2.63E+08
Installation Fixed Cost	US\$	26260500
Connection Cost	US\$	9150000
Total Installation Cost	US\$	2.98E+08
Marginal Equipment Cost	US\$	2.63E+08
Marginal Installation Cost	US\$	35410500
Marginal Total Cost	US\$	2.98E+08

Capital Investment Boiler

New Boiler Costs	US\$	0
Installation Costs	US\$	0
Total Avoided Boiler Costs	US\$	0

Other Inputs

Operating Hours	hrs/yr	2000
Gas Price	US\$/kWh	2.10
Discount Rate	%	6%
Electricity Import Price	US\$/kWh	0
Electricity Export Price	US\$/kWh	7.76
Self Consumption %	%	0%
Boiler Efficiency	%	80%

Operational Performance

Variable O&M	US\$/kWh	0.549
Variable O&M	US\$/a	4501800
Fixed O&M	US\$/a	91500
Labour	US\$/a	2745000
Total O&M	US\$/a	4920245
Boiler O&M costs	US\$/a	0
CCGT Gas Consumption	MWh	1871984
Boiler Gas Consumption	MWh	0
Net Consumption	MWh	1871984
Heat Output	MWh	0
Electricity Output	MWh	820000
Exported Electricity	MWh	820000
Electricity Used On-Site	MWh	0

OUTPUTS

Year	Total	0	1	2	3	4	5
Marginal Costs							
Capital cost	US\$ millions	-263	-263				
Installation cost	US\$ millions	-35	-35				
O&M	US\$ millions	-81	-7	-7	-7	-7	-7
Fuel input	US\$ millions	-433	-39	-39	-39	-39	-39
Total cost	US\$ millions	-812	-345	-47	-47	-47	-47
Discounted	US\$ millions	-689	-345	-44	-42	-39	-37
Production							
Electricity	MWh	9020000	820000	820000	820000	820000	820000
Electricity discounted	MWh	6855271	820000	773585	729797	688488	649517
Revenue							
Electricity revenue	US\$ millions	700	64	64	64	64	64
Discounted revenue	US\$ millions	532	64	60	57	53	50
Net Cost/Income (not discounted)	US\$ millions	-113	-281	17	17	17	17
Net Cost/Income (discounted)	US\$ millions	-157	-281	16	15	14	13

Economic Summary before subsidies			
Levelised Electricity Cost	US\$/kWh	10.05	€/kWh 8.19
Net Present Value	US\$	-148,164,297	
Internal Rate of Return	%	-8%	
Simple Payback Period	years	17.67	