

Supplemental Materials for David M. Newbery and Michael G. Pollitt, "The Restructuring and Privatisation of the CEGB - Was It Worth It?" *The Journal of Industrial Economics* 45 (3), September 1997, pp. 269-303

List of acronyms in order of appearance

CEGB	Central Electricity Generating Board
CCGT	combined cycle gas turbine
REC	regional electricity company
TFP	total factor productivity
DEA	data envelopment analysis
ESI	electricity supply industry
R&P	Restructuring and privatisation
CO ₂	carbon dioxide
SO ₂	sulphur dioxide
NO _x	nitrogen oxides
FGD	Flue Gas Desulphurisation
PESI	privatised electricity supply industry
AGR	Advanced Gas-cooled Reactors
PWR	Pressurised Water Reactors
CCA	current cost accounting
FFL	fossil fuel levy
EdF	Electricité de France

Units

kWh, TWh kilowatt hour, terrawatt hour = 1,000,000,000 (1 billion) kWhr
kW, MW, GW kilowatt, Megawatt = 1000kW, Gigawatt = 1000MW

Appendix A Mapping the CEGB to the restructured ESI: Sources and Methods

The compilation of comparable accounts for the CEGB's assets before and after restructuring in 1989 requires a careful reconciliation which is attempted below. Three types of accounts are identified: the pre-restructuring CEGB (A), the successor companies (B) and the post restructuring CEGB (C). The major sources are given at the beginning of each subsection and further details are reported at the end.

The basis of the reconstruction of the CEGB is the summation of the costs and revenues of the four successor companies. It is assumed that the business of the four successor companies is essentially the same as that of the old CEGB. Regulatory accounts net out double counting of direct sales in revenues and costs for PowerGen and National Power. Actual year source is used where possible.

(A) Allocation of revenue in the CEGB (CEGB Annual Report and Accounts):

Revenue = Sales to RECs and large users and sales of ash etc.
= Generation, transmission, pumped storage and interconnection costs
= Fossil fuel + Nuclear fuel + Staff costs + Deprec. + Purchased power from France, Scotland, others + Mats and Services etc + CEGB profits

(B) Allocation of Revenue in the CEGB successor companies:

(i) Generators (Totals from regulatory accounts: National Power and PowerGen; from Annual Report for Nuclear Electric/Magnox Electric (second tier supply business adjusted for 1993-96)

Revenue = Revenue from sale of electricity at pool prices + Ancillary services + Other generation income (sales of ash etc)
= Fuel + Depreciation + Staff costs + Nuclear decommissioning costs (Nuclear Electric) + Materials and services etc (including use of system, excluding gas for trading costs) + Reported Profits + Exceptions + Restructuring

(ii) National Grid (NGC Annual report and accounts and First Hydro Regulatory Accounts 1995-96)

Revenue = Transmission revenue + Pumped storage revenue + Interconnection revenue + Energis revenue + Other: inc contracting, ancillary services, settlements
= Purchases of electricity + Depreciation + Staff costs + Materials and services etc + Reported Profits + Exceptions and Restructuring

(C) The Allocation of Revenue in the reconstructed CEGB:

Revenue = Revenue from sale of electricity and electricity services to final consumers + Other generation income (sales of ash etc)
= Fossil Fuel + Nuclear Fuel + Staff costs + Nuclear decommissioning costs (Nuclear Electric) + Depreciation + Materials and services etc + Reported Profits + Exceptions + Restructuring

Pre-restructuring adjustments 1985-89

The pre-restructuring totals are then further adjusted by:

(1) Subtracting electricity purchase costs (France, Scotland and other generators) from both the costs and revenues of the old CEGB. This is because such purchases no longer occur in the new businesses. Interconnected and non-CEGB power is purchased direct by RECs and other customers. (Source: *CEGB Annual Report and Accounts*)

To convert from current to historic costs the following adjustments are made:

(2) Subtracting the initial fuel adjustment in the historic cost accounts from nuclear fuel cost.
(3) Adjusting the historic cost depreciation by the amount in the reported historic cost accounts.
(4) Subtracting the current cost adjustments excluding monetary working capital from the total current cost.

(5) Subtracting cost of abandoned schemes from total costs in 1988-89. This avoids the major discrepancy reported between the historic and current cost accounts in 1988-89 resulting from exceptionally large nuclear provisioning under historic cost accounting.

Other related statistics - pre restructuring - are calculated as follows:

Materials and services is the residual.

CEGB sales figures from *Handbook of Electricity Supply Statistics 1989* for 1985-86, *NGC Seven Year Statement 1995* and *NGC Annual Report 1995-96*.

Total Employees is taken from *CEGB Statistical Yearbook 1988-89* and excluding employees of B. Energy International.

Post-restructuring adjustments 1989-96

Post restructuring transactions between the successor companies must be netted out. This involves making the following adjustments:

- (1) Subtracting connection charges and use of system charges paid by generators to NGC and generators' share settlements payments from the costs and revenues of reconstructed CEGB. (Source: NGC data for 1990-95, estimated for 1995-96).
- (2) Subtracting purchases of electricity made by NGC (for ancillary services and pumped storage) from the three generators from the costs and revenues of the reconstructed CEGB. (Source: *NGC Annual Report and Accounts*)
- (3) Subtracting ENERGIS costs and revenues from the components of costs and revenues of the reconstructed CEGB. (Source: *NGC Annual Report and Accounts 1994-96*, NGC (1995b)).
- (4) Restructuring costs, reported in the relevant accounts, where these are charged to operation costs, are subtracted from the total cost and result in higher profits. This ensures consistency for the cost benefit analysis. Restructuring costs related to the privatisation of British Energy and the sale of NGC's Pumped Storage Business (PBS) are not included. (Source: *Regulatory Accounts*).
- (5) First Hydro, which took over operation of PSB, is added to NGC's continuing and discontinued businesses for 1995-96.
- (6) Subtracting the revenue from gas sales and the cost of gas sales from revenue and costs and the difference from profits for National Power.

Other related statistics - post restructuring - are calculated as follows:

Fuel figures are from annual reports or the privatisation prospectus for National Power and PowerGen 1995; PowerGen figure for 1994-95 comes from MMC (1996b) and 1995-96 is estimated from National Power data.

Staff costs (National Power and PowerGen regulatory accounts, Nuclear Electric/Magnox Electric and National Grid annual reports).

Staff numbers (PowerGen regulatory accounts, National Grid annual reports excl. Energis, National Power annual reports (UK business only 1993-96), Nuclear Electric/Magnox Electric annual reports)

Profit is reported profits plus restructuring and exceptionals charged to operating costs.

Materials and services etc is the residual cost element.

Tax (Annual reports).

Output NGC Seven Year Statement 1995 and NGC Annual Report 1995-96.

Table A1		Restructuring costs in CEGB and successor companies							
		<i>£ million charged to profit and loss account</i>							
		1988-89	1989-90	1990-91	1991-92	1992-3	1993-94	1994-95	1995-96
National Power		11	491	93	76	150	37	28	4
PowerGen			164	24	51	28	36	0	-4
Nuclear Electric			108	92	240	52	212	2	0
National Grid			8	7	47	39	51	27	14
Net Government			0	0	0	-4	-4	-4	-4
Total		11	771	216	414	265	332	53	10
Source: Accounts, DTI/DOE expenditure plans									
Table A2		Accounts of Nuclear Electric						<i>£ million current</i>	
		1989-90	1990-91	1991-92	1992-3	1993-94	1994-95	1995-96	
Turnover	<i>£ million</i>	2058	2202	2432	2706	2962	2841		
of which	Levy	0	1195	1265	1280	1230	1251	1163	
Operating Costs (hist)		1833	1876	1950	2042	2166	1623	1636	
of which		1833	1876	1950	2042	2166	1623	1636	
	Fuel Costs	858	816	837	846	843	645	563	
	of which provisions*		596	562	606	577	379	327	
	(payments to BNFL/Nirex)**		471	506	560	596	1203	632	
	Materials and Services	381	453	495	508	471	456	501	
	Staff costs	305	306	327	320	303	272	272	
	Historic Cost Depreciation	210	211	225	253	278	250	300	
	Current Cost Depreciation	382	356	333	329	336	366	406	
	Decommissioning	79	70	66	65	61	57	0	
	Exceptionals	0	20	0	50	210	-57	0	
HC profit excl levy before exceptionals			-661	-685	-712	-726	-429	2325	
CC profit excl levy before exceptionals			-806	-793	-788	-784	-545		
HC profit before exceptional costs		225	346	482	714	1006	1161	1162	
CC profit before exceptional costs		53	201	374	638	948	1045		
Taxes paid			0	0	0	31	33	52	
Sum of nuclear provisions			9551	9883	10456	11009	10461	10895	
Nuclear Provisions current liabilities (hist)			720	1354	2142	2976	2636		
	past liabilities (historic)		8831	8529	8314	8033	7825		
Capital employed historic net assets inc nuc			5633	6027	6709	7623	8110	8334	
Nuclear Provisions current liabilities (curr)			720	1354	2142	2976	2636		
	past liabilities (current)		8831	8529	8314	8033	7825		
Capital employed current net assets			8118	7815	8430	9697	10219	10443	
Nuclear Provisions in year			666	631	672	638	436		
of which	non-fuel		70	69	66	61	57		
HC RoR incl Levy income	percent		na	8.3	11.2	14.0	14.8	14.1	
CC RoR incl Levy income	percent					10.5	10.5		
Output	TWh	42.5	45.0	48.4	55.0	61.0	59.2	62.7	
Employees	numbers	14415	13924	13300	12283	10728	9338	8815	
Capacity	MW	7997	8357	8363	9059	8904	8929	10107	
Source: Company Accounts									
Notes:	* Current provisions for future reprocessing of current fuel								
	** Actual payments out of accumulated provisions for current reprocessing of past fuel								

Appendix B Fuel prices and future investment costs

Imported coal prices until 1990/91 are taken from DTI (1993, p42), updated from *Coal Week International*. Power station gas prices are taken from *World Gas Intelligence* for the PESI, but are assumed to be 10% higher under the CEBG, reflecting a world in which energy liberalisation proceeds more slowly. British coal prices are taken from House of Commons (1993), and assumed to be £1.51/GJ in 1993/4 falling to £1.33/GJ in 1997/8 linearly, at October 1992 prices under the privatisation scenario. Under the CEBG counterfactual pithead prices are higher because the industry is operating further up the marginal cost schedule. The coal supply schedule is assumed to follow the predictions of Boyds (DTI, 1993) until 1996/7 and House of Commons (1993) to 1998, corresponding to continued cost reductions of 5% per year in real terms at each level of supply. The extra cost under the CEBG counterfactual is then the excess of the total cost of supplying at the pithead marginal cost rather than the PESI pithead forecast price, for the extra tonnage taken, plus (in the pro-privatisation counterfactual), the additional cost of mining coal, taken as 5% higher at each level of output. Delivery to relevant power stations is taken as 17p/GJ (October 1992 prices) for domestic coal, and 22p/GJ from ARA for imported coal. Oil prices (HFO 3.5% sulphur) are taken as ARA prices plus duty but with no transport cost as oil-fired stations are typically adjacent to refineries. Orimulsion is assumed to be priced at ARA coal prices. Table A4 gives the real fuel prices used in the scenarios in £/MW(e), ie the cost of generating the electricity.

Imports from EdF over the cross-channel link under privatisation is at pool prices, with the French enjoying the FFL until 1997, but under the CEBG would have been at avoidable cost of marginal plant, taken as small domestic coal, ie roughly half the market price.¹ The imports from Scotland are taken to be the same at the same true social cost under both alternatives.

The only investments that need to be costed are those that differ between scenarios. They are expressed as a fixed capital cost per kW capacity averaged over the construction period up to the year commissioned, a fixed O&M costs per kW/yr, and a variable fuel cost per kWh. At the terminal date, plant must be valued and the differences in the terminal capital values added to the discounted differences in costs until the terminal date. The value of plant is measured relative to a reference base-load CCGT plant - if, as with nuclear stations, it has lower future operating costs then it will have a positive value, if it has higher operating costs it will be worth less than the CCGT, and will have a negative value. The extra costs of the CEBG compared to the privatised ESI is then the discounted value of the extra annual costs less the present value of the terminal value of extra CEBG plant (of which there will be more nuclear and coal, and younger CCGT).

Table A3 Capital and operating costs of new generation plant

	Nuclear Large Coal		CCGT
Capital £/kW	1400	1000	425
O&M £/kW/yr	45	35	30
fuel p/kWh	0.45		
Thermal efficiency		39	52
Construction yrs	5	5	3
Load factor	75	85	85
Life years	40	40	25

The nuclear costs are taken from Fells and Lucas *UK Energy Policy Post Privatisation*, (1991, p22, BNFL base case) but fuel prices left at 1990 values in view of the slightly lower values given in DTI (1995b, p18), which, however, are themselves argued to be rather optimistic. The Hinkley Point C 'pessimistic' case in

1. Strictly, it should be the average of the avoidable costs on the two systems.

Fells and Lucas has fuel costs of 0.55p/kWh and O&M costs of 1.16p/kWh (both at 1987 prices), higher than the BNFL O&M costs of 0.61p/kWh, comparable to those given here. Note that Sizewell B (the proto-type for Hinkley Point C) cost £2964 million in March 1995 money (House of Commons, 1996, pxxvii) for 1,300 MW, or £2280/kW. Costs would have to be cut 28% to give the capital cost shown here (at 6% including interest on capital in construction), in line with the estimates for future replication costs.

The costs of large coal are taken to be 35% higher than the average cost of a coastal and inland power station taken from the Hinkley Point inquiry (which was at 1987 prices), reflecting inflation to 1994/5 prices. The CCGT costs are typical of eg Seabank (a joint venture of British Gas and Scottish Hydro) who plant to build a 775 MW CCGT station near Bristol for £315 million, with Siemens awarded the contract. (*Power News*, Jan/Feb 1996, p6). In the same issue Deeside CCGT is reported to have achieved 52.07% efficiency, near the design maximum of 53%.

Appendix C The simulation fuel and capacity models

The model starts with a forecast of electricity demand for the next 7 years published in NGC (1995), extrapolated thereafter at 1.5% pa, and a forecast of capacity available, subject to a maximum age of 40 years for conventional generation, 35 years for Magnox, (and an irrelevant 25 years for CCGT). Historical and forecast fuel prices are given in Table A4 for internationally traded fuels (coal, oil, gas), in original units and per £/MW(e) after conversion in generation (which is the short-run avoidable cost of generation). The fuel demand is then chosen to minimise avoidable costs, subject to various constraints, such as the coal and other capacity remaining, the need to meet the sulphur limits, as well as fuel prices and the other non-economic objectives of the players (eg the coal contracts signed with the generators and passed on to franchise customers after the Parliamentary Inquiry of 1993). Sulphur limits compel the CEGB to install more FGD and eventually, as coal plant is retired at the end of the century, to replace old coal plant with CCGT. The larger reserve margins also compel the CEGB to install more capacity than the privatised ESI (PESI), and after 2000 this is assumed to be in CCGT. Under the PESI, French electricity enjoys £6/MWe premium as a non-fossil fuel until 1996, when the fossil fuel levy is treated as ending with the privatisation of British Energy, the new nuclear company. (Actually, it was reduced from 10% of the retail price to 3.7% in November 1996 for six months to fund remaining nuclear obligations and renewables and is expected to fall again in 1997). This much is common to both counterfactuals.

The differences between the CEGB and the PESI in electricity generated by different fuels for the two counterfactuals are given in Table A5. Positive values show the excess of the fuel burn under the PESI compared to that under the CEGB, and negative levels correspond to larger fuel use by the CEGB. Note that the main difference is that the PESI burns more gas, particularly up until the end of the century, and initially imports more over the links, while the CEGB burns more British coal, installs more FGD, and brings more nuclear power on stream towards the end of the century. The CCGT capacity under the PESI comes from NGC forecasts, while that under the CEGB is determined primarily by the sulphur limits, as the CEGB maximises its British coal burn. After 2004 the need for the CEGB to replace aging coal plant with new CCGT capacity rapidly erodes the difference, and the CEGB ends with more CCGT as it operates with larger reserve margins. Differences in new capacity are described in Table 3, and the merit orders differ between the counterfactuals: under the CEGB nuclear runs first (ie on base load), then coal, then gas and oil; while under the PESI nuclear and imports are on base load, then gas, leaving coal as the mid-merit variable output residual.

The differences between the scenarios in total operating costs are derived from the differences in fuel used, differences in non-fuel cost by type of plant (per kW of capacity per year), and differences in the interest on capital costs for new investment, calculated at the relevant discount rate (6% and 10% in the results reported in the text). Terminal capital values are the present value of the difference between the value of electricity and the annually avoidable costs, where the value of electricity is set equal to the average total cost of new CCGT capacity.

Table A4

Real Fuel Prices

	£/MWe At 1994/5 prices																			
	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
Coal: domestic	22.8	21.4	20.5	18.7	18.2	17.7	17.2	16.7	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1
Coal: imported+orimulsion	14.3	14.1	15.0	13.9	13.5	13.5	14.3	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2	15.2
Nuclear fuel+O&M at 75% LF	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
Oil	15.6	15.2	16.2	15.1	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7	16.7
gas	17.6	18.1	16.4	15.9	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8

Table A5

Differences between projected ESI and counterfactual public ownership

Case 1 Pro-privatisation scenario

Priv ESI less CEEB

		90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
<i>Differences in</i>																					
Nuclear + Scotland imports	TWh	0	0	0	0	0	0	0	-2	-8	-8	-10	-17	-17	-17	-17	-17	-17	-17	-17	-17
Imports (EdF only)		0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Orimulsion		0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-1
Orimulsion + FGD		0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
Oil		0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"CEGB" CCGT		0	0	16	24	22	23	23	18	31	30	18	5	-2	-11	-32	-44	-61	-76	-99	-117
IPP CCGT		0	2	3	14	31	31	59	61	61	61	61	61	61	61	61	62	80	88	120	135
Total gas		0	2	19	38	53	54	82	79	92	91	79	66	59	50	29	18	19	12	21	18
Balance: coal		0	-14	-23	-43	-58	-58	-86	-84	-92	-91	-77	-57	-50	-41	-20	-9	-10	-3	-7	-8
of which: FGD domestic		0	0	0	0	0	0	0	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
imported		0	0	0	5	10	13	-15	0	-11	-5	-5	-10	-15	-20	-15	5	5	18	15	12
domestic		0	-14	-23	-48	-68	-71	-71	-72	-68	-73	-59	-34	-22	-8	8	-1	-2	-8	-9	-7
Unused sulphur balance	kt	0	50	319	627	871	900	1083	1004	1028	1058	864	549	416	254	-1	-7	7	6	136	47
Memo item: UK coal	Mtce	-1	-7	-11	-21	-29	-30	-30	-35	-34	-36	-30	-20	-15	-9	-3	-6	-7	-9	-9	-8
Memo item: imported coal	Mt	0	0	0	2	4	5	-6	0	-5	-2	-2	-4	-6	-9	-6	2	2	7	6	5
Memo item: FGD capacity	GW	0	0	0	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Memo item: CCGT capacity	GW	0	0	3	6	8	8	12	12	14	14	12	10	6	3	2	0	-3	-4	-4	-6
Carbon balances	Mt C	0	-2	-5	-8	-11	-11	-16	-16	-16	-16	-13	-9	-8	-6	-3	-1	-1	0	-1	-1

Case 2 Pro-CEGB scenario

Priv ESI less CEEB

		90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
<i>Differences in</i>																					
Nuclear + Scotland imports	TWh	0	0	0	0	0	0	0	-2	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
Imports (EdF only)		0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orimulsion		0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	-1
Orimulsion + FGD		0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
Oil		0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"CEGB" CCGT		0	0	16	14	10	15	18	18	31	29	18	6	-9	-22	-37	-49	-66	-80	-110	-129
IPP CCGT		0	2	3	14	31	31	59	61	61	61	61	61	61	61	61	62	80	88	120	135
Total gas		0	2	19	28	41	46	77	79	92	90	79	67	52	39	24	13	14	8	10	6
Balance: coal		0	-12	-19	-28	-41	-46	-77	-80	-87	-85	-74	-62	-47	-34	-19	-8	-9	-3	0	0
of which: FGD domestic		0	0	0	0	0	0	0	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
imported		0	0	0	5	-5	-2	-35	-20	-31	-25	-20	-20	-15	-20	-15	6	6	18	15	12
domestic		0	-12	-19	-33	-36	-44	-42	-47	-44	-48	-42	-30	-20	-2	8	-2	-3	-9	-3	0
Unused sulphur balance	kt	0	22	257	425	532	617	804	795	818	835	719	552	381	164	-8	-6	8	13	45	-45
Memo item: UK coal	Mtce	-1	-6	-9	-15	-16	-19	-18	-25	-24	-25	-23	-18	-14	-6	-2	-6	-7	-9	-7	-6
Memo item: imported coal	Mt	0	0	0	2	-2	-1	-15	-9	-13	-11	-9	-9	-6	-9	-6	2	2	7	6	5
Memo item: FGD capacity	GW	0	0	0	0	0	0	0	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Memo item: CCGT capacity	GW	0	0	3	6	6	7	12	12	14	14	12	10	7	4	2	1	-2	-3	-3	-5
Carbon balances	Mt C	0	-2	-3	-5	-7	-8	-14	-14	-15	-15	-13	-11	-8	-6	-3	-1	-1	0	0	0