

CHAPTER 1 NOTES

1. In the early years of this century, the link between electrification and modernisation was recognised across the political spectrum. In his address to the All-Russian Congress of Soviets on 22 December 1920, V.I. Lenin said

"Communism is Soviet power plus the electrification of the whole country".

2. There are two main categories of non-food energy use in modern cities. The first is transportation, characterised by powered vehicles on fixed tracks such as trains, or vehicles with more flexible travel and fuelling patterns, such as automobiles. The second category is stationary energy equipment, relying on energy delivered by the transportation system or, more typically, distributed by fixed reticulation grids.

3. The density of the SSD was 277 persons/sq km, varying from a high of 6963 in Waverley to a low of 10 in Wollondilly Shire. The two largest LGAs were also the least dense, and their exclusion would increase the density of the SSD to a more representative 476.

The boundary of the SSD was redelineated by ABS in 1976 "to embrace the area expected to contain the urban development of Sydney (and associated smaller urban centres) for a period of at least twenty years" (ABS 1983a).

The SSD boundary is therefore more useful for forward projections than for historical studies, and is not always closely related to the actual urban area. ABS and previous statistical agencies have used various definitions of Sydney in the past, and all comparisons of area and population must be made with caution. On questions of metropolitan definition, see also Spearritt (1986).

Of the areas added to the SSD in 1976, the two densest were Gosford and Wyong (110 persons/sq km average in 1986) and the two least dense were Hawkesbury (formerly Colo) and Wollondilly (13.0 persons/sq km average in 1986). The average density of the Blue Mountains LGA (of which the less dense part had been added to the SSD in 1976) was 46.8 persons/sq km in 1986.

Thus there are major variations in density and urban quality throughout the SSD. Nevertheless, any departure from the 1986 SSD as the Sydney boundary would require constant adjustment to the energy statistics of the ABS and of other organisations, and any gains in refinement would be exceeded by the inherent errors in those statistics.

4. Nuclear fuels mined on the earth do not originate from the sun, but derive their energy from the same class of nuclear material transformations. It is also arguable that geothermal energy is the residue of the formation of the planet.

5. Some primary energy sources are 'renewable': in that, the rate of collection by the techno-energy system does not exceed the rate of accumulation. Wind and solar radiation are effectively inexhaustible. Timber may be temporarily exhausted if the rate of collection in any locality exceeds the rate of regrowth. Regeneration will occur if the techno-energy system is managed in a way which allows it, so the resource may still be considered renewable.

6. Vales Point and Munmorah power stations were well north of the Sydney urban area when they were built, in 1964 and 1967 respectively. The enlargement of the SSD in 1976 brought them just inside the northern boundary. Accordingly, the JCB assigned 4,943,000 tonnes of the 18,550,000 tonnes of coal used in NSW in 1985/6 to the SSD, but for the purposes of this analysis the two power stations are considered to lie outside Sydney.

7. If the rate of urban heat generation exceeds the rate of loss to the surroundings, the local temperature rises and consequently the rate of heat loss increases until a new stasis is reached. The mean winter temperature in Central London, for example, is about 3 degrees C higher than that of its hinterland (Changnon 1979).

8. Not all data sources make clear distinction between energy delivered to Sydney and elsewhere, and those which do often employ their own definition of the urban boundary. All estimates are adjusted to the boundaries of the SSD as defined previously, with the minor modification of the northern boundary to exclude all power stations outside central Sydney. The time period is nominally the 1986 calendar year. Adjustment has been made to published financial-year data, or alternatively the latest available raw data (generally 1986/7) have been used.

NSW electricity councils reported on a calendar year basis until YE December 1985. They then made the transition, not all in the same way, to financial year reporting. The 1986 data have therefore been estimated from various sources including the SCC 1986/7 report and unpublished EnANSW data covering quarterly periods. State-wide generation statistics are only available on a financial year basis, from ECNSW and ESAA. Gas statistics are reported to the EnANSW on a calendar year basis. Total NSW energy consumption may be derived from EnANSW reports, on a financial year basis.

Since energy use patterns shift relatively slowly, a mis-match of half a year is unlikely to make a difference of greater than 1% in the estimated use of the major fuels.

9. The PCC also includes two LGAs outside the SSD, Greater Lithgow and Rylstone Shire. In 1986 these contained only 2.8% of the population served by the PCC, equivalent to 0.75% of the SSD population. PCC data are not adjusted to correct for sales outside the SSD.

10. For simplicity and consistency, the following ratios for primary to delivered energy, as calculated from EnANSW 1987,68, are used throughout:

Electricity	3.37	
Gas	1.08	
Oil	1.05	
Coal	1.20	
Other	1.00	(no losses assumed)

These ratios are fairly consistent with those derived directly for Sydney utilities. Because of transmission losses in their respective distribution systems, the councils purchased from the ECNSW about 4.1% more energy than they sold, and the ECNSW sent out from its power stations 4.6% more energy than it sold to the councils. The thermal power stations themselves sent out about 32.9% of the primary energy content of the coal they burned (ECNSW 1986,103). Therefore the total ratio of primary to delivered electricity was:

$$1.041 \times 1.046 \times 3.040 = 3.31 \text{ (not including energy associated with coal mining).}$$

Estimated gas losses for the SSD were 11%. However, the loss rate would have been lower in the rest of NSW, where the proportion of residential sales is lower.

11. The State Rail Authority (SRA) operates over 500 route-km of electrified track in NSW. Most of this is within Sydney, but it extends some 20 km west of the SSD boundary to Lithgow. In 1986 the electrification of the line to Port Kembla, 30 km to the south, was completed (SRA 1986,38). During 1987 the SRA purchased about 660 GWh (2.4 PJ) of energy from the ECNSW for traction.

12. Some natural gas was processed to reduce its calorific value to that of the 'town gas' formerly made by AGL from coal and naphtha, so that it could be used by unconverted gas appliances. A programme of equipment conversion had been under way since 1976, and by the end of 1986 about 62% of AGL's customers, including all of the biggest industrial customers, were taking unprocessed natural gas.

13. The 1985 ABS Survey of Motor Vehicle Usage estimates average annual vehicle kilometres travelled (VKT) by vehicle types, and the proportion of VKT on capital city roads (ABS 1986c). It also estimates the rate of fuel consumption in litres per 100 kilometres for each type of vehicle and aggregate national consumption of petrol, diesel and liquefied petroleum gas (LPG) powered vehicles.

Fuel consumption varies markedly between conditions of highway driving, where speed is high and constant, and Sydney driving, where mean peak hour traffic speeds on major arterial roads were as low as 25 km/hr in 1985/6 (TANSW 1986,40). Urban weightings to be applied to average vehicle fuel consumption may be calculated from new vehicle test data published by the federal Department of Resources and Energy and have also been derived specifically for Sydney by the Urban Transport Study Group (UTSG 1983). The total fuel consumption for road vehicles in the SSD in 1986 is estimated at about 3750 million litres. It is estimated that ferries and diesel rail used a further 50 million litres, bringing the total energy content of petroleum transport fuels (excluding aircraft) to over 133 PJ (see Table 1.1).

Petroleum product use by various Australian Standard Industrial Category (ASIC) groups in the NSW in 1986 is estimated by the Energy Authority (EnANSW 1985a). The most petroleum-intensive industries, in particular petroleum refining, food and beverages, textiles and clothing, are concentrated in Sydney. The allocation of the oil consumption of those entire ASIC groups to the SSD is a reasonable simplification, and a necessary one in the absence of detailed data for each individual manufacturing unit.

About half of NSW residential sector oil consumption may be allocated to the SSD on the basis that about half the households using oil as their main heating fuel in 1986 are located there (ABS 1987a). Commercial oil use may be similarly allocated.

14. Some 4 PJ of bagasse was used in 1986, almost all of it to generate electricity and steam in sugar mills in the Northern Rivers region of the state.

Wood use estimates vary widely, because most of the fuel is gathered free by users and so does not appear in commercial sales statistics. The federal Bureau of Resource Economics (BRE) estimates 1985/5 wood use in NSW at over 22 PJ (BRE 1987,74). This seems excessive, given the high tonnages implied for each residential user. The more modest EnANSW estimate of 16 PJ of wood and bagasse combined is used (EnANSW 1987,68). A proportion of this may be assigned to the SSD on the basis of the number of households in Sydney using wood as their main heating fuel (see Table 1.1).

15. The vastly greater coal consumption outside the SSD is readily explained by the location of the state's basic iron and steel works at Newcastle and Pt Kembla. About half the state's electricity, gas and oil was used within the SSD. Since the SSD had nearly 63% of the NSW population, the per capita use of these energy forms outside Sydney was significantly greater. For the solid fuels timber and bagasse, per capita use outside the SSD was considerably greater.

16. There is a clear distinction between petroleum, most of which supplies transportation services, and the other fuels, which supply mainly stationary energy services. Each state is integrated into a largely uniform national road transport system, and the petroleum products are traded interstate and internationally. On the other hand, the state non-transport energy systems are not strongly interconnected. They are based mainly on local primary energy sources which, with few exceptions such as NSW's natural gas, are neither traded interstate nor imported.

17. The 1985/6 national energy survey (ABS 1987a) found that the penetration of major household appliance types was very similar in all capital cities. The major variations were in the penetration of roof insulation and air conditioning, in the level of energy consumption per household, and in the mix of fuels supplying thermal appliances.

18. The high residential consumption of electricity was consistent with the price structure: Table 1.5 shows that typical residential and commercial consumers paid less in Sydney than in the other capitals. Industrial consumers, on the other hand, paid least in Melbourne.

19. It should be noted that the value of fixed assets given in Table 1.7 is in historical cost terms. A far greater proportion of the ECNSW's fixed assets represented recent investment, and so were valued closer to true replacement cost than the SRA's.

The ECNSW accounted for over 18% of NSW government and semi-government capital works in 1985/6, just behind roads (22%) and well ahead of public transport (10%) and water and sewerage (9%) (NSW Budget Papers 1986/7,II,99). Much of the capital investment for electricity supply had been raised by loans rather than internal financing. The net loan liability of the ECNSW made up about a quarter of all NSW government and semi-government guaranteed debt, and fully 79% (\$ 3360 m) of NSW government and semi-government net foreign currency exposure in June 1985 (ibid,213).

20. Some of the most interesting explorations of the urban future have been through the medium of film. *Escape From New York* (Director J.Carpenter, USA 1981) postulated the de-energisation of Manhattan and its conversion to a walled prison for criminals from the rest of the USA. Petrol forms the basic unit of currency in the vestigial economy. *Mad Max II* (Director G.Miller, Australia 1983) has similar elements, and in *Mad Max: Beyond Thunderdome* (Directors G.Miller and G.Ogilvie, Australia 1985) methane biogas powers the few generators and vehicles remaining in a post-apocalyptic, post-urban region located somewhere near the ruins of Sydney. *Blade Runner* (Director R.Scott, USA 1983) postulates a partially de-energised Los Angeles, in which energy conversion has permanently altered the climate.

21. The urban siting of nuclear power plants has not, however, become acceptable. See for example Mazuzan (1986) on the efforts of the Consolidated Edison Company of New York to construct a power reactor in the neighbourhood of Queens in the mid 1960s.

22. Substation record sheets provided by ECNSW (private communication, 1982). The indicated peak load of the 7 substations concerned (representing 14% of Sydney demand) was over 2.6 times the magnitude of the minimum load. The variation in the entire NSW system over a typical 24 hour period in the winter of 1986 was about 2:1 (ECNSW 1986,16). Gas demand in a part of Sydney with a typical balance of residential, commercial and light industrial load in 1984 also varied in a ratio of about 2:1. However, because of the dampening effect of its predominantly industrial and continuous gas use the gas demand variation for the whole city was only 1.2:1 (Butters & Davis 1986,5). Sydney's gas supply had a better record of reliability than electricity, even though the primary resource was located much further away and delivered via a single pipeline. In July 1982 the pipeline ruptured at the Moomba end, 1300 km from Sydney. Although it was out of service for 56 hours, the compressed gas stored in the pipeline, combined with some restriction of use by the largest consumers and increased production of gas from naphtha in Sydney, made restrictions on residential use unnecessary (AGL 1982,12).

23. EnANSW (1987b) gives the 1987 purchase price of a continuous electric water heater as \$195 and the installation cost as \$150. Annual consumption was estimated at 2830 kWh, which at the SCC tariff applying on 1 January 1987 would have cost \$209. A 34 cm colour TV set cost about \$400 in 1987, and consumed about 75 w. If used 3 hours per day it would consume 82 kWh per year, costing \$6.06.

If the purchase price is distributed evenly over an assumed 10 year operating life, energy costs would constitute over 85% of the cost of service for the water heater, but only 13% for the TV (excluding other costs such as repairs).

24. The following trends in US utility forecasting were identified by Huss (1985):

SECTOR	MODELLING TECHNIQUE USED	% OF UTILITIES USING TECHNIQUE			
		1972	1976	1980	1984
Residential	Trend	83.7	58.3	9.3	0
	Econometric				
	End Use	4.7	14.6	40.7	51.9
	Other	7.0	8.4	0	7.7
Commercial	Trend	86.0	62.5	14.8	2.0
	Econometric	4.7	27.1	75.9	62.8
	End Use	0	0	7.4	25.5
	Other	9.3	10.4	1.9	9.7
Industrial	Trend	75.0	49.0	7.5	0
	Econometric	4.5	24.5	75.4	69.5
	End Use	0	0	3.8	12.2
	Other	20.5	26.5	13.3	18.3

It should be emphasised that the models defined as "end-use" were relatively simple:

"In the residential sector these models are characterized by forecasts by appliance where the number of households times the appliance saturation times the use per appliance results in a consumption per appliance. In the commercial or industrial sector, these forecasts are generally done by equipment types such as heaters, boilers, furnaces et cetera" (Huss 1985,32).

25. Cost recovery is by no means the only aim of user class differentiation. Electricity pricing in Sydney in 1986 was strongly subject to requirements of social and economic policy made by or imposed on the suppliers. The conventional user class categories were well suited to price discrimination, and in fact their evolution reinforced it. Users in different groups are generally offered different tariffs and pay different average prices. In 1985 for example, the residential, commercial and industrial consumers of the PCC paid respectively 6.6, 10.3 and 7.9 cents per kWh of electricity consumed (PCC 1986/7,51).

One reason for this is variation in the cost of supply. Transportation cost for discrete energy forms depends on the location of the consumer in relation to the established distribution network, as does the cost of initial connection in the case of reticulated energy forms. Once a consumer is connected to the reticulation grid the effect of space on the cost of continued supply is usually minor, but the effect of the consumer's magnitude of demand at the time of peak demand on the grid becomes an important factor.

The metering of energy sales to residential and smaller commercial consumers is generally unable to distinguish the time of use, and if costs are to be recovered tariffs must be struck at some average which roughly corresponds to the cost which a typical consumer of that class imposes on the system. More expensive and sophisticated maximum demand or time of use metering is justified for larger commercial and industrial consumers. Prices to those users can therefore be more closely related to the actual cost of supply, and the use of class approximations is less necessary.

26. The 1985/6 National Energy Survey, was restricted to the 17 most common and energy-intensive types of household appliances, (eg dishwashers, water heaters and refrigerators) (ABS 1987a,8). The Survey omitted lighting and most electronic equipment (eg televisions, tape recorders, clocks) small powered equipment (eg vacuum cleaners, food mixers), and small thermal equipment (eg irons, kettles). With the inclusion of these categories the full range of energy using equipment commonly found in Sydney households runs to nearly a hundred types.

27. Reliable NSW data on commercial energy use is difficult to obtain because of the diversity of functions and building types which the energy suppliers, for convenience, classify as commercial.

NSW Government and public hospital energy demand in 1984/5 gives some indication of the diversity of commercial sector energy use. 8.42 PJ was consumed in public buildings and 1.74 PJ in water supply (EnANSW 1986c), together accounting for about 27% of the 38 PJ used in the NSW commercial sector in that year (EnANSW 1985,59). The breakdown of public building energy use was:

	PJ
Offices	0.71
Schools	0.84
Dept of Health hospitals	0.80
Other hospitals	4.95
Colleges and prisons	0.62
Other institutions	0.50

Although the energy service demand is qualitatively similar to the residential sector, the pattern of demand varies with the closeness of the commercial function to residential activities and building forms. The energy demand of a low-rise restaurant, for example, will probably have more in common with that of a house than that of a high rise office building.

A survey of 93 air conditioned office buildings by the Building Owners and Managers' Association in 1987 found that their 1986 energy consumption was disaggregated as follows (excluding car park and "other" demand):

	%
Ventilation and cooling	56
Lifts	11
Lighting and small power	16
Space heating	15
Hot water	3

The NSW Government's design targets for air-conditioned office buildings were expressed in different terms (EnANSW 1986c,21), making comparison difficult:

	%
Tenant Light and Power	32
Refrigeration	25
Ventilation and other electricity	30
Heating	9
Hot water	3

28. EnANSW estimates the following energy service breakdown of NSW industrial energy use in 1978/9 (EnANSW 1981b,20):

	PJ	%
Process Heat:<100 C	3	0.6
100-400 C	68	14.2
>400 C	221	46.1
Power	68	14.2
Electrolysis	9	1.9
	<hr/> 478	<hr/> 100.0

(Feedstock energy is not separately tabulated).

29. The ABS records, at the national level, the distance travelled by motor vehicles operating within and outside capital cities, without distinguishing travel by trip origin, destination or purpose. The transportation energy used within and outside the SSD by cars and station wagons, and by vehicles which generally carry freight (vans and trucks) can therefore be estimated. Table 1.1 indicates that nearly half of all NSW transport energy is used within Sydney. Of this about three quarters is used by the predominantly passenger vehicles (cars and station wagons), and one quarter by vans and trucks.

Table 1.10 follows the classification of person-trip purpose adopted by the Sydney Area Transportation Study (SATS 1974 I-11). The SATS breakdown of total daily business trips by purpose within the study area in 1971 was as follows:

Home-Based:	%
Work (manufacturing)	11.5
Work (other)	23.1
School	17.9
Shopping	10.2
Social/Recreation	13.8
Personal Business	10.8
Non Home-Based	12.7

While a large volume of data on Sydney transportation has been accumulated by SATS and ABS, the structure of this data does not allow energy use by purpose to be estimated with any confidence.

30. For the purposes of comparing residential use internationally, Schipper et al (1985) group residential energy use into the categories of "water heating", "cooking" (ie the main thermal cooker) "space heating" (all of which correspond to the "thermal" category at Level 2 in Table 1.10) and "appliances" (all power and electronic equipment). This classification fails to capture the energy supplied to food related activities in the form of hot water, power or refrigeration.

31. A more systematic hierarchy of needs was proposed by Maslow (1954). Whether they live as hunter gatherers or in a developed urban economy, human beings require bio-energy in the form of food to maintain physiological function and a certain level of personal hygiene to avoid illness. The next level of need is shelter: the maintenance of a controlled environment protected from the changing states of the geo-energy system. Once shelter is assured the needs for sexual and social interaction, esteem and then personal 'self-actualisation' manifest themselves.

32. The spatial and social organisation of the household has changed more than the functional. Girouard (1980) traces the social reorganisation of the household from feudal master-servant relationships to modern class structures. Boyd (1968) succinctly summarises the spatial influences on the infant domestic architecture of Australia at the end of the 18th century:

"It was about four centuries after the great community hall of the mediaeval manor house began to break into a collection of private rooms, and one and a half centuries before each collection of private rooms began to melt back into a single living space...It was midway in history between Inigo Jones and Le Corbusier" (p.11).

33. The microwave oven is the perhaps the first revolutionary innovation in cooking technology since the open fire, in that it generates the heat inside the food rather than outside it.

34. Higher-level services may still be energy-intensive. A householder may purchase a heated swimming pool, say, to provide a high level of personal care (ie year-round access to comfortable conditions for exercise) as well as higher level needs for status or social interaction, which he may perceive the pool to offer. Even the energy price is a relatively small part of the total cost of the service.

35. The discrepancy in personal care energy may be explained partly by climate and partly by fuel mix. Lower ambient water and air temperatures in Victoria would increase the energy required to heat water to the same desired washing temperature, and to maintain that temperature in storage water heaters.

At the same time the greater penetration of gas appliances in Victoria would tend to increase the average delivered energy needed to produce the same useful energy services; the 6.3 GJ/capita for personal care consumed mainly by gas water heaters in Victoria will produce a lower ratio of useful energy than the 3.8 GJ/capita consumed by mainly electric water heaters in NSW. The actual difference in useful energy will be less than the 66% difference in delivered energy.

With regard to space conditioning, Sydney has a milder climate than any of the other capitals except Brisbane. As would be expected the penetration of air conditioners and central heaters is lower, and so is the demand for space heating and cooling energy. It is less than 12% of NSW residential electricity demand and about 28% of total residential energy demand.

36. After considerable public opposition from the SCC to the government's plan to transfer \$ 82 m of its funds to assist more sparsely populated rural county councils to match urban prices led (SMH 19.5.87), the government legislated in June to remove the SCC's special status and to make it and all other county councils clearly subject to the direction of the Minister for Energy (SMH 9.4.87). At the same time the Energy Authority was reconstituted as a full government department. The minister lost no time in publicly warning the councils that he was dissatisfied with their performance and efficiency, and was setting targets for improvement (DT 11.9.87).

Despite the fact that electricity demand growth had slowed considerably in the early 1980s, the ECNSW suggested that failure to commit more power station sites may lead to electricity shortages at some future time. The minister publicly rejected this claim, saying that "...Elcom is crying wolf at a time when it has a very expensive plant reserve, approaching 70 per cent" (SMH 16.4.87). In June 1987 the government legislated to restructure the board of the ECNSW and to make its planning processes subject to scrutiny by the Department of Energy and by parliament (EnANSW 1987,12). It also established an inquiry to determine whether the ECNSW could obtain coal, either from its own mines or from private suppliers, at less cost (ibid,14).

Relations were further strained by a parliamentary Public Accounts Committee report, which found that the ECNSW had attempted to avoid public scrutiny of its "incompetent" management of a \$ 73 m coal washery at Ravensworth, which had never operated as intended (SMH 29.10.87). The Minister claimed not to have been properly informed, and therefore not responsible, and used the issue as a lever to remove the ECNSW's general manager.

CHAPTER 2 NOTES

1. By the beginning of 1815 the effective milling capacity of the colony was still no more than 50 to 70 bushells of grain per day, producing 3100-4400 lbs of flour (Linge 1980,92).

The first steam engine in the colony was brought out by John Dickson, a Scotsman who may have been associated with the engineers Watt and Rennie, and who had some personal experience in the design and manufacture of steam engines. He was recommended to Governor Macquarie by Earl Bathurst, the Colonial Secretary, who noted Dickson's intentions to erect a steam sawmill and to attempt the manufacture of iron, and directed that he be granted land in Sydney and in the interior (HRA I/VII,693). Dickson arrived in October 1813 with £10,000 worth of equipment, including a steam engine from his Southwark works. In April 1814 Macquarie reported that Dickson had been granted a suitable site for the erection of his engine in Sydney, together with 3,000 acres in the interior and 10 convicts, to be supported at government expense for 18 months (HRA I/VIII,159). The steam engine was expected to commence dual operation as a sawmill and grain mill by the end of the year.

The engine did not commence operation until June 1815, and then solely as a grain mill (SG 3.6.1815). The delay may have been due partly to the death of the trained assistant Dickson had brought with him, and partly to the extensive works needed to assure a supply of fresh water at the site, on the east of the present Darling Harbour (SG 17.6.1815). The waterside location was necessary for the transport of "grain, timber [presumably for the intended sawmill] and fire-wood" (ibid). Coal replaced firewood as the engine's fuel (Ellis 1969,18). There is no record that it was ever used for sawing, but in 1827 it supplied power to a brewery built on the site by Dickson and his then partner Mackie (Walsh 1963,40).

2. In 1828 the Sydney press reported experiments in gas lighting by the druggist McNaughton (SG 30.5 & 5.9.1828) and the lamp and oil merchant Thomas Wood (SG 1.8.1828). From the account of McNaughton's apparatus it is apparent that it burned vapourized oil and not coal gas. In 1835 Wilson's wharf on Cockle Bay (now Darling Harbour) was regularly gas-lit by the engineers Bourne and White, who on the basis of this success offered to sell gas to the public (Ginswick 1959,232).

3. The government completed its second mill on the ridge to the west of the town by 1802, and commenced a third in 1805. By 1806, the first mill needed rebuilding (Selfe 1902, 100). The government continued to operate mills until the late 1820s.

Several private windmills were also built in Sydney between 1800 and 1841: 3 in what is now the Domain and Botanic Gardens area, 3 at Miller's Point, 6 on the Darlinghurst ridge and one in Waverley (ibid). A mill was erected in 1827 on the roof of Barnet Levey's store in George Street, but was declared a public nuisance and removed in 1828 (ibid, SG 26.9.1828). Not all of these were in operation at the same time. The official Returns record 8 windmills in Sydney in 1829, a maximum of 10 in 1831, and 7 in 1836 and 1841 (RC). The only new mill erected in Sydney after that date was built in Paddington in 1846, and was the last working windmill in Sydney when it was demolished in 1878 (Selfe 1902,105).

A cloth fulling mill was built by Simeon Lord in the Lachlan Swamps in 1815-16, and a paper mill was built nearby by Fisher and Duncan in 1818 (Walsh 1963,31).

5. In April 1808 the government suspended the duty on coal and set a price of 10s per ton at Newcastle, "...taking into consideration the high price of Fuel and the distress of the the Poor Inhabitants for that Indispensible necessary of Life..." (HRA I/VI,153). The duty was reimposed in October 1811.

6. Nevertheless wood continued to fuel government installations and prisons at Parramatta, Liverpool and Windsor (SG 25.10.1821, 18.10.1825), and in Sydney itself during the occasional periods of coal shortage (SG 14.6.1826).

7. In 1836 the AAC labour force consisted of 5 free workers and 64 convicts, of whom 6 were probably "mechanics" or skilled workers, and the rest miners (HRA XVIII, 134). The value of the labor subsidy may be estimated from prevailing wage rates (Coghlan 1918) and AAC claims of the price rises which would result if the subsidy were withdrawn (HRA XX,480).

8. Bourke conveyed to the Colonial Secretary AGL's request for free transportation of materials on convict ships. The request was refused (HRA I/XVIII,738). As the equipment arrived, however, it was stored free of charge at the government warehouses by the Colonial Engineer, Major Barney, who by then had become a director of AGL (Ginswick 1960,238).

9. The acquisition of a site took three years. In September 1836 the chairman of AGL approached the Governor for a grant of land inside the town boundaries, but was refused. The company then sought to purchase land outside the boundaries, as required by its Act, but negotiations came to nothing. In July 1839 AGL sought, again unsuccessfully, to purchase a piece of government land before it was offered for auction in the usual way (Ginswick 1960,241). The company finally purchased a site on Darling Harbour in September 1839, and at the same time managed to obtain an amending act removing the restriction on gas-works within the town boundary (ibid,242). In May 1839 AGL's request for 50 convict labourers to undertake site works, which would have represented a significant subsidy given the rising cost of free labour, was refused (ibid,244) possibly in anticipation of the assignment system ending in that year.

AGL petitioned the Colonial Secretary in 1839 for an end to the AAC monopoly of coal mining on the grounds that the growth of Sydney, the scarcity of wood, the introduction of steam power and now coal gas were so increasing the demand for coal, that "...the said Monopoly becomes a serious incumbrance to the public and a cause of deep but just complaint" (HRA I/XX, 193). In 1840 the AAC used the same argument about the increasing demand for coal to press for more government assistance in the form of convict labor (ibid, 479).

10. The industries with the greatest power requirements were located at the few available power sources. Simeon Lord's water-wheel, which commenced operation in 1814 on a stream flowing into Botany Bay, drove a woollen mill as well as a flour mill (Linge 1980,87). The steam power of the colony was devoted almost exclusively to grain milling until the 1830s. Although John Dickson intended his steam engine to drive a sawmill and to pulverize tanner's bark as well as to grind corn (SG 17.6.1815, HRA I/VII,693), there is no record that this occurred. Sydney acquired seven steam mills before the first application of steam to another industry - a sawmill which commenced operation in 1841 (RC, 1841.) By that time the rest of the colony had 15 steam grain mills and a steam cloth mill at Penrith, a sawmill in the Illawarra and two engines at the Newcastle coal mines (ibid).

11. It is difficult to estimate the amount of coal used in Sydney in 1841, but some indication is given by the domestic demand for NSW, which was about 32,000 tons in that year (see Table 3.2). The total steam power of the colony was about 1150 hp, two thirds of it in steamships and probably 90% of it burning coal (see table below). Given the wide range of efficiency and hours of use of each engine, total coal consumption might have amounted to between 9,000 and 18,000 tons. This leaves a considerable amount to be allocated to thermal use in industry and households, especially given the probable concentration of demand in Sydney (Ellis 1969,28,Linge 1980,90,RC 1831-46).

Estimated NSW coal consumption, 1831-46

	Engines	hp	Vessels	hp	Total	hp	NSW coal cons (tons)
1831	6	112	-		6	112	
1836	8	140	-		8	140	10920
1841	36	400	15	750	51	1150	32000
1846	130	1430	23	1150	153	2580	38000

Coal allowance for military personnel in 1822 was about 4.5 tons per fireplace per year (SG 28.6.1822).

If each of the 4,600 dwellings in Sydney in 1841 had used coal at this rate, then the total domestic demand would have been about 20,000 tons. Some households would have used more than this amount, and many no coal at all, but these figures give some indication of the scale of thermal energy demand in the residential sector alone, apart from public institutions and heat-intensive industry. Considerable underlying thermal demand is further indicated by the fact that although the number of engines in the colony increased threefold over the next 5 years, and the estimated aggregate horsepower more than doubled, domestic coal demand rose barely 20%.

12. AGL's initial investment was L 25,000. The AAC was capitalised to L 1 million, but it is not clear what proportion was invested in the Newcastle coal mine.

13. Birmingham 1836 population estimated from Briggs (1963,86). In 1835 Birmingham had 60 engines with a total power of 1000 hp (Singer et al 1958). Sydney reached a similar power level in about 1843.

14. In 1855 the government resumed the site of Simeon Lord's water mill at Botany. Three 100 hp engines were installed to service reservoirs at Crown Street and at Paddington, completed in 1859 and 1864 respectively. By 1874 the engines were pumping over 4 m gallons per day (Aird 1961,11).

By 1881 additional pumps had been installed to raise water to the new Woollahra reservoir. The new pumps were 2.5 times more efficient than the old ones (Selfe, SMC 1880).

15. Harrison emigrated to Australia from Scotland in 1837. He was editor for a while of the Melbourne Age and is said to be the first to have considered the export of meat (Singer et al 1958).

Refrigeration technology went through several phases in the nineteenth century. Two British patents for cooling, by an air-compression process and by the expansion of volatile fluids, were taken out in 1834 (Singer et al 1958). The latter, by Jacob Perkins, embodied all the elements of the refrigeration plant current at the end of the century: the evaporator, the condenser, the compressor and the regulating valve (Selfe 1896,xxxv). In the intervening years there was considerable development in the refrigerating medium and the power source for the compressor.

16. Selfe was at the time chief draughtsman at the Sydney engineering firm of P.N.Russell and was personally involved in the construction of the Harrison machine. He designed a compressed air refrigerator in 1881. In 1896 he reviewed developments in refrigeration in the following terms:

"Although compression machines now largely outnumber those working on the absorption principle, and are daily replacing them, it must be remembered that the latter led the way and for a long time carried all before them"(Selfe 1896,xlix).

He also noted, with some justification:

"It will be seen that New South Wales has, in the past, done a large share of the work by which the refrigerating machinery of the world has been brought to its present perfection" (ibid,xxvii).

17. It was introduced by Samuel McGowan, a student of Morse, who brought with him an assistant and several complete sets of apparatus. The assistant was described as a "first class electrician", possibly the first use of the term in Australia (Moyal 1984,16).

18. "In contrast to its southern neighbours, the colony of New South Wales was altogether slower, more cautious and hidebound in its response to the revolutionary new system of speeding the transfer of commercial and social information. In July 1855, with telegraphic activity booming in Victoria, NSW Governor Sir William Denison, an engineer by training himself...declared that...there did not appear, in the present state of the Colony, to be 'such a demand for the adoption of these rapid means of conveying intelligence' to justify the outlay required" (Moyal 1984,21).

19. Railways expenditure as proportion of public sector and total capital formation, 1861-90:

Net Capital Formation (L m)

	Railway	Public Sector	Private Sector	Total	Railway Public	% of: Total
1861-70	4.77	7.40	16.81	24.21	64.5	19.7
1871-80	8.65	15.11	53.82	68.93	57.2	12.5
1881-90	25.72	42.85	106.72	149.57	60.0	17.2

20. From Mansfield (1841), Coghlan (1918,716) Butlin (1962,259):

	Persons per Room	Persons per Inhabited Dwelling
1841		6.7
1851		6.4
1861	1.40	5.4
1871	1.08	
1881	1.05	

21. 106 of the 165 gas lamps were paid for by publicans and 14 by the government. The best lit streets were Sussex, York, Pitt and King, which between them had over a third of the gas lamps.

22. This conclusion was supported by an experiment which supposedly demonstrated that the cost of gas lamps would be twice the cost of oil lamps giving equivalent light.

23. In 1851, for example, the SMC reduced the term of its current contract with AGL from 5 to 3 years expressly to give a Mr A. Wilson, the local representative of the Hydro-Carbon Gas Company of Manchester, the opportunity to establish an alternative system of gas lighting (SMC 24.3.1851). Nothing came of it.

24. On renewal of the contract AGL increased the price per public light by one third (SMC 31.3.1854). The Commissioners accepted, but not without an exchange of acrimonious letters accusing the company of "exorbitancy" (ibid 27.4.1854). On that occasion at least the AGL price may have been justified, because the shortages of labour caused by the gold rushes of 1851-2 had pushed up the price of coal, and AGL's internal records reveal that in early 1854 it was buying coal at four times the 1851 price (AGL 1687/235x).

25. Under its 1837 Act AGL was empowered to open any public streets, but obliged to give due notice to the municipal authorities and to make good the damage. There were few problems in the 1840s when most of the streets were unformed; indeed, AGL frequently asked the Council for the intended level of the street alignment when it put down its mains.

The Council spent far more on street paving and maintenance than on street lighting: up to 50% of expenditure in its early years (see Maiden 1966) compared with 2 to 3% of expenditure on lighting throughout this period. The SMC frequently accused AGL of contributing to costs by inadequate restoration. In 1881 the Council resolved

"That in consideration of the fact that the AGL Co. has had free and unrestricted right to and use of the Streets of the City, as a means for the conveyance of Gas to their customers, and that such use may materially affect the cost of maintaining the Streets by the Corporation, this council respectfully submits that the said Gas Company should give this matter their consideration with a view to a considerable reduction in their present charge for each ordinary public lamp." (SMC 6.7.1881).

26. Before the 1880s the most common form of gas lamp was the 16 cp 'batswing' burner. In 1879 AGL sent the Council a list of rates for its new range of 50, 80 and 200 cp lamps (SMC/LC 14.8.1879).

27. In the 17 years to 1884, three smelters near the Hunter River consumed 340,000 tons of ore and 1.67 times that weight of coal (Linge 1980,553). Total NSW coal consumption over the same period was about 9,453,000 tons. The annual coal consumption of the smelters averaged about 6% of this, about the same as the annual coal consumption recorded by AGL.

28. The engine and rolling stock were imported from Britain. The chosen date was the 25th anniversary of the opening of the world's first public railway, between London and Manchester (Linge 1980,174). Australia's first steam railway began operation between Melbourne and Port Melbourne on 12 September 1854 (Aplin et al 1987 VII,66).

29. The Richmond line was actually intended for horse operation when construction began in 1863, but was opened as a steam line in November 1864 (RNSW,30). For a contemporary view of the advantages of horse working, see Poppercome (1844).

30. In 1870 there were 750 watermen registered for life under the provisions of the Sydney Police Act 1833 (V&P/LA 1870,965). The Sydney harbour ferry developed as a distinctive design during this period. The North Shore Steam Ferry Company ordered the world's first double-ended screw ferry in 1879. It was designed by the ubiquitous Norman Selfe (Andrews 1975,18).

31. An 1849 description of the new Rosemorrin copper smelting works, which used fuel for steam engines and for blast furnaces, notes "a wharf at which the coals and wood for fuel are landed" (SMH 21.4.1849).

Firewood seems to have been less subject to the price fluctuations of coal during the gold rush induced labour shortages of the early 1850s, or the coalfield labour disputes and price maintenance agreements of the 1870s. During the miners' strikes of 1873 the price of coal in Sydney doubled to 40s-45s per ton, while wood prices remained at 10.5s to 12.5s per ton wholesale, and the equivalent of 20s-25s per ton when delivered in small quantities (Coghlan 1918,1615).

32. The merchants as a group, particularly those operating outside the City, were notorious for giving short weight, and bills to regulate their activities were introduced in Parliament in the 1880s, though without success.

33. Sydney had 7 wind and 2 watermills in 1841, but none by 1881. The last Sydney windmill closed in 1878 (Selfe 1902.105). Water power was last used Sydney in 1855, when the creek feeding Lord's mill at Botany was resumed by the government for the Sydney water supply (Aird 1961.10). The use of water power in the colony as a whole peaked in the early 1850s. In 1881 there were still 9 watermills in operation outside Sydney, most of them in the southern highlands, and one wind mill at Camden (RC 1881). Commercial horse powered mills declined from a maximum of nearly 30 in the late 1840s to only one in 1881.

34. Horse population ('000) and ratio per capita (from RC 1841- 81):

	County of Cumberland	Settled Districts	Total NSW
1841			76.7 (0.39)
1851			116.4 (0.61)
1856	17.3 (0.16)	114.8 (0.50)	168.9 (0.63)
1861	17.8	155.3	233.2 (0.65)
1866	19.1	167.9	278.4 (0.65)
1871	18.3	173.9	377.6 (0.73)
1876	7.3*(0.012)		366.7 (0.58)
1881			400.0 (0.53)

* Metropolitan Sydney

35. The progressive change in the energy technology of manufacturing is well-illustrated by the NSW woollen cloth industry, which had been established using water power on Botany Bay as early as 1814 (Linge 1980.87). By 1868 there were 5 woollen mills in NSW; only the one at Bowenfels, representing about 8% of the output of the industry, was still powered by water (SMH 23.10.1868). The machinery for it had been brought from Lord's mill at Botany (SMH 11.4.1856).

By the 1860s most stages in the process of cloth manufacture were mechanised and increasing production speeds put pressure on the remaining hand processes. With local wage rates rising to three times the level in the British textile industry (Linge 1980.469), the choice between employing more labour in those processes and mechanisation was clear. As one woollens manufacturer put it:

"...in a colony like this, where labour is high, the object is to obtain machinery to economize labour as much as possible" (ibid.468).

Ebsworth's Mill was the largest woollen mill in NSW, and the only one in the City of Sydney (when it was still Barker's Mill). In 1865 it had a single engine of 16 hp driving all the machinery but by 1871 had 3 separate engines with a total power of 48 hp (SMH 12.10.1868, ATCJ 8.7.1871, Linge 1980.570). The mill was destroyed by fire in May 1872 and reopened in 1873 with machinery capable of producing 120,000 yards of cloth per year (ie less than the 3,000 yards per week it was producing in 1868).

In 1868 Ebsworth's mill installed automatic feeding apparatus to transfer the wool from the roller to the carder, work for which girls had previously been employed (SMH 12.10.1868), so substituting power for unskilled labour.

The next phase of mechanisation in the cloth industry increased the productivity and the bargaining power of skilled workers, though not always immediately. Power-looms had displaced hand-looms in the English worsted industry by the 1850s (Singer et al 1958 V.580) but by 1868 only one of the five NSW mills was using them: Rayners mill at Parramatta had 12 looms installed (SMH 23.10.1868). One of the other mills, Byrne's also of Parramatta had acquired 20 power looms, and after "an infinity of trouble" had trained the weavers in their use. Thereupon they struck for higher wages and Byrne reverted to the old hand looms, for which there was still presumably a greater pool of labour (SMH 11.4.1865).

Byrne claimed that the power looms broke the wool, but Rayner was apparently using his power looms successfully on similar quality wool. It may also have been that Byrne had no great need for increased weaving output: the other operations had to work overtime to keep up (SMH 20.10.1868).

36. Energy services were also changing working conditions in other ways. The gas lighting installed in Ebsworth's woollen mill allowed work to go to 9 pm when necessary, and also allowed closer supervision of machine operations (SMH 12.10.1868). In some instances mechanisation enabled more children to be employed, in tasks where energy substituted for muscle-power and machinery for skill (Linge 1980,468). The danger to children and other workers from powered machinery was one of the factors behind the NSW Government's interest in factory legislation in the mid 1870s, though the first Factories and Workshops Bill introduced in 1877 lapsed, and the legislation finally enacted in 1896 was relatively backward compared to Victoria's (Coghlan 1918,2092).

37. One of these was the Newcastle and Wallsend Coal Company, which was closely linked to AGL. Two of its five directors were on the AGL board, and one of its first contracts was for the supply coal to AGL (Ellis 1969,57). This represented one of the first, though informal, attempts at vertical integration in the NSW energy industries.

38. Owners, managers and workers all benefitted from the increasing importance and price of coal. By 1861 it was well understood that a position within the energy system gave workers exceptional leverage:

"The miners were, to a man, members of the union, and, comprising as they did a body of skilled men whose services were both of the greatest public utility and almost irreplaceable, formed an ideal force in a labour struggle" (Coghlan 1918,1437).

In the 1870s the Newcastle and Wallsend Coal Company, for example, bought back 60% of its capital from shareholders and then paid dividends of 50% per annum on the remaining shares (Ellis 1969,122).

39. Estimated coal consumption in 1881 (various sources)

	TONS
AGL gasworks	43260
Other gasworks	5000
Newcastle copper smelters	33000
Railways	170000
Steamships	250000
Other (mainly Sydney)	250000
TOTAL	751468 (RC)

40. An 1858 amendment to its original Act empowered AGL to extend its mains beyond the City. Both Bathurst and North Shore gas companies were founded by disgruntled ex-AGL engineers, J.N.Wark and J.W.Fell respectively. In 1879 Fell threatened to supply Ashfield before AGL could do so from its small works at Five Dock (Broomham 1987,70).

41. AGL directors also served on the boards of the Newcastle and Wallsend Coal Company, the Commercial Bank of Sydney, the Australasian Steam Navigation Company, the Sydney Morning Herald and the short-lived Sydney Railway Company. Furthermore, at least 15 of AGL's 389 shareholders in 1881 appear on the roll of life appointments to the Legislative Council (1881 shareholder list appended to report of select committee on AGL Amendment Bill, 1873). There were also several MLA shareholders and family links between shareholders and members of parliament.

42. By 1881 several important shale mines had been established near Hartley and Katoomba in the Blue Mountains, and at Joadja near Berrima (Birmingham et al 1979,120). The shale was crushed at the mines and heated in retorts to extract the crude oil. The oil was then distilled into kerosene and other fractions, either at the mine or at refineries elsewhere (ibid, 127). In Sydney, refineries were established at Oyster Bay in 1866 (SMH 21.4.1866) and at Waterloo in 1868.

Oyster Bay refinery built by the Australasian Mineral Oil Company began operation in advance of large scale shale production, using volatile Hunter region cannel coal which yielded coke as well as oil (SMH 21.4.1866). In 1868 it was refining and distilling crude oil imported from Peru, using US made stills (SMH 11.9.1868).

Locally produced kerosene had to compete against American imports. The local oil had the cost disadvantage of having to be extracted from shale, whereas American oil was produced from wells (SMH 21.4.1866). Another price disadvantage was the cost of packaging: the SMH noted in 1868 that the imminent arrival of automatic tin manufacturing plant would lower the cost of tins and "...have the effect of putting our kerosene upon a more even footing with that which comes to us from America" (SMH 11.9.1868).

Early kerosene companies (Sources: Jack 1973, Linge 1980, SMH 21.4.1866, 11.9.1868, 7.10.1868, 11.12.1868)

Company	Inc. year	Capital (L '000)	Details
Australasian Mineral Oil Co	1866	70	Located North Shore: used Hunter Vally cannel coal and Peruvian crude; made tins
Hartley Kerosene Oil & Paraffine Co	1866	30	Worked Katoomba seam
Western Kerosene Oil Co	1868	50	Worked katoomba seam: plant at Waterloo
NSW Shale & Oil Co	1873	100	Worked Hartley Vale and New Hertley seams; distillation on site
Australian Kerosene Oil & Mineral Co	na	na	Began mining Joadja 1873- 4, Katoomba 1890-1.

NSW kerosene consumption during the 1870s is not recorded. Shale production was nearly 16000 tons by 1876 and 28000 tons in 1881 (RC 1876,1881). Not all of this was used in local kerosene production: some was exported for processing in Britain, Europe and America (Jack 1973,122) and some was used in Sydney and elsewhere for gas making.

43. Kerosene production costs were defrayed by the ready market for other fractions of shale oil: other lighting oils (naphtha, gasoline, blue oil for gas works), cleaning oils, lubricants and wood preserving oils (Jack 1973, 128). The shale industry had close technical connections with the NSW gas industry, and with the opening of new mines on a larger scale after 1900, formed a nucleus for the later development of petroleum refining in Australia.

44. Tallow made from the carcasses of slaughtered sheep and cattle had long been the basis of small scale candle and soap manufacturing in the colony. The financial crisis of the early 1840s gave tallow special importance in determining the minimum value of stock in a rapidly falling market (Coghlan 1918,494). A large number of boiling-down works were established in the colony and in 1850, the peak year, some 11,700 tons of tallow were produced from 1.7 m sheep (ibid).

Most of the tallow was exported. Some was locally processed into soap and candles for export, as well as for the domestic market. In 1841 NSW imported more tallow candles than it exported, but by 1851 exports exceeded imports by a factor of 10 (RC 1841,1851). The increasing local production did not lead to lower local prices, however. Tallow candles retailed at about 5d per pound for most of the period 1841-1881.

45. Consumption of candles in NSW calculated from NSW Statistical Registers, taking into account local production, imports and exports

	'000 lbs	lbs/cap
1872	2650	4.9
1876	2996	4.8
1881	3772	5.0
1896	6804	5.5

CHAPTER 3 NOTES

1. The first practical automatic-feed carbon arc lamps were introduced in 1846. The first proposed application of electricity to lighthouses was not the arc lamp, however, but Nollet's 1850 patent for electrolysis of water to produce hydrogen and oxygen for a "lime-light" (Singer et al 1958 V,181)

2. Swan and Edison fought a celebrated lawsuit over the rights to the filament lamp, which had been described in a patent lodged by Edison in England in 1879. They eventually combined forces in the Swan and Edison Electric Light Company, registered in October 1883 with an authorised capital of L 1 million (ibid,216, Dunsheath 1962,134).

3. The viaduct location was chosen so that previous legislation protecting the gas companies' monopoly on placing apparatus underground for lighting purposes would not be infringed. The site was considered "fill" not "ground". The English Electric Light Company was associated with Edison and used his equipment.

4. There five most favoured were: (i) The number of low voltage DC generating stations could be increased, or (ii) storage batteries at the edge of the distribution radius could be charged from a single DC station, and then relay power for a further distance. (iii) Power could be generated at high voltage to decrease energy losses, and the voltage reduced at local substations with the aid of the rotary transformer (invented in 1874) in the case of DC, and (iv) Alternating current AC transformers (available from about 1882). Alternatively, (v) high voltage AC could be converted to low voltage DC in local mechanical converter stations.

5. Each system had influential supporters: AC had Ferranti, Westinghouse and Tesla, and DC was backed by no less an authority than Edison, whose entire system was based on it (Singer et al 1958,200) (ibid). Ferranti designed the 1889 Deptford Power Station in London to operate at 10,000 volts, four times the highest voltage previously attempted (Singer et al 1958,200). Westinghouse was the largest manufacturer of AC transformers in the USA and Tesla was the inventor of the AC motor.

Edison's tactics bordered on the unscrupulous. In 1889 his associate H.P.Brown strongly backed the adoption by the New York State legislature of AC for electrocution, successfully recommending that Westinghouse alternators be used for the purpose. The deadly properties of AC were then widely publicised by Edison, and led to attempts to set legal limits on AC voltages. Westinghouse considered instituting proceedings for conspiracy (ibid,201, Hughes 1983,108).

6. The Telegraph Office again displayed a battery arc light on the occasion of the visit of the Duke of Edinburgh in December 1867, under the personal supervision of E.C.Cracknell and with the use of a locally made "self-adjusting apparatus" (SMH 21.12.1867).

7. In March 1881 Cole's circus was advertised as "illuminated throughout by the great electric light, which literally turns night to day by its far reaching and piercing rays" (TCJ 12.3.1881). The visits of naval vessels were also occasions for arc-lighting displays, from the ships themselves (SMH 10.1.1882,5) or from small boats cruising among the fleet (ISN 6.8.1881).

Mr W.Lant Campbell, a visitor from London lecturing at the NSW Royal Society in October 1880, concluded with regard to the domestic use of the electric light, that "he did not think that Mr Edison was likely to succeed for some time" (TCJ 30.10.1880). The pioneering Sydney electrical engineer, H.H.Kingsbury, also lectured (SMH 19.4.1882).

8. In 1881 H.H.Kingsbury brought back several Edison generator sets from New York, where he had gone to negotiate a licence with the newly formed Edison Indian and Colonial Company (Cannon 1975 III,108). It is probable that these were used in the first Sydney installations.

Mid 1881 date for the Circular Quay installation inferred from report in ABCN 5.10.1889: it was said to have worked without accident to that date, although "...the captains of the ferry boats complain of the intense glare causing them to miscalculate the distance from the wharves" (ISN 17.2.1883).

9. Two of the largest installations were those at Her Majesty's Theatre and Hotel and the Hotel Australia. The former had 6 arc lamps and 900 incandescents (ABCN 30.11.1889) The latter had about 20 arcs and over 1000 incandescents to serve its 350 guest rooms, and also ran "ventilating and hairdressing machinery" operated by electricity (ABCN 20.12.1890).

Norman Selfe describes the Hotel Australia installation as one of the engineering highlights of NSW for 1890, adding that "The whole was designed by the writer", though giving H.H.Kingsbury credit as the electric lighting contractor. His ambiguous reference to "refrigerators and ice-making machinery" suggests that it could have been electrically operated. The "ventilating and hairdressing machinery" was probably electric fans (ibid).

Most of these early installations were powered by their own steam engines. However, a 3 arc lamp installation at Hagon's store in King Street in 1888 was run by a 4hp gas engine (ABCN 12.1.1889) and another installation at the Sydney Technical College in 1892 was to be powered by an oil engine (ABCN 16.7.1892). Some commercial organisations which already had their own engines to power hydraulic lifts sometimes ran dynamos from them, as in the case of the Dalgety and Co. woolstores in 1892 (BEJ 15.10.1892).

10. One of these was J.W.Willoughby, who had premises in London and opened a Sydney store in mid 1882 (ISN 7.1882 & 8.1882). As for specialist 'medical' electricians, "Probably the biggest of all electrical healing enterprises was set up under the name of the Electro-Medical and Surgical Institute, in a three-storey building at the corner of Elizabeth and Bathurst Streets, Sydney" by H.Freeman and R.Wallace (Cannon 1975 III,138). Cyril Pearl records that

"Dr Kelly, of Phillip Street, vended an electric girdle, price one guinea, guaranteed to cure any case of "nervous debility", and McLaughlin's Electric belt, deluxe models of which cost ten guineas, girdled more prosperous but equally sanguine Sydney abdomens" (Pearl 1958,48).

11. In 1886 Kingsbury and Co. sold the rights to Edison's patents, including the incandescent lamp, to the Australasian Electric Light, Power and Storage Co. which in turn sold them in 1891 to the Brush Electrical Engineering Co. of Sydney (Cannon 1987 III,108). Kingsbury continued to install Thomson-Houston lamps imported from the UK, was sued successfully by Brush for patent infringement in the NSW supreme court in November 1891, and was restrained from "using, importing or dealing with the Thomson-Houston lamp, or any other incandescent lamp, without the consent of the company" (DT 14.11.1891).

12. Firms included Westcott, Marshall and Adams trading as Kirkland and Co. (ABCN 22.2.1890), Everett and Prestwich (ABCN 5.4.1890), Woods Brothers (ibid) the Williamson Electrical and Engineering Company, agents for the British Mather and Platt DC dynamos (ABCN 7.6.1890) and the Electrical Material Co., agents for the Australasian Electric Light, Power and Storage Co. of Melbourne (ABCN 5.7.1890).

Although most equipment used was British or American in origin, European manufacturers were also represented. One of the most influential was the Hungarian firm of Ganz and Co., which established a Melbourne agency in December 1886, originally to promote its roller flour milling equipment (Kunz 1969,131). The agency became associated with the Austral Otis Engineering Co. in 1888 and began to expand its electrical business: the parent company had been a world leader in AC systems since 1878 (Hughes 1983,96). Ganz and Co. were also represented directly in Sydney by mid 1890 (ABCN 5.7.1890).

13. In mid 1879, for example, both *The Australian* and the *Town and Country Journal* carried lengthy articles on electric execution (TCJ 12.7.1879).

14. The latter provision had been accidentally omitted from the Municipalities Act, 1867, making it necessary to pass the Municipalities Lighting Act, 1873 (Larcombe 1973 II,199). The City of Sydney, which was covered by separate legislation, had contracted for lighting with the Australian Gaslight Company since 1843.

15. In addition to the street lighting rate of up to 2.5% of assessed value which councils were empowered to levy under the 1873 legislation, the 1884 Act gave them the power to raise revenue from private gas sales, and to raise special loans for gas undertakings beyond the general limits on borrowing imposed by the Municipalities Act. The Municipal Gas Act Amendment Act of 1886 extended the power to borrow for gasworks even further, by allowing a council's power to levy general and special rates to be used as loan security, in addition to the gaswork assets themselves (Larcombe 1973 II,201).

16. The Local Government Bill referred to and another attempt in 1894 to amend the Municipal Gas Act to include electric lighting were among eight unsuccessful attempts between 1876 and 1894 to introduce new local government measures (Maiden 1966,88).

17. For example Rockdale, Hurstville and Kogarah in 1887, Randwick, Woollahra, Paddington and Waverley in 1893, and the St. George municipalities in 1897 (Larcombe 1973 II,202).

18. Bathurst Council had canvassed the possibility of a municipal gasworks as early as 1880, was unable to negotiate a purchase price for the local private company, and set up its own gasworks in 1888: the two competed until 1914, when the company finally sold out to the municipality (Larcombe 1973 II,202).

19. Some of the most valuable contemporary information on the costs of early electric lighting installations was contained in the letters of "JL", which the Sydney Daily Telegraph published in June 1890. While according to the mayor of Tamworth "JL" was identified with gas company interests (DT 24.6.1890), his analyses of the Tamworth, Young and Moss Vale installations were detailed and comprehensive, and fair in the sense that costs were analysed as if the installation were fully utilised, rather than partly utilised as was inevitably the case at the outset.

20. The Tamworth installation consisted of two 12 hp steam engines running two DC dynamos, with a total capacity of 500 incandescent lamps of 20 cp each. Some 210 lamps were actually installed, together with arc lights at the intersections of the main street and, for occasional use, at the town oval. About 2.5 square miles out of a total municipal area of 9 square miles were lit, requiring 20 miles of cable and giving a very modest average light intensity of about 7.6 cp per lighted acre, or about 610 cp per cable mile.

21. However, the electric lamps were shut off at 2am each night and not lit at all on the 8 nights each month around the new moon, whereas the gas lamps had burned all night, every night. Furthermore, the estimate of "seven times the light" was heavily weighted by the few arc lamps, and the outlying incandescents gave illumination that was barely the equal of gas lamps. The owner of the Tamworth gasworks replied:

"The relative cost for 89 electric lamps is about L7.14s9d per lamp, for 52 gas lamps (burning the same hours) L4.1s3d per lamp, and I feel quite satisfied the gas company would be only too happy to light the 89 lamps with gas and give a better light for the same price paid for electric light" (DT 26.7.1890).

The Tamworth gas company was able to continue paying its regular 10% per half year dividend despite the loss of the lighting load, at least in the short term (ABCN 26.1.1889).

22. The council adopted the policy of charging the maximum legal lighting rate of 6d in the L, and effectively subsidising private installations to extend the business. "JL" pointed out that even if the whole private lighting market in the town were captured and the tariffs then raised to a "more business-like" level, the installation would always run at a loss because of the interest charges on capital (DT 30.7.1890).

23. The prospects for success did not appear bright at mid 1890. In both cases the expenditure was estimated to exceed the income, and in both cases the contractors were forced to change, at some cost, from DC working to AC to obtain satisfactory illumination (DT 7.30.1890).

24. In May 1888 St. Leonards council rescinded its previous decision to build municipal gasworks in opposition to the North Shore Gas Company, and combined with the neighbouring boroughs of East St. Leonards, Victoria and North Willoughby began to explore the question of joint lighting by either electricity or gas (ABCN 26.5.1888 & 19.1.1889). The discussions remained adjourned indefinitely and the municipalities concerned remained lit with gas.

In March 1890 it was reported that Goulburn council had accepted a tender from Kirkland and Co. for an installation of 150 street and 500 private electric lamps (ABCN 1.3.1890). The council was unable to negotiate a loan, however, and Goulburn remained lit with gas (DT 11.6.1890).

25. The protagonists themselves and other interested parties were well aware of the precedent which the proceedings would set. When the board of the Australian Gas Light Company first discussed the possibility of applying to parliament for an electric lighting act in November 1889, they resolved to await the result of the Newcastle Gas Company's application (AGL MSS 2921/11x,26.11.1889). The Newcastle municipalities petitioned parliament that the gas company's bill "...would be an unusual precedent in law..." and that the principles embodied in it

"...if successful in this issue, may be extended to other large growing centres of population in the district, and in the end root out and destroy the paternal feelings of Municipal Government, and become antagonistic to same." (V&P/LA 1890,111).

26. Its initial offers had been rejected for some years because the council considered the asking price of L16 too high (V&P/LA 1890,97). The price of gas declined as sales for private lighting increased. By 1889 the company was supplying gas to some 322 public lamps at an average price of about L5/17/8, with the contract price for

the most common type of lamp being L5/10/- (estimated from evidence of Newcastle Town Clerk to the select committee on the Borough's bill - V&P/LA 1890,43,45). The contract was due to terminate at the end of 1889 and in May of that year the council resolved to explore the possibility of lighting with electricity.

27. Waratah had a municipal gasworks, Wallsend and Plattsburg were supplied by gas from a private company, New Lambton, Wickham, Stockton, Hamilton and Adamstown were considering building municipal gasworks and Lambton had just entered a contract with Kingsbury and Co. for electric lighting. The Lambton scheme was to have commenced operation on 1 May 1890, but by 29 May the machinery was "not yet landed" (V&P/LA 1890,105). It proved in the end "an ill-fated concern which was short lived" (Allbut 1958,28), though the NSW Statistical Register for 1902 still lists it. Kingsbury does not seem to have had great success after the first promotional phases of electric lighting. He designed the installation at Young, which was not soundly based financially, and the one at Roberts' Hotel, Newcastle, which was raised in evidence before the select committee as an example of the kind of poor advice and management which the Council would be careful to avoid (V&P/LA 1890,47).

28. In April 1890 the council voted by the narrow majority of 7 to 5 to call tenders for a municipal electric lighting installation. By July the aldermen were said to be unanimous in support of the council's bill. The tender of Kirkland and Co. for an installation of 400 street lights and 700 private lights was accepted. The contractor was to run the plant for 5 years for L 1,150 per annum plus 8.5% of the contract price of L 8,930. The council could purchase at any time once it was satisfied that the installation was working properly, and expected to be able to operate it for L 950 per annum. In addition the council purchased a site for the installation at a cost of L 1,000 on its overdraft at 7%.

29. In common with almost every private gas company in the colony, the Newcastle gas company was accused of exploiting its local monopoly, and though it had progressively reduced the price of gas, it was accused of doing so only under periodic threats of the establishment of competing private or municipal gasworks (NSWPD 2.10.1890,3382). From the mid 1880s the company paid its shareholders a regular 15% dividend, as did AGL (V&P/LA 1890,92), and had substantial cash reserves. It was in a powerful commercial position to protect its monopoly by undercutting any competitors.

In 1885 after rejecting an offer from the Newcastle gas company for a 10yr street lighting contract at L13/10/- per lamp, the municipality of Waratah decided to erect its own gasworks. The gas company then extended its mains along the northern border of the municipality. The council felt obliged to keep its rates to private consumers low, so that they would not be attracted to the gas company, and therefore could not lower its lighting rate as much as had been anticipated. The Mayor of Waratah expressed suspicion of the company's motives:

"It is considered that the company have acted towards us in a very arbitrary manner. They would not come when they were wanted, and when they did come they forced themselves under powers they were supposed to have ..." (V&P/LA 1890,104).

30. The Mayor of Newcastle did not demonstrate any clear grasp of the cost in his appearances before the select committees beyond the assertion that "We are assured by practical men, by electricians, that we can get these lights at L2 a lamp" (V&P/LA 1890,98). When asked whether he had taken any trouble to test the statements of the experts, he replied that he had no skill in the matter, and referred all questions of cost to the town clerk (ibid,46). The latter based his estimates on operating costs alone, and only when pressed directly did he admit that interest payments on the purchase price of the plant and site would increase costs by some 70%. (ibid,45).

An annual cost for each of the planned 400 public electric lamps can be estimated, by drawing together figures given in isolation at various times before the select committees, at L4/17/8 for the initial period of operation by the contractor, and L5/4/3 after council purchase, even if council's optimistic assertion that it could operate the works for nearly 20% less than the contractor is accepted. This estimate puts the cost per electric street light far above L2, and indeed above the figure of L4/17/6 per gas lamp which the council rejected in 1889 (ibid,96). No such consolidated estimate of cost appears in any of the evidence, nor any mention of the number of private consumers expected, nor the rates they would be charged.

It was implicitly accepted by the council that private sales would lower costs to the ratepayers, but no evidence was presented how this would be so. Indeed, given the market power of the gas company, it could be expected that the initial penetration of the private lighting market would have to be subsidised.

31. The only amendment to the gas company's bill proposed by the select committee was that any municipality, other than Newcastle, had to give permission before the company could supply electric light to anyone in its area.

The second reading of the gas company's bill was defeated by a vote of 46 to 7, and such was the sentiment against the bill that despite pleas that the House not "do a thing which can only be characterised as an undue exercise of force" it was immediately discharged by a vote of 32 to 22 (NSWPD 2.10.1890,3391). The second reading of the council's bill was debated immediately afterwards, but could not capitalise on the mood: the title had omitted the intention to supply beyond the municipal boundaries, and so the bill was ruled out of order (ibid,3394).

32. The Borough of Newcastle Electric Lighting Bill (No.2) was initiated in the Assembly on 21 October 1890, and referred to a new select committee which heard evidence only from the town clerk and reported on 12 November that it did not deem it necessary to make any amendment (V&P/LA 1890,65). Thereafter, the progress of the bill was slow. It was not read a second time until 30 November 1891, and the only substantial amendment was that the electricity undertaking was to maintain a separate account rather than, as the council had wished, for any profits to go to general municipal purposes (NSWPD 30.11.1891,3121). The Newcastle gas company mounted a rearguard action against the bill, petitioning on 9 December 1891 to be heard at the bar of Legislative Council, where it may have expected more support for private enterprise: its petition was, however, rejected (NSWPD 17.12.1891,3800).

33. General accounts of the changes in the political life of New South Wales in the 1880s and 1890s include Coghlan (1918), Hawker (1971) and Loveday and Martin (1966).

34. Ministerial crises in 1882, 1887, 1889 and a constitutional crisis in 1895 led to dissolutions of parliament (Hawker 1971,63). Between the beginning of 1881 and the beginning of 1904 there were 10 parliaments and 12 ministries.

35. Almost 4300 bills were introduced in the 45 years between the introduction of responsible government in 1856, and 1901: double the number of the next 45 years (ibid,70).

"Each House saw a number of its bills lost in the other, because of lack of time, obstruction or bad management of the business paper, but many bills never even left their House of origination...The legislative crush at the end of a session was especially marked in the Assembly as ministers and others hastened to add new bills to the notice-paper and to push those already on it into the Upper House. The less important bills inevitably suffered from want of attention and many criticisms were made of the regular "slaughter of the innocents""(ibid).

The evolution of the parliamentary relationship to the issue of electric lighting can be traced not only through records of debates, but also through the reports and minutes of Parliamentary Select Committees. These were appointed in large numbers during the nineteenth century, but declined in popularity from the late 1880s, partly because of the rise of the party system which gave members of the government less time consuming ways of monitoring the activities of private members with regard to particular issues (Hawker 1971,87).

Percentage of Bills presented to the NSW parliament, late 19th century (calculated from Hawker 1971,70-71):

Category of Bill	House of origin		Enacted		Enactment Rate
	Assembly	Council	Assembly	Council	
Private	11	3	4	3	.55
Public(govt)	44	5	24	3	.56
Public(member)	29	8	5	1	.15
TOTAL	84	16	33	7	.40

Both houses regularly resorted to select committees to consider the electric lighting bills introduced between 1888 and 1895, but they did not take the opportunity to establish a pool of members with expertise in the issues. Of the 47 members of the Legislative Assembly who served on electricity-related committees between March 1888 and November 1892, only 7 served on more than one. This meant that each committee had to undergo a learning process, often with the help of the same expert witnesses (the Superintendent of Telegraphs, E.C.Cracknell, was by far the most popular witness, appearing before 5 of the 7 committees). Committee membership generally included the parliamentary sponsor of the bill, whose line of questioning often revealed close alignment with its commercial sponsors, and also ministers, who could find time to attend few, if any, committee meetings. Although committees typically comprised 9 or 10 members, it was unusual to find more than four at a meeting, and meetings often lapsed for lack of a quorum. Nevertheless, the minutes of evidence comprise a valuable record of commercial and technological progress in electricity in NSW.

37. Among the major issues of the period were fiscal policy, as espoused by the supporters of "Protectionism" on the one hand and "Free Trade" on the other, and sectarian and racial issues, as embodied in the attitudes of successive governments to Catholic education and Chinese immigration (Coghlan 1928,1240-45). The governments of the 1880s were led by Free Traders such as Parkes, Robertson and Stuart. The longest lasting Protectionist government was that of Dibbs, from October 1891 to August 1894.

38. The Labor party first contested elections for the Legislative Assembly in June 1891, and returned 36 members, compared to 50 for the Parkes government and 55 for the opposition (ibid,1848). The Labor members initially supported the Parkes government, but in October 1891 Parkes resigned due to difficulties with his nominal Labor allies and was succeeded by Dibbs. Dibbs' dependence on Labor support to remain in office therefore gave Labor considerable influence, though it was limited by Labor's internal dissensions and Dibbs' refusal to appoint Labor nominees to the Legislative Council (ibid,1855-57).

39. Replying to Labor parliamentarians who opposed the pledge on the grounds that it was at the same time vague and restrictive, the then president of the Trades and Labour Council reportedly said:

"The statement of Labour members that questions of monopoly and class privileges cannot be determined is simply quibbling. Every one knows that we refer to such matters as the Australian Rights Purchase Bill upon which we think a solid vote of the Labour members should be given" (ibid,1872).

The Bill was laid aside in the Assembly shortly after.

40. The NSW government spent an average of L7 million of ordinary expenditure and L4 million of loan money each year between 1881 and 1885, about three times the level of a decade earlier (Coghlan 1918,1409). The loans were spent principally on railways. Construction became more expensive and new lines less remunerative, since they were built increasingly for local political reasons.

The initial radial extension of the railway trunk routes from Sydney and Newcastle to the most populous inland areas was at first guided by compelling geographic and economic factors. By 1881, however,

"...the aims and objects of the further expansion of the railway system were becoming increasingly diffuse and were being swayed by more pressures and persuasions at various levels of political complexity..." (Linge 1980,395).

Some of the pressures came from the legitimate concern of the government for the development of inland areas in the longer term interest of the entire state. Some lines, however, were extended through the influence of local interests, and, corepresented an increasing subsidisation of some sections of the community at the expense of others. By 1890, 42% of the interest due on railway loans had to be met from general taxation (Coghlan 1918,1409).

41. The Grafton Lighting Act 1884 establishing the Grafton Gas Company was probably the first piece of legislation in NSW to refer to electric lighting.

42. The bill sought to empower E.H.Taylor, chartered accountant, and G.K.Kirkland, electrical engineer, to:

"...acquire, erect, lay down, fix and maintain electric lines, meters, accumulators, fittings, works and apparatus within the City and Suburbs of Sydney aforesaid, to facilitate and regulate the supply of electricity for lighting and other purposes..." (NSW Government Gazette 18.11.1887).

Kirkland, who was to contract for the Newcastle installation some 2 years later, had by April 1888 designed nothing larger than a 340 lamp installation at Sydney University (V&P/LA 1887-8,1114).

The bill was based on the British parliament's Electric Lighting Act of 1882, which allowed the Board of Trade to issue provisional orders to private companies to set up central-station electric lighting, with the proviso that the local council could purchase the system at low residual cost after 14 years (Hughes 1983,61). Taylor and Kirkland had thoughtfully removed this restrictive clause "on the assumption that the local authorities would not care to take over the work", though Kirkland did state

"...we shall be in a position to extend small central stations to any suburb, and shall be prepared to give the municipality of each suburb the option of purchasing under reasonable conditions" (V&P/LA 1887- 8,1110).

It is unlikely that the promoters were unaware of the SMC's resolution of September 1887 to seek information on "the best system of lighting the parks and squares of the city" (SMC 14.9.1887) since the chairman of the company backing the venture was stated to be a City alderman (V&P/LA 1887-'8,1110). The promoters had sent copies of the bill to the SMC, and chose to interpret the lack of response as lack of objection.

Other features which the bill omitted from its British model included a time limit for the carrying out of the work, and an anti-monopoly provision against limiting consumers to any single lamp design: indeed, this bill proposed just such a limitation until the select committee amended it (ibid,1104). The only other substantial changes proposed by the committee were a limitation to 200 volts for DC distribution and 100 volts for AC, except by approval of the Superintendent of Telegraphs, E.C.Cracknell. The latter succeeded in having inserted into the bill a provision, similar to the one in the Grafton Lighting Act of 1884, for the government supervision of all technical and safety aspects electric lighting installations, to be carried out under his own offices (ibid,1122).

43. Much of the evidence heard by the committee was from local businessmen who declared that electric lighting, which some of them had seen in Britain or in their neighbours' premises, was a good thing, and that they would take supply from a public company if there were one. Several favourable comparisons were made with gas, in relation to the superior brightness and cleanliness, lower temperature and fire risk, and probably lower cost of electric light (though no actual data were offered at any stage). The scope for electric motors was also mentioned.

The Professor of Physics at Sydney University, R.Threllfall, declared that electricity was safe if distributed at low voltage, and that even overhead cables would not interfere with the telegraph wires if kept at a suitable distance. When asked whether electric lighting was "merely in its infancy", Cracknell stated that it was "...now so far advanced that we may safely consider it of established public utility" (ibid,1121). He also insisted that the cables should be installed underground, which the promoters had already stated to be their intention.

Kirkland concentrated in his evidence on assuring the committee of the financial sufficiency of his backers, who had already acquired land in Kent St. at a cost of L12,000, and were prepared to lay out up to L100,000 on a building and plant. He also presented the lack of any firm technical direction as a virtue:

"We do not bind ourselves to any particular plant, but should the Bill pass through Parliament we shall obtain the best plant of the latest description, and most economical form, that is possible to be obtained in England, Germany, or anywhere else where the plant is made" (ibid,1109).

44. The bill sought powers for the company formed by three Sydney businessmen "to supply certain cities and towns in the colony with the electricity for lighting and other purposes" (NSWPD 1.3.1888,3014). The promoters proposed to form separate companies in Sydney, Bathurst, Newcastle and other towns, and had issued a prospectus some two years earlier (V&P/LC 1887-8,339). Two of the promoters were local agents for the American Electric Manufacturing Company of New York, from which the equipment was to be purchased. They had already sold arc lighting installations in Melbourne, and to a NSW colliery.

The Legislative Council's select committee on the bill sat during the same period as the Assembly's committee on the Sydney and Suburban Electric Lighting Bill. Remarkably, no reference was made in either committee to the other bill. The only common witness was E.C.Cracknell.

The committee heard a considerable amount of evidence from electrical engineers with overseas experience, chiefly C.J.Bogue, who was to be the electrical engineer for the Sydney company. Bogue had worked for over six years in Boston, New York and other US cities, and he lectured the committee at length on voltages, safety, insulation, the growth of overseas installations and system economics. Much of his effort was directed to countering Cracknell's view that operating voltages should be low and cables underground, to prevent interference with the telegraph and telephone wires. He cited as evidence installations in the USA, in Melbourne and even the Government electric lighting installation at Sydney's own Redfern Station, where overhead power cables and telegraph wires crossed at all angles and were sometimes carried on the same poles, without apparent problems.

It was essential to the economics of the system proposed that Overhead cables and high operating voltages should be allowed. A high voltage DC circuit was proposed for arc lights, and separate low voltage circuits for incandescents. In addition it was considered that the area of service could be extended by means of charging remote accumulators from the high voltage system (ibid, 335). The other electricians appearing before the committee supported Bogue's claim that undergrounding was expensive and unnecessary. The promoters contented themselves with offering an exhibition of their equipment to the committee, and reporting the lack of response from the City Council, to which they had sent several copies of the bill. There was no discussion of their financial backing or commercial plans (ibid,339-4).

The higher installation costs and increased power losses associated with underground cables would have made the system unworkable. In the event, the select committee ignored Cracknell's suggestions for undergrounding and for voltage limits of 200 for incandescents and 1000 for arc lights: they allowed up to 300 and 3000 volts respectively for DC working, and up to 1000 volts for AC. The Superintendent of Telegraphs was, however, to have power to specify precautions to be taken at voltages higher than these (ibid,331).

45. The company's seven promoters included A.H.Whiffen, the electrical engineer at Tamworth and local agent for the Crompton Electrical Company of England, which was to supply the equipment and which itself had a large financial interest in the venture (V&P/LA 1891,751). Another promoter was W.Wynne, Manager of the Daily Telegraph Company, which by then was selling electricity to six other consumers from the plant which Whiffen had installed in its offices two years earlier.

The other promoters would have been well aware of the demand for electric lighting among their commercial neighbours, even at a price reckoned to be slightly higher than gas, of the potential to reduce unit costs through full utilisation of plant, and of the need to obtain powers to set up a distribution system in the public streets (ibid,761). The bill set a maximum price of 1s per kwh, but it was stated that the price would probably be lower. Whiffen submitted that the cost of a 10 cp (30w) incandescent lamp used for 6 hours each night would be L3/6/6 annually, while that for a nominal 20 cp (5 cu ft/hr) gas burner, which he held to give equal illumination, would be L3/17/1 (ibid,762).

Whiffen assured the select committee that the proposed low voltage DC system of arc and incandescent lighting was "the one which Edison himself adopts and uses," and that it would run electric motors (ibid,754). Alluding to the "battle of the systems", Whiffen made much of the dangers of AC. When Dibbs asked "would there be power sufficient under this Bill in the event of Parliament deciding to change the mode of execution to kill a man?" E.C.Cracknell replied in the negative (ibid,758).

The proposed system of distribution at 300 volts through underground mains met the requirements of Cracknell, who objected only to the provision in the bill which proposed to give technical supervisory powers to the SMC rather than to his own Telegraph Department. On this occasion the select committee declined to accommodate him, but instead made the bill subject to "any Act hereinafter to be passed for the regulation and inspection of electricity generally" (ibid,749).

46. When Dibbs asked whether electricity were not "a little beyond the municipal mind" Manning replied "I think the aldermanic mind is quite equal to the Parliamentary mind" (V&P/LA 1891,763).

Dibbs introduced the bill for its second reading in September 1891, in the following terms:

"Opposition to the bill can only be based on a very flimsy argument indeed - that the right of lighting the city belongs to the municipal council of Sydney...The right to provide a water supply belonged to the municipal council; but Parliament thought it wise to take that matter out of the hands of the municipal authorities...The municipal council have adopted a dog-in-the-manger policy. They are prepared to oppose the bill because they think they should have the sole right. But up to the present they have not moved in the matter...they must not now stand in the way of private enterprise accomplishing what they themselves have neglected" (NSWPD 22.9.1891,1942).

47. J.D.Fitzgerald (Labor, West Sydney) said:

"Everyone knows that the Australian Gaslight Company has a monopoly of the very worst description. If you raise your finger against that company they threaten to cut your gas off. They supply a meter which requires an expert to read so that the gas consumer has to depend on the honesty of the gas company. I presume we shall have a similar state of things if this bill becomes law" (NSWPD 22.9.1891,1946).

On the other hand, J.S.T.McGowen (Labor, Redfern, premier October 1910 to January 1913) said:

"...I believe the people of Sydney are perfectly satisfied with the light they have at present. it is only lately that they have commenced to complain. On the other hand, I know that a large number of men employed by the gas company would be thrown out of work" [if this bill were passed] (ibid,1942).

48. The debate was recommenced by J.Garrard, who repeated Dibbs' arguments and tried to undermine support for the SMC's bill by suggesting that

"...the corporation would not act as a generator of electricity, but would enter into contracts with well-known companies for the purpose of generating and distributing electricity" (NSWPD 2.3.1893,4799).

He could do nothing to defuse the opposition, however. He finally attempted to mollify the pro-SMC forces by offering to insert a clause in the bill, making it inoperative unless the council passed a resolution for it to be brought into operation, but to no avail. The motion for the second reading was defeated 49 votes to 15: 16 Labor members voted against the bill, and none for it (ibid).

49. The Australasian Rights Purchase Association was formed by predominantly Melbourne businessmen, including A.U.Alcock, the owner of an electricity supply company (V&P/LA 1892,330). Their intention was to secure the water power rights in each of the colonies, and to transfer them to locally incorporated subsidiaries for development (ibid,319). The local offshoot was to be the New South Wales Electric Supply Company Limited, with a total authorised capital of L500,000 of which 30% had been allotted as "fully paid up" to members of the parent company. Although the latter had subscribed only L20,000 it was stated that they would have no trouble raising the rest privately, since they were "the wealthiest men in Australasia" (ibid).

The promoters intended to connect a generator site at the Colo River with another 14 miles away on the Grose River, and thence to transmit power a further 34 miles via Richmond, Windsor, Parramatta, Granville and Burwood along the Parramatta Road to a substation on the boundary of Glebe and the City (ibid,317). The bill gave only an approximate transmission route and technical details, but the project was declared feasible by the expert witnesses appearing before the select committee, including Threlfall and Cracknell, who had recently acted as technical consultants to the SMC for its own bill.

Hydro-electric schemes of similar size were by then in operation in many parts of the world including Frankfurt and Rome, and the Niagara Falls project was under construction (ibid,321). Cracknell did not oppose the scheme, despite the fact that the transmission would necessarily be above ground at about 20,000 volts, provided that the Government were empowered to enforce certain rules in relation to distances from telegraph wires, and that the Company was prohibited from setting up a telegraph service along its transmission route in opposition to the government's monopoly (ibid,328). (This was Cracknell's last appearance before a select committee. He died in January 1893 after a particularly hot Australia Day parade.)

Doubts about the ability or intention of the Association to carry out the work were raised in parliament;

"...we have on our statute-book a number of bills...which have been dead letters, and have prevented other people from taking up the works authorised in those bills..."(NSWPD 6.4.1893,5796)

Cracknell and others suggested that a time limit for the company to commence work be inserted. This turned out to be irrelevant, since the bill was eventually defeated, but it would have been a prudent precaution. The select committee was told in October 1892 that in the same year the Tasmanian parliament had granted the Australasian Rights Purchase Association water power rights in connection with the proposed lighting of Zeehan and Dundas, the completion of which was expected by March 1893 (V&P/LA 1892,326). In March 1894, however, it was reported that the Association intended to seek a two year extension of time in which to spend the comparatively small sum of L10,000 and transfer its local authorisation to the Tasmanian Water Power Electric Company (BEJ,10.3.1894).

There is no record that the application succeeded or that the scheme was carried out. Allbut (1958,72) records that Zeehan was first electrically lit, by steam power, in 1900, and that the first hydro-electric scheme in Australia was at Launceston in 1895.

The Australasian Rights Purchase Association was also connected with the Hillgrove and Armidale Water-Power Electric Company: the company engineer, Palmer, and its secretary, Michelmores, appeared before the select committee on that bill in October 1892 and it was passed in March 1893, apparently without debate. The BEJ reported in February 1894 that the plant was to be supplied by the Crompton Co. and would be running by August 1.

50. This backfired to some extent, even in the Legislative Council, when some members made rough calculations of the value of the power in terms of the coal it would displace, and concluded that it was potentially so large that it ought to remain the property of the state (NSWPD 18.10.1893,470).

In response it was pointed out that neither the government nor the municipalities had the resources to undertake the project themselves, and that the bill included an option for government purchase after 15 years, albeit at a premium.

51. The usual anti-monopoly arguments were left to non-Labor members on this occasion:

"Notwithstanding what has been said to the contrary I hold that this bill will give a monopoly to a private company. The most extraordinary thing is that the labour party are so quiet on this occasion. They are quite willing to forfeit their principles" (NSWPD 9.2.1893,4057).

One of the two Labor members on the bill's select committee made the uncharacteristic reply:

"There never was a bill before this Parliament in which the principle of state right is so absolutely conserved...I do not understand the blind, obstinate attempt to prevent any development of anything like private enterprise in this country" (ibid).

Cotton, the Labor member for Newtown, was asked "...if it is not a fact that he acted as agent for this company at Penrith? I think the hon. gentleman will not contradict my statement..." (NSWPD 9.2.1893,4057).

Later a Legislative Councillor, Cox, was accused of being a shareholder (ibid 24.1.1894,168). He did not deny it, but another Councillor came to his defence, resenting the implication that this would cause any conflict of interest.

52. The SMC's own electric lighting bill had just been introduced, and given the sentiment of the House there was some confidence that it would be passed. The SMC would then have the sole rights to reticulate electricity within the City and could well have looked on the Australasian Rights project as a potentially cheaper source of bulk electricity than coal-fired generation.

The only objection one of the aldermen could raise was that the select committee had not taken evidence from a representative of the SMC (NSWPD, 9.2.1893,4050), which underlines the influence which the SMC had by then attained on the electric lighting issue. Another alderman pointed out that the bill had been before the City Councillors for months, that they had taken no adverse action, and that "...we have every reason to suppose that they are favourable to the measure" (ibid,4053). He said later:

"The city council have no idea whatever of supplying electric power to the citizens of Sydney. The utmost limit to which they would go would be to supply light to individual householders. It is doubtful whether they would even do that. What it has been proposed that they should do is to light the public streets, and it is questionable whether they would go any further than that" (ibid 6.4.1893, 5798).

53. Fears were also raised that sales of cheap electricity by the company could undermine the economic viability of municipal electric lighting works along the transmission route, particularly at Penrith (NSWPD 9.2.1893, 4054, 6.4.1893,5799): an early instance of support for the monopoly rights of municipal electricity enterprises in face of private competition.

54. Strong opposition to the bill outside parliament may also have had some influence. The Labor Electoral Leagues used the bill as the very illustration of the monopoly rights and private privileges to which they wanted united opposition from Labor members. The *Bulletin* expressed similar sentiments:

"The chance of levying backsheesh on a metropolis doesn't come every day, and the company - chiefly a Melbourne crowd, with very many excellent friends in the Sydney legislature - may be safely trusted to make the most of it" (Bulletin. 20.3.1893).

The Sydney press gave considerable coverage to the issue of electric lighting, particularly in the period 1891 to 1893 when the competition to supply it intensified:

"At the present moment the difficulty seems to be not to get anybody to undertake the work, but to determine who shall be allowed to do it. In fact, arrangements are in progress for the settlement of the matter by a sort of triangular duel" (SMH 24.9.1891).

Objective and disinterested reporting on the issue was rare. The Bulletin was consistently anti-monopolist. One of its milder descriptions of AGL was "...this oppressive and plundering monopoly..." (Bulletin 14.4.1883). It opposed AGL's electric lighting bill and the Australian Rights Purchase Bill with equal vehemence, and raised the suspicion of conspiracy in the following terms:

"The claims of [AGL] are being actively or passively boomed by the daily press, many of the bosses or influential members of which are enormously interested shareholders in the gas monopoly, and naturally desire to prevent their shares going down to zero. And, strangely enough, many of the individuals who approve of the Australasian Rights Bill...also approve strongly of the proposal to confer an electric lighting monopoly on the great Sydney gas-monopoly..." (Bulletin 20.5.1893).

The commercial associations of the *Sydney Morning Herald* with AGL, and those of the *Daily Telegraph* with the Sydney Electric Lighting Company, were reflected in their reporting. The *Telegraph* had the easier task, since it could play on public prejudice against AGL and so narrow the debate to a clear choice between private and municipal enterprise:

"The Australian Gaslight Company, which has long enjoyed and highly profited by absolute control of the lighting of Sydney by gas, taking alarm at the outcry of its discontented customers, seeks, no doubt with a view to forestalling dangerous competition, to take to itself the function of supplying electric lamps. The Sydney Electric Lighting Company...asks to be allowed to enter into the business by supplying 100,000 lights. Last, and certainly least, is the tardily conceived and miserably inefficient scheme of the City Council (DT 13.11.1891).

The *Telegraph* made much of the Council's proposal to use high voltage AC distribution from two of three planned power stations, in contrast with the low voltage DC system proposed by the Sydney Electric Lighting Company:

"Because they do not know, or do not care, invisible death and destruction are to be laid all over the city, save in the favoured Kent-street quarter" (ibid).

The *Telegraph* published lengthy lead articles on the high cost of municipal lighting schemes in the United States (DT 7.10.1891,3) and in New South Wales country towns (DT 12.6.1890) to emphasise the inevitability of municipal inefficiency. At the same time it accused the City Council of intending to sell the rights it might obtain to private enterprise:

"...the council has no intention of building anything like adequate electric lighting works for the citizens of Sydney, but coolly asks that Parliament will delegate its powers to the council in order that those powers may be hawked out to the highest bidder. We trust that no such proposal will ever be countenanced by the Parliament of this country" (DT 6.10.1891).

The *Herald* had a more delicate task in promoting the cause of AGL. It conceded the SMC's right to establish its own electricity supply for public lighting, but tried to undermine the usual municipal argument that the initial high costs should be offset by private electricity sales:

"When it is considered how large an increase in light would be obtained under the proposed [Council] scheme in the streets, and parks, and public places, the increase of cost that would be incurred by the council is not a very important matter; and it is not to be assumed that for the purpose of saving this loss it would be just or wise for the council to increase its capital outlay by a sum of £60,000 for the purpose of competing with private enterprise in the supply of light to private consumers, especially if profit could only be obtained in this direction by beating private enterprise out of the field" (SMH 6.10.1891).

The *Herald* conceded that the electric lighting of Sydney would eventually become a monopoly, but, using the NSW railways as a case in point, questioned the wisdom of entrusting the management of a monopoly to a public body liable to political influence:

"The City Council may have the command of special facilities for the effective lighting of the city, but in the management of a commercial undertaking such as this it may be constitutionally exposed to disturbing influences, and that liability should not be overlooked as one of the factors of the problem" (SMH 24.9.1891).

Despite the best efforts of the *Telegraph* and the *Herald*, the Legislative Assembly effectively defeated the two private bills in early 1893, leaving the field open for the Council. The *Herald* had to content itself with reassuring its readers, many of whom were no doubt AGL shareholders:

"This is not to say that the period of gas is over. For domestic purposes, for motive power, and in several other spheres it is more than holding its own against the new competitor, it is increasing in use, and promises to reach a wider employment still" (SMH 4.3.1893).

55. The directors first discussed the subject of electric lighting as early as September 1881, and resolved to import samples of the Swan-Edison and other incandescent and arc lamps (AGL/DM 11.8.1881, 7.11.1881). In October 1881 the company's London agent began on his own initiative to send occasional reports on electric lighting developments there and in Europe. The reports were read and discussed, sometimes in the presence of the agent (AGL/DM 14.10.1881, 17.3.1890). A pre-emptive move was made in 1883 with the substitution of 800 cp for 200 cp gas burners at three prominent locations in the City where arc lamps had been installed: "As a set off against the Electric Light..." (AGL/DM 3.1.1883).

No decisive action was taken, however, until the end of the decade. The introduction of electric lighting bills in 1888 was noted, and though the secretary could see "...nothing to object to on behalf of this Coy" he did submit a new scheme for the renewal of the public lighting contracts which AGL held with 32 municipalities (AGL/DM 2.6.1888). The scheme was to reduce the contract prices per public lamp in return for longer contracts, with the apparent intention of reducing the inclination of the municipalities to undertake their own gas or electric lighting, or contract with private electricity suppliers. There was an early sign of trouble with this strategy in April 1889, when Redfern offered to accept the reduction, but not the change in the contract conditions (ibid, 15.4.1889).

The directors continued to take no significant action, despite the fact that a major shareholder wrote to the board in September 1889, urging them to "...take an early opportunity for obtaining power to supply the Electric Light if necessary" (AGL/DM 23.9.1889). They decided to hold off applying to parliament pending the outcome of the Newcastle gas company's bill (ibid, 26.11.1889) and to maintain the strategy of undermining municipal interest in electric lighting.

56. By 1881 AGL was experiencing difficulty in getting legislation even on purely gas matters through the Assembly. By 1891 its support in parliament was restricted to the Council, where sat several of the company's directors and shareholders. AGL was not reluctant to use its influence. For example the minutes record:

"Messrs Norton, Moses and Campbell [all Legislative Councillors] to have Clause 44 [of the SMC electric lighting bill] expunged, when the measure reaches the Legislative Council, through some member not a Director of the gas Company" (ML MSS, 10.8.1896, 345).

The select committee on the AGL electric lighting bill included at least three AGL shareholders: R.Hill, S.Charles and A.Riley.

57. In June 1890 the directors resolved to publish in pamphlet form correspondence from "JL" on municipal electric lighting, which had appeared in the *Daily Telegraph* in the same month (ibid 16.6.1890). The pamphlet was distributed to all shareholders and municipal councils, with the following preface:

"It will be observed that the author of the correspondence has most impartially and exhaustively investigated all the conditions under which the electric light is supplied to the municipalities of Young, Tamworth and Moss Vale, and the results arrived at cannot but be reassuring to those interested in gas companies; while, at the same time, they will be of immense value to the municipal authorities of those districts which are contemplating the substitution of electric light for gas" (Electric Lighting of Municipalities, AGL June 1890).

"JL's" analyses of costs were well founded, though his impartiality was questionable since he was in fact an AGL director who received payment from the board for his fact-finding efforts (AGL/DM, 16.6.1890).

58. The AGL chairman pointed out quite correctly to the select committee on the bill that the company could produce electricity at less cost than any competitor because it already had staff, and land in locations suitable for power stations (V&P/LC 1891,1011):

"Ours being a large company, and understanding the working of light, we think we would be able to supply electricity to the public, or to the municipalities, quite as well, if not better than any other company starting specially with that object. We have, as it were, no preliminary expenses to pay" (ibid,1010).

He also suggested, as a further economy, that underground cables could be laid in the same trenches and at the same time as gas mains, a proposal which E.C.Cracknell greeted with considerable alarm (ibid,1010,1018).

59. It sought an increase in the authorised capital of the company from L850,000 (of which L690,000 had already been subscribed by shareholders for gas purposes) to L2 million, and the power to borrow as much again (V&P/LC 1891,1014).

60. The involvement of the Council with electric lighting is outlined by Anderson (1955), though incompletely and without placing it in the context of the other municipal issues of the time. In February and March 1882 the town clerk was instructed to make enquiries on the practicability and cost of public electric lighting from Swan in England, Edison in the USA, and the NSW Superintendent of Telegraphs, E.C.Cracknell (SMC, 7.2.1882, 14.3.1882). Cracknell advised that the equipment then available was not adequate for large scale lighting, and that the Council should grant no lighting concessions to private companies until a dependable system became available (Anderson 1955,9).

In April 1888 the SMC resolved

"That application be made to the Hon. the Premier to introduce a Bill to Parliament, to enable the City and Suburban Councils to do all necessary Acts and things for, and to facilitate and regulate the supply of High Pressure Hydraulic Power...and for the extinguishing of fires, and other purposes in the City and its Suburbs; also for power to enable the City and Suburban Councils to do all necessary acts and things for, and to facilitate and regulate the supply of Electricity for Lighting and other purposes, within the City and Suburbs" (SMC 10.4.1888).

No such bill was prepared.

62. A resolution instructing the City Solicitor to "prepare a Bill to enable this Council to borrow money to erect or buy Gas Works" was passed in August 1886, immediately after passage of the Municipal Gas Act Amendment Act (SMC, 17.8.1886). There is no record that such a bill was actually prepared. A year later Council made renewed enquiries on electric lighting, again without result (ibid,14.9.1887).

63. The SMC resolved:

"That applications be invited both in Sydney and in London for the right to establish in this city a system of electric lighting and application of electric powers to include the lighting of the streets, lanes and parks of the city, and also the supply of electric lighting for domestic purposes. Applicants to be informed that the Council is prepared to consider such applications and enter into a contract for a term of years for the lighting of the city, or a section thereof, as may be deemed advisable" (SMC 22.1.1889).

This drew at least one response from London, from a "powerful syndicate who can command necessary capital", seeking a 42 year concession (SMC/FC 22.10.1889). The Council replied that it would consider a 21 year concession, but nothing further came of the approach.

64. It was approached for permission to erect posts to run electric wires in Pitt and Castlereagh Streets, and refused (SMC 14.2.1889). It was also approached by electrical contractors and engineers offering to light the fishmarkets (SMC/FC 19.3.1889) and the new town hall, built in 1888 (ibid,20.6.1889). The SMC eventually accepted the GPO's offer to light the Woolloomooloo fishmarkets from the GPO's existing lighting plant at Cowper Wharf (ibid,26.9.1889).

65. Tenders for a dual gas and electric lighting system for the town hall were first called by the Finance Committee in July 1889, possibly as an afterthought to calling tenders for the lighting of the fish-markets (SMC/FC 20.6.1889). Only after the tenders were submitted in August did the Finance Committee consult an expert, E.C.Cracknell. It then resolved to return the tenders unopened and to establish a committee of 5 aldermen,

two architects and Cracknell to prepare specifications for lighting the town hall by electricity alone (ibid,7.8.1889). A tender was selected from a new batch, but after a disagreement in the Finance Committee the matter was again referred to the subcommittee which changed the recommendation, failed to negotiate a price and called tenders for a third time (ibid,26.9.1889 et seq). Eventually, by December, the contractors were chosen (ibid, 17.10.1889,12.12.1889), but it was over a year before the installation was completed. The president of the Engineering Association of NSW commented on the delay:

"One might ask, if it takes so many months in a city like this to erect a plant of machinery to instal a building like the Town Hall, how many years will it take to erect an installation for lighting the whole of the city?" (EngANSW 1890-91,13).

66. The Electric Lighting Committee consulted several experts, and included in its report proposals prepared by Cracknell and Threllfall which were far more detailed than any submitted by the Council's competitors. The proposal was for three power stations, at Kent Street (next to AGL), at a site bounded by Forbes, Bourke and Wilson Streets Woolloomooloo, and the corner of Castlereagh and Devonshire Streets. The first two sites could be serviced by water and the third by rail. Distribution from Kent Street was to be DC and the other stations AC. Total installed capacity was to be 9941 hp.

The proposed scheme was heavily weighted towards street lighting. A system of 431 arc and 1443 incandescent street lamps was proposed, to replace the 3,000 gas street lamps, and provide "twelve times as much light with an increase of cost of maintenance of less than 22 per cent" (SMC/ELC 1891 att.1). The scheme allowed for only 16,000 private lamps, one sixth the number proposed by the Sydney Electric Light Company. The number was considered adequate for "all private lighting to be required for some years" (ibid,3).

Total system costs were estimated to be sensitive to private lighting sales, even though the latter were estimated to account for only 30% of energy once the full provision for 16,000 lamps was taken up. The net annual income from private lighting at full utilisation was estimated at L5,000, and the public lighting cost at L16,000 (ibid,2). With only 5,000 private lamps connected, however, the system would lose L3,000 and hence cost the ratepayers L24,000, or nearly twice as much as they were paying for gas. The risk of underutilised capacity would be reduced if the initial private lighting provision were less, but subsequent increases in capacity would be more expensive.

67. It was stopped four times by prorogation of parliament, and once on the point of order that the leave by which the bill was introduced did not mention the power contained within it for the Council to supply electricity outside the limits of the City, subject to the consent of other municipalities.

68. This was elevated to a point of principle, as support for municipal enterprise had been. The Labor member for Young, J.C.Watson, said in debate in 1894:

"I should like to see Sydney lit up with this...most efficacious means of public lighting. But I must oppose the bill at every stage...as long as it contains a provision allowing the old evil of sweating to be continued, and which would allow profits being made out of the citizens and transferred to private syndicates..."(NSWPD 4.12.1894, 2987).

Labor was confirmed in its suspicions by statements like that in the town clerk's report of 1895:

"The actions of Parliament have caused the Council's measure to be buffeted about from pillar to post, simply because of an objection by the labor representatives, to permit the Corporation to let contracts for a work, which can better be done in that manner than in any other, and with manifestly more advantage to all concerned. Like many other projects which would provide work for the workless, this measure once passed, would open up many avenues of employment now closed (SMC/TC 1895,4).

On the sixth introduction of the bill in August 1896 it was sponsored by a City alderman who stated that he disagreed with the clauses giving the Council the right to subcontract, and asked that they be negatived (NSWPD 4.8.1896,2012). This opened the way for Labor support and the bill was passed in the Assembly. A last minute attempt was made in the Legislative Council to restore the provisions allowing the City Council to lease out its lighting powers, on the grounds that it could not borrow enough to light the entire City (ibid,24.10.1896,3487). This was unsuccessful, but an amendment limiting the Council to supply electricity for private lighting only, and not for other purposes, was carried (ibid). The Assembly insisted on the removal of this amendment, and the bill was finally enacted.

69. In 1893 the town clerk had reported that "with the contemplated introduction of the electric light it has become necessary to somewhat curtail the further extension of the gas system" (SMC/TC 1893,4). The Welsbach incandescent gas mantle could be fitted to existing gas lamps to give over four times the illumination with only three quarters the gas consumption (SMC/CS,27.8.1896).

70. The committee considered and rejected the possibilities for using water power from the Colo River (on the grounds of expense and seasonal unreliability), combining the power station with a garbage destructor (too experimental), obtaining supply from the Railway Commissioners, and siting the power station at a coal mine away from the City (difficulty and expense of efficient control). It recommended that the power station be located on a waterfront site at Kent Street owned by the Council. This site met all the criteria for transport of coal and removal of ash by water, access to harbour water for cooling, and location near the centre of the forecast energy load: the same criteria which had led AGL to locate its original plant on the adjoining site sixty years earlier.

71. Cardew visited Sydney in February and March 1900, confirmed the suitability of the Kent Street Site, and worked out the technical and financial details of the proposed installation.

He proposed an installation with an initial capacity of some 2500 hp (SMC 1900,265). This was two and a half times the capacity previously proposed, mainly because the balance of forecast public and private demand was reversed. Whereas the earlier scheme had allowed for up to 16,000 private lamps consuming about 30% of energy, Cardew allowed for up to 60,000 private lamps, accounting for about 75% of energy sales after five years of operation. All the energy was to be generated at Kent Street and distributed at high voltage to substations at the town hall and at Woolloomooloo, whereas the earlier proposal had been limited by the technology of the time to three separate power stations.

72. The Strand Electric Company was said to enjoy the benefits of a concentrated commercial load with a high daytime lighting demand. Cardew estimated that the company's price averaged 4.5 d/kWh (about what the SMC's initial price would be) including a good margin for profit (SMC 1900,269). The private companies were essentially limited to single blocks, since the SMC had continually refused their applications to string wires along public streets (SMC/FC 24.3.1892, 21.2.1894).

73. The Council and the government accused each other publicly of mismanaging the City's sanitation before the plague, and the cleanup itself. The town clerk reported:

"...a feeling grew in many minds that the mainspring of the Government's action - in itself in every way commendable - was the seizing of a political opportunity, more than the safeguarding of the City's welfare" (SMC/TC 1900,4).

The fact that the AGL site was the only property not resumed was taken by the Council as confirmation of this (ibid,5). An alternative explanation would be that the site, having been in continuous use as a gasworks for sixty years, would not have the same accumulation of refuse as the general wharfs abutting it.

The Council's credibility declined:

"The maladministration of the City of Sydney had been a matter of comment for several years, and when an outbreak of bubonic plague occurred during 1900 the City Council made a somewhat futile effort to better its administration" (Coghlan 1926,2215).

Facing intervention in its affairs by the Lyne government; the Council expressed the hope that new legislation would set its relationship with the state on a better footing:

"The bill to remodel the Council was introduced to and carried through Parliament in a bitterly hostile spirit, and the Government viewing, therefore, the new Council as proteges, will assist their schemes, possibly to forward the City's interests, probably to demonstrate the superiority of the new Council over the old...A case in point is the Council's scheme of electric light and power for the City. Nothing could exceed the care and skill with which the Council deliberated upon this question." (SMC/TC 1900,5).

74. NSW and Sydney population (from SR) ('000)

	City	Suburbs	rest of NSW	TOTAL
1881	106.6	128.7	543.4	778.7
1891	109.1	290.9	766.0	1165.3
1901	119.0	372.2	880.8	1372.0

75. The Redfern to Hunter-street Tramway Act passed in March 1879 allowed the government to construct a tramway to carry passengers from Redfern station to the Exhibition Building in the Domain. The tramway was opened in September 1879, and operated by horses for two weeks until the arrival of the steam cars ordered for it (Paddison 1956,178). The same legislation was used as a model for the Tramways Extension Act of 1880 (NSWPD 31.5.1883,2023).

In 1883 the NSW supreme court ruled after a tram accident that the Tramways Extension Act 1880 empowered the Railway Commissioners to use only horses, and that the use of steam, by then almost universal, was illegal. The government recalled parliament for the express purpose of passing the Tramways Declaratory Act, "to declare legal the employment of Steam Motors on Tramways constructed, worked or maintained in pursuance of the Tramways Extension Act 1880", and so render the government and its employees immune to prosecution in case of any further accidents (NSWPD 29.5.1883,1947). The prospect of suspending steam tram services even for a short time was rejected:

"The traffic on the tramways has grown to such an enormous extent, the system has so completely eaten up every other means of conveyance between the heart of the city and...the outlying suburbs, that it would have been impossible for any other system to have conveyed people to their homes and to their place of business" (ibid,1955).

The bill was passed with general support, and one member took the opportunity to suggest that the government should experiment with electricity as a motive power (ibid,30.5.1883,2001).

76. In 1889 the government decided to construct another cable line from King Street wharf in the City to Ocean Street, Edgecliff. The line was not opened until September 1894 (ibid). Part of the delay was due to the decision taken in the course of construction to increase the power of the engines, in anticipation of extending the line to Oxford Street and to Rose Bay (PWD 1893/4,5).

The cable system was not to be extended further. When the government decided on the construction of the Ocean Street cable line in 1889, it referred a separate proposal for a cable tramway along George Street to the Parliamentary (PS) Standing Committee on Public Works (V&P/LA 1896,487). In June 1891 the Committee reported that it would be prudent to await the results of the Ocean Street cable line, and that there was a difference of opinion as to whether cable or electric power would be more suitable (ibid).

77. In 1889 the government had commissioned a report on the working of tramways by electricity from an English engineer, Sir John Fowler. Fowler recommended two systems as suitable for Sydney: the preferred one, provided that overhead wires were acceptable, was the American Thomson-Houston system (Fowler 1890,8). The other was a system of mobile accumulators charged from generator stations at the end of the line. This was in use in Britain where overhead wires were not then permitted, and which had the advantage of requiring no alteration to the permanent way (ibid,5).

In November 1890 an experimental electric tramway commenced running between Bondi Junction and Waverley, powered by overhead wires from the generators at the Randwick workshops, (RC 1890/1,73). It was reported that "the stationary engine gave some trouble at first, but the defects have been remedied" (RD 1890/1,73).

In 1893 the equipment was transferred to North Sydney cable tram power house, to work the Military road electric tramway through overhead wires (PWD 1893/4,32).

Norman selfe, for one, was not impressed:

"...two steam motor boilers, which as motors would probably have drawn 600 people after them, supplied power, and after having their energy transferred into an electric current and applied to two electric tramcars, drew a maximum of say 80 people" (ABCN 20.12.1890).

Selfe preferred the Judson revolving shaft system which, unlike cable, could drive cars in either direction at varying speed.

78. It recommended that the power should be generated by the surplus capacity of the existing engines at the Rushcutters' Bay cable depot, but foreshadowed the need to consider electrification of the entire system:

"If electric traction is to replace the present steam service it will be well to select a site for a central generating station, and erect the power plant there, instead of spending a large sum of money on temporary works which may be abandoned in the near future" (V&P/LA 1896,490).

The only point on which the (PS) Committee disagreed was the route: it was unanimous on the need for the tramway from Circular Quay to the Railway Station, but only narrowly in favour of the section along Harris Street (ibid,11).

79. To the few members who raised any doubts about the desirability of electric traction in preference to cable or steam, the Premier himself replied

"The idea that this great city is to be cramped down through our barbarous methods of locomotion is absolutely abhorrent to me ... I hold that the more...tram-wires we have the better, so long as they will pay" (NSWPD 27.8.1896,2715).

The Committee (PS) had reported that the line would indeed return an annual profit to the state of over 10% on the capital invested (V&P/LA 1896,488). The working expenses per tram-mile were estimated at 86% of the Ocean Street cable line, and only 42% of those of the Sydney steam trams (ibid,489).

80. The Labor member for Pyrmont, T.M.Davis, said:

"One advantage of the electric tram will be that instead of reducing the number of hands it will give increased employment, and it will have the effect at the same time of reducing the fares charged, which have largely to be paid by the working classes, whose wages have been reduced. I regard this as one of the most democratic proposals ever submitted to the House..." (NSWPD 27.8.1896,2724).

Many Labor members voted against the bill, however, possibly accepting the argument put by several speakers that the tramway would further delay the long-discussed extension of the railway into the City, the construction of which would have created even more employment.

Another major cause of opposition was the anticipated effect of stray electric currents on the Sydney telephone system, which at that time still used single wire earth return. The (PS) Committee concluded that the problems of interference and cross-talk on the telephone system were so great that remedial measures would have to be taken in any case, and the cost of those measures should not be ascribed to the tramway. Whereas only a few years earlier parliamentary select committees into electric lighting bills had almost invariably deferred to the views of the Superintendent of Telegraphs, this committee stated

"The streets of a city are designed primarily as a means of transit, and not as alleyways for telephone or telegraph lines. In the construction of this tramway...every known means should be adopted to reduce external disturbance to a minimum. This having been done should disturbance still exist it must be dealt with by alterations to the lines so affected" (V&P/LA 1896,491).

A country MLA raised the novel argument that the omnibus service ought to be continued because it was a means of profit to farmers who sold feed; on the other hand the electric tram also had advantages for farmers if it destroyed the telephone system and so brought back the horse cabs which the telephone had displaced (NSWPD 27.6.1896,2726).

81. The government thought it prudent to immediately introduce the Electric Traction Act, to enable the Railway Commissioners to use electric traction on existing tramlines, and so forestall the legal problems which had arisen in the transition from horse to steam power.

82. The spare engine capacity at Rushcutters' Bay was taken up to power a new electric tramway between the cable terminus at Ocean Street and Rose Bay (PWD 1896/7,6).

83. The City Council welcomed the George Street electric tramway, while regretting that it caused the almost instantaneous demise of the Sydney Tramway and Omnibus Company's horse buses, "...the most cleanly, rapid and reliable service the City has enjoyed for many years past" (SMC/TC 1896,11). The Council had, in fact,

supported an unsuccessful bid by the same company in 1890 to obtain powers to construct a cable tramway in the City, with the proviso that it should have the option of eventual purchase (ibid, 1890;ABCN 26.7.1890).

84. The separate North Shore tramway was also electrified. Three other suburban lines were operated by steam. A short and lightly used tram line at Manly, which had opened with steam in 1903, reverted to horse operation from 1904 until 1908: the last horse tram in Sydney.

85. The suburban rail system was expanded with the North Shore line during the 1890s, largely to exploit the demand which the success of the tramways had revealed.

86. Some companies got as far as the introduction of the necessary bills to parliament. Even non-Labor members expressed the view that it was not only the prerogative but the obligation of government to provide tramways and other essential services. T.H.Wilks, the member for Balmain North, said in the debate on the George Street tramway in 1896:

"We live in an age when the government are compelled to recognise the convenience of the public. They are compelled to recognise that facilities for traffic are just as essential to the ordinary welfare of life as is the question of a water supply" (NSWPD 17.8.1896,3724).

By the end of the century the issues of control of electric tramways and of electric lighting had become entangled. In 1884 T. Saywell had been granted an Act to enable him to operate a private steam tramway between the Rockdale railway station and Lady Robinsons's beach, where he intended to subdivide land for building. In 1898 he secured the introduction into parliament of Saywell's Tramway and Electric Lighting Bill, to enable him to operate the tramway by electricity, to sell electricity for public and private uses in Rockdale and neighbouring municipalities, and for extension of the term of the original act by 20 years. A select committee of the Assembly was told by the Mayor of Rockdale that the proposition had wide public support, including the unanimous support of the council, which had no intention of undertaking electric lighting and was "perfectly satisfied to leave this matter in the hands of Mr. Saywell" (V&P/LA 1898,668). Furthermore, the council had the right to establish its own electricity works or to acquire Saywell's at any time. Representatives of the Railway Commissioners and of the Postal and Telegraph Department also expressed no significant objections.

The bill was eventually abandoned, after being introduced and stopped by prorogation three times. In June 1900, on the one occasion it was debated in the Assembly, the government was united with the Labor party in opposing it. Opposition hinged on the issue of the right to sell electricity rather than on the electrification of the tramway. One Labor member stated that the electricity would be sold at a higher price than if provided by a public enterprise, while another, the future premier J.S.T McGowen, opposed it because it would

"...absolutely prevent those municipalities from lighting their streets with electricity because the surplus power available to Mr. Saywell could be sold at a much cheaper rate than electricity supplied by a municipality" (NSWPD 26.6.1900,370).

87. Some caution is required in interpreting the data in the NSW Statistical Registers of the time. The exclusion of small unmechanised factories, and the inclusion of electric power installations which serve almost exclusively lighting or traction loads, overstate the degree of overall mechanisation. The data in Table 3.5 are corrected for the latter distortion.

88. Many of the factories outside Sydney were concerned with the increasingly energy-intensive processing of food for the Sydney market and for export. The largest power users outside Sydney in 1902, (apart from the smelters and ironworks which were also the lowest *thermal* energy users), were flour mills, sugar mills, butter factories, refrigeration plant and sawmills (SR 1902,661). The largest metropolitan power users in 1902 were engineering, brewing, meat preserving, sugar refining and building materials.

89. It is estimated that AGL had about 8,000 residential consumers in 1881 and 46,500 consumers of all classes in 1901 (AGL 1932). It is estimated that about 44,000 of these were residential, ie a 5.5 times increase, compared with a 2.1 times increase in Sydney population. There were about 92,000 dwellings south of the harbour (SR 1896).

90. The selling price was reduced from 78 pence per thousand cubic feet in 1881, to 48 pence in 1901. The increasing scale and mechanisation of production enabled AGL to increase the volume of gas made from each ton of coal by nearly 50% during this period.

91. The consumption of candles per capita in NSW remained steady for most of this period of increasing gas penetration, (see Chapter 3 note 45) suggesting that urban kerosene use was the more affected.

92. These included installations by H.H.Kingsbury for the Hon.H.R.D.White and H.C.White (ABCN 30.11.1889), and by Williamsons for John Eales, Morpeth.

93. AGL advertised that

"Cooking by gas is far superior, cheaper, and cleaner than cooking by any other means. The gas is always ready for use day and night at a moment's notice. Its use for cooking purposes renders the Mistress of the house almost independent of servants" (Wicken 1891).

94. The town clerk of the City Council noted in his annual report for 1892:

"As factories multiply, and the necessities for chimney stacks increase, it is apparent that in order to retain the purity of our atmosphere, strenuous efforts are necessary to minimise the possibilities of pollution..."(SMC/TC 1892,9).

95. After an unsuccessful attempt in 1881, the company obtained an Act of parliament in 1883 which cleared the way for expansion, by raising the capital limit to £850,000 and removing the limitation on the area of land it could hold. AGL built and operated small gasworks at Balmain, from 1883 to 1887, and Five Dock, from 1881 to 1886 (Lukey 1897,16). Each of these served independent local networks, which were connected to the main gas grid on completion of a large new gasworks at Mortlake in 1886. Mortlake was well sited to serve AGL's expansion westward and northward. AGL purchased the Parramatta Gas Company in 1890, dismantled its works in 1891 and its connected its network, extending from Granville to Prospect, to the grid. In May 1893 gas supply commenced to Ryde, Gladesville and Hunter's Hill (ibid,23).

96. Between 1886 and 1892, the first years for which NSW statistics are available, AGL production averaged over 87% of the total. After 1892 several country gasworks came into operation, and for the remaining period to 1904 the AGL proportion of NSW production remained in the range 76-80%.

97. The Sydney Hydraulic Power Company (SHPC) Bill was introduced in February 1888 and passed in December, after one interruption by prorogation. Its rival was first introduced in December 1887, stopped by prorogation three times, and finally abandoned in October 1889.

The Sydney Hydraulic Power Company Bill was opposed by the SMC. The Council's objections, as expressed by the two City aldermen in the Assembly, were almost identical to those it expressed three years later in opposition to the granting of electric lighting powers to private interests: that the municipality should control the public streets, and should provide such services itself. Speaking against the bill, Alderman M.Chapman said

"Not only this Government, but previous governments have promised to introduce a bill to give different localities the powers of self-government ... I believe that the public would like the bill to be brought in at once, and include, not only the bill to supply the city with hydraulic power, but also the bill to light the city and suburbs by electricity" (NSWPD 1.5.1888).

These principles were rather undermined by the fact that the SMC had lent its support to the opposing bill, which was essentially identical but granted the SMC an assured annual return instead of a proportion of profits above a certain level (ibid). The SHPC bill enjoyed wide support, including that of another SMC alderman, and passed the crucial second reading stage by the comfortable margin of 41 votes to 8 (ibid, 87).

98. It is estimated that the hydraulic power system delivered about 1 TJ of energy in 1894, while AGL delivered about 660 TJ. About 3% of the coal energy was delivered to the point of end use by the hydraulic power system compared with about 26% for gas (losses included). Gas engine and pump efficiency could well have been as low as 10%, so overall system efficiencies for driving hydraulic equipment may have been similar.

99. In May 1890 the electrical engineer H.Van de Velde presented a paper to the Engineering Association of NSW describing "Van Rysselberghe's Hydro-Dynamo System of Electric Lighting" in the following terms:

"...a distribution of energy in the form of water under pressure or compressed air is also a distribution of electricity. Considering that they may be utilised for driving a dynamo, and by the aid of a suitable motor, the energy which has been mechanically distributed can be converted into electricity" (Eng ANSW 8.5.1890,32).

Despite over a decade of British and American experience with DC electric power reticulation, Van de Velde placed great faith in an experimental Belgian system of dispersed generation of electricity from reticulated hydraulic power:

"With our present knowledge, we have to give up the idea of a large central station, distributing the direct current, over a whole city at a reasonable rate: carrying to each house and to the most distant spots of a thickly populated city, the charm and hygienic advantages of the electric light. We must also give up the expectation that every workshop and each small manufacturer will get his motive power from such [a] central station" (ibid,33).

100. The 1890s were a particularly fluid time for technological innovations. Unusual hybrids were proposed, sometimes tried, and often superseded. Among those not introduced in Sydney was the pneumatic system of power distribution by compressed air, which was strongly advocated by Norman Selfe in the 1880s (Eng ANSW 1885/6 49,1888/9,181).

101. Sydney had in fact fallen well behind its rival Melbourne where a succession of mergers had produced a company capable of supplying two suburbs by 1891, and which supplied large parts of Melbourne with traction power as well by 1899. The Melbourne City Council itself began supply in 1894 (Allbut 1958,40). The Victorian parliament passed an Electric Power and Light Act in 1896 (Edwards 1969,13).

CHAPTER 4 NOTES

1. The Electric Lighting Committee comprised 12 of the 24 SMC aldermen. Its composition was relatively stable in the three year periods between Council elections. Between 1919 and 1924 the average length of service on the committee was 3 years. The greatest turnover was in 1922 when 5 new members were appointed.
2. Its decisions were subject to the ratification of the full Council. As late as 1913, matters as trivial as the acceptance of a tender for the purchase of empty cases from the Electric Light Store still had to be referred to the committee (SMC/ELC 12.5.13).
3. In 1913 a report commissioned by the Lord Mayor on the workings of the various departments of the Council stated:

"The Electric Light Undertaking is the one Department of the Municipal Council which is capable of demonstrating that its work is being economically and efficiently carried out, and freed from Municipal routine and patronage, would be able, by comparison with other Electric Light Undertakings, to show the profits which were commensurate with the volume of business transacted" (SMC 1913,580).

4. This crucial difference of perception was graphically illustrated by a 1922 report on the ELD by the accounting firm of Smith and Johnson, and the reaction to it by the General Manager of the ELD, H.R.Forbes Mackay. In order to evaluate the success of the ELD, the investigating accountants were forced to assume its objectives:

"Doubtless the original conception to embark upon an Electricity Supply undertaking was due to the consideration of, firstly, that the City should enjoy an efficient lighting scheme, and secondly, that the profits derived therefrom should go in relief of rates" (Smith and Johnson 1922, 15).

The response by Forbes Mackay is itself a history of the lack of policy of the Council, and of his own part in filling the vacuum:

"Messrs. Smith and Johnson base practically all their comments, criticisms and recommendations on the assumption, which they themselves make, that the Council's policy has been to operate the Electricity Supply Business as a commercial concern, the object being to earn the largest possible return on capital invested. I believe this to be a mistaken assumption. For ten or twelve years, up to 2 or 3 years ago, at short intervals, the Council has been asked by me to indicate what its policy was, but no policy was indicated. Therefore, as Head of the Department, I had to shape my own policy.

That policy was to sell electricity at the lowest price at which it could be sold without making a loss, to as many people in the metropolitan area of Sydney, for as many different purposes as practicable. The Council, as constituted up to the end of last year, undoubtedly favoured this policy, though a definite resolution to that effect was never passed. The present Council passed a few weeks ago a resolution which seems to show that its policy is now practically what I, without instruction, have followed in the past. The resolution is as follows:

"That the policy of the Council's Electricity Supply Undertaking be laid down as follows: (a) To produce electric light and power at the lowest possible rate; (b) To produce sufficient to cover working expenses, interest, sinking fund, depreciation, and allocation of a maximum of one percent (1%) towards the relief of rates" (quoted in Smith and Johnson, 1922, 95 *ibid*,95).

5. The only years in which there was a contribution to the rates were 1918 (L 22,000), 1922 (L 33,000) and 1923 (L 30,592). This represented an average return on capital of 0.6% of total capital investment in those years.
6. The estimates did not prove particularly accurate, even after several revisions at the request of the Civic Commissioners. Forbes Mackay's explanation was "that the rate of growth in the consumption of electricity had not increased as fast as, when preparing the estimates, he had anticipated it would grow" (SMC/CC 1928,79). The growth in sales was only 8.4% in 1928, compared with 18.4% in 1927.
7. The British consultant largely responsible for the initial planning of the power station in the 1890s, P.Cardew, had suggested an economic limit for the site of less than 8 MW in 1900, and revised it to nearly 50 MW in 1909, if the boiler house was extended (SMC 1909,617). The original power station was extended in the

early 1910s and again in the 1920s, when it reached its maximum installed capacity of over 75 Mw. The complete rebuilding of the power station was commenced by the SCC in the late 1940s and completed by the ECNSW in the early 1950s, with an ultimate capacity of 200 MW.

8. The SMC was unable to install new plant until 1921, by which time sales had more than doubled (SCC 1935,19). The system load factor increased from 31% in 1913 to 40% in 1919 and remained at that level throughout the interwar years (SCC 1935,34). An enforced slowing in the rate of supply expansion therefore contributed permanently to more efficient use of generating resources (viz SCC 1935,34). So did the interchange with the RD. The peak power taken by the SMC in the early 1920s was equivalent to 20% of its own capacity (Pearce 1924,19). The average price paid by the SMC was higher than its own average production costs, but less than the marginal cost of installing extra capacity for peak load (Smith & Johnson 1922,16).

9. He criticised on economic grounds the Council's earlier decision to extend Pymont rather than to take supply from the Railway Commissioners, as Forbes Mackay had recommended at the time (Pearce 1924,17). As to the options for future supply expansion, Pearce stated

"My view is, therefore, most definitely that the new source of supply for the needs of Sydney after 1929 should be provided by the Railway Commissioners, and that the City Council should continue the policy of purchasing their requirements from the Commissioners, other than those provided at Pymont" (ibid,22).

He estimated that a decision on a new power station would not have to be made until 1929 on the assumption of about 15% annual energy and demand growth on the SMC system and continuing interchange with the RD system, (ibid,21).

Pearce was also asked to report on the location of a new power house, and specifically on whether it should be sited near a source of coal. As early as 1914 the SMC expressed the view that the acquisition of a mine near Sydney would assure a constant supply of coal at a reasonable price, a concern made more urgent by the war-time coal strikes. Advertisements in the press drew dozens of offers of coal properties in the period to 1922 (Anderson 1955,79). In January 1921 Forbes Mackay recommended to Council the purchase of the Balmain colliery to supply Pymont and the purchase of the site adjacent to the colliery for the location of a new power station, but the Council was by then no longer interested (ibid,80).

Pearce considered four possible sites: on the South Coast near the mines, on the Georges and Parramatta Rivers and on Botany Bay. He rejected the remote sites on the grounds that the cost of transmission would be too high, but acknowledged that technological developments would make remote generation progressively more attractive (Pearce 1924,24). The Botany Bay site which was eventually chosen, and where Bunnerong power station was built, was narrowly placed first in order of priority for detailed investigation, followed by the Georges River site.

10. A Royal Commission appointed by the government to inquire into the Bunnerong contracts led to the prosecution and conviction for bribery of the Deputy General Manager of the ELD, S.Y.Maling, and his subsequent dismissal by the Civic Commissioners (SMC/CC 1928,697). A Labor Alderman, Frank Green, was prosecuted for collusion with Maling but not convicted.

The Commissioners also revised some aspects of the organisation and operations of the ELD, along lines long advocated by its General Manager Forbes Mackay. In 1928 the Electricity Accounts Branch was transferred to his direct control from the City Treasurer's Department, and the Sales Branch was reorganised (ibid,53).

11. Despite some inclination to take independent action at the beginning of their two year administration, the Commissioners like the Council before and after them took the advice of Forbes Mackay in technical and pricing matters. In 1922 Smith and Johnson had recommended that "an expert Business Manager be appointed to take charge of the business and financial side of the Undertaking", to which Forbes Mackay responded

"There is no case known to me of a big electricity supply undertaking in the British Empire being under the control of any kind of man except an engineer..." (Smith and Johnson 1922,19,101).

The Civic Reform Association which represented conservative political interests on the council, favoured a board similar to the Railway Commission, to insulate the ELD from the kind of political interference which, they claimed had been exercised by the Labor aldermen (SMH 30.11.1929). There was also some suggestion that a permanent board would be better able to supervise and direct the activities of Forbes Mackay, who had increased the autonomy of the ELD during the Civic Commission. He was criticised for "dictatorial methods" by a leading Civic Reform member of the electricity committee, who remarked that anyone who wanted information from the ELD had to "drag it out, dig it out, or bomb it out" (SMH 21.10.30,26.2.31.)

Before the necessary legislative changes could be made, however, the Lang Labor government was returned to office.

12. Actual load growth in comparison with forecasts by Pearce :

	MAX DEMAND (MW)		ENERGY SALES (GWh)	
	Forecast	Actual	Forecast	Actual
1925	64	71	255	202
1926	74	80	294	236
1927	85	93	338	278
1928	97	124	388	301
1929	110	124	446	348
1930	24	111	513	333

This suggests that the SMC could have continued to meet its peak load with the assistance of the RD, and probably most of its energy requirements from Pyrmont until well after the depression. J.T.Lang, the Labor premier of the time, took a more benevolent view of the decision to build Bunnerong:

"It is human nature that evil things should be remembered when good things are forgotten. An amount of L 10,000 did change hands, and ruined many reputations in the process. But it was only a very minor consideration when the magnitude of the achievement in construction is realised. If Labor had not built Bunnerong in the twenties, it could not have been built during the Depression. There would have been no money.

That would have meant that we would have probably been unable to supply our wartime industries with power. there could have been a disastrous collapse in defence supplies when they were needed most" (Lang 1956,370).

13. Competition from the remaining private electricity companies was a major concern for the Council in the 1900s. Although, unlike the Council, they were geographically constrained in their area of supply, their sales continued to grow even after the Council laid cables past their supply areas. The sales of the Empire Electric Lighting Company, for example, increased by 24% in the year to June 1906. (SMC/TC 1905,292,315).

The persistence of the private companies growth limited the return on the capital which the SMC had to invest in, any case, to supply its own consumers, and therefore slowed the rate at which Council costs could be lowered. There was also evidence that the companies were building up business at a loss, in order to inflate the price they could exact from the Council at the time of purchase, which they considered to be inevitable: the Empire Electric Company had approached the Council to discuss sale as early as 1903 (Anderson 1955,35).

In his report of 1906 the Town Clerk discussed at length the options of competing with the companies, or of purchasing them. It was estimated that financing the purchase of the Empire Company would add about .125d to the cost of each unit produced, or about 6% of the average 1906 cost, while the increased scale of production would lower the cost by .25d (SMC/TC 1906,211). Apart from the economic reasons, an "ethical" argument was advanced, based on a concern for the welfare of private capital which would have been unthinkable under later Labor control of the Council:

"No man would regard with favour the prospect of gradually losing his capital by reason of competition with a public body, of which he is a member, and to whose funds he had to contribute" (ibid, 210).

The Council was also sensitive to competition from other quarters. It reprimanded the Railway Commissioners for supplying electricity to an itinerant circus, and for continuing a long-standing arrangement to light the Sydney Cricket Ground (SMC/TC 1905,272). It also protested formally to the premier against the proposal of the Professor of Electrical Engineering to establish a power station to supply the Sydney University precinct (ibid). The proposal is described by Scott(1909). The paper makes no reference to the possibility of taking supply from the SMC.

In 1913 the Council purchased the only other municipally owned undertaking in Sydney, that of the Redfern Council, because increasing industrial development to the south of the city promised to stimulate the demand for electric power and possibly establish Redfern as a serious competitor (SMC 1913,445).

14. The SMC introduced the hire of arc lamps and electric motors in 1906 (Anderson 1955,34). It also introduced a full contract lighting service in 1909, under which it supplied and maintained arc lamps and lit them to an agreed schedule (SMC/TC 1909,164). The latter scheme was only moderately successful and was phased out in the 1920s. Motor hire continued until well after the second world war.

15. Special cases multiplied: in 1909, for example, the Master Process Engravers' Association of NSW applied successfully to the Council to have electricity used in lamps during the day time for exposing printing plates charged at power rates (SMC/TC 1909,152).

16. This, together with rising capital expenditure on the Bunnerong power station, contributed to several years of losses. In 1928 the Civic Commissioners planned to eliminate the deficit by raising prices to the full extent allowed by the 1920 tribunal, but this was obviated by a fall in the cost of generation due to the completion of the more efficient Bunnerong power station, and a 15% surge in sales, due partly to a long and severe winter (SMC/CC 1929,53).

17. Consumers were grouped as residential, commercial, factory or 'church', and the distinction between lighting and power was removed for all consumers except factories (SMC/CC 1928,81). Maximum demand tariffs were no longer available to residential consumers, but became obligatory for commercial users. The first explicit time of use feature, an offpeak water heating tariff, was introduced.

18. In 1905 the ELD appointed a "canvasser" to counter the publicity of the private companies and to counteract AGL's propaganda. The Town Clerk's reports of the 1900s devote considerable space to discounting the latest rumours of reversion to gas lighting in British cities (SMC/TC 1905 & 1911).

The ELD established a formal Publicity Branch in 1909, specifically to promote the newly introduced metal filament lamp. This was a cheaper, more durable and more efficient form of incandescent lighting than the carbon filament designs it replaced - so efficient, in fact, that the consumption of energy for lighting declined in the short term, and promotion was considered necessary to recover sales (SMC 1909, 164).

19. The SMC marginal power tariff increased slightly in 1921 but declined steadily from 1923. In 1933 the SMC introduced a promotional "cooking" tariff which reduced by 20% the price of all marginal power (ie beyond the first high price block) in households with electric ranges. In 1913 the price of electricity for cooking had been nearly 500% higher than the price of gas (per unit of delivered energy). By 1937 it was only 60% higher.

20. In February 1927 the ELD established a city showroom to demonstrate and sell domestic appliances and commenced mobile promotions from trucks in the suburbs. Appliances purchased from the ELD were installed free of charge (Anderson 1955, 109). During the period of the Civic Commission, these activities were fully integrated into the main Sales Branch, which by 1929 comprised Industrial, Commercial Illumination, New Buildings, Motor Hiring and Domestic Sales and Service divisions (SMC/CC 1929,53).

These developments were welcomed by appliance manufacturers but not by the electrical retail trade, which believed that the Council was making a loss on its sales activities, and therefore competing unfairly (SMH 13.6.1930,13). The Commissioners tried to justify the activities on the grounds that they increased electricity sales, even if they did not show a trading profit (SMC/CC 1929,56).

When the Council was restored the retailer organisations took their protests not only to the Lord Mayor but to the government, which tried to make arrangements acceptable to all parties (SMH 13.6.1930,13). This proved impossible, and the promotion and sale of appliances by the Council continued.

21. The Sydney Municipal Council Electric Lighting Act of 1896 gave the Council power to supply electricity in adjoining municipalities, with their consent. During the period 1904 to 1909, before the Electric Light and Power Supply Company commenced operation, the City Council was the only practical source of supply for the inner suburban municipalities, several of which approached the Council to discuss possible arrangements.

The first approach was from Glebe, which in August 1904 broke off its street lighting contract with AGL over the issue of levying rates on the gas mains, and reverted to kerosene lighting (SMH 2.8.1904). The SMC replied that supply was still being extended to parts of the City, but could be available to Glebe within twelve months. The Glebe council then decided to construct a combined garbage destructor and power station and applied to Parliament for an enabling bill (SMH 5.10.1904). This bill was withdrawn in favour of the more general Municipalities Electric Lighting Act, 1904, which gave all municipalities the power to construct electricity works, but subject to a referendum of ratepayers which made the powers almost unusable, even for councils which could raise the finance.

There was some suspicion in the Legislative Assembly that this ostensibly democratic provision had been inserted by the Legislative Council (with the approval of all 12 AGL shareholder MLCs) to "prevent the machinery of this bill from working properly" (NSWPD 20.10.1904). It was reported that Glebe council's decision to introduce the electric light was opposed by many of its rate payers (SMH 7.11.1904). The effect was to leave Glebe, and all other suburban municipalities, even more dependent on external suppliers, and to enable the City Council to seek favourable conditions for supply extensions.

The first extension beyond the City boundaries was to Paddington in 1905. It was at the request of private consumers including the Benevolent Society of NSW, which had constructed a new wing for the Royal Hospital for Women that was dependent on a supply of electricity to operate the lifts and lighting (Anderson 1955,36). The City Council eventually negotiated an agreement which allowed the Paddington council to levy rates on the mains, and the City Council to recover the extra costs in higher local prices.

No further extensions were made until 1910. In the intervening period the Council was approached at various times by Glebe, Randwick, Waverley, Woollahra and Newtown councils, and by private consumers outside the City. Each request was considered ad hoc, and negotiations broke down over various issues. Glebe wanted the right to purchase the Council's mains after 10 years, whereas the Council considered 25 years a minimum (SMC/TC 1909,172). Woollahra wanted only underground mains (ibid,171). In the case of Randwick the potential private load was considered economically attractive, but not the street lighting load unless the adjoining councils also took supply (ibid).

22. The Borough of Balmain Electric Lighting Act 1906 empowered the Balmain council to contract with the ELPSC and to supply other municipalities, and so effectively became the medium by which the ELPSC could compete with the SMC. In October 1909 the Lord Mayor hurriedly called a conference of suburban municipalities to discuss general conditions for supply extension (SMC/TC 1909,173). Of the seven municipalities which sent representatives, Newtown, Ashfield and Petersham soon made agreements with the Balmain Corporation. With the suburban municipalities now negotiating from a position of some strength, the City Council immediately became more accommodating. In 1910-11, six municipalities entered into agreements which specifically limited the local price, rather than simply tying it to movements in the City tariff as the Council wished (SMC/CC 1928,84).

This episode clarified for the suburban councils the divergence between their own interests and those of the City Council, and showed them how the possibility of an alternative supplier strengthened their position. It also strengthened the ELD's position by convincing the Council of the need to increase its efforts to expand rapidly.

23. The suburban extension of the City Council's supply area became identified with the Greater Sydney issue for the municipalities north of the Harbour, and so was seen as a threat to their autonomy. Addressing a meeting held to discuss the supply of electricity in the northern suburbs, an alderman said:

"It may be very nice for Mr. Nesbitt [the Sydney Town Clerk] and the City council to want us to take the Electric Supply from them, but the more we connect ourselves with Sydney, the more we will encumber ourselves with a Greater Sydney. Their electric light cables will be the first loop around our legs, and the next thing will be that the *lassoo* of a Greater Sydney will have settled around our necks and we will be inextricably tangled in it" (Anderson 1955,49).

In January 1911 the SMC instructed the Electric Lighting Committee to consider the advisability of forming a "Metropolitan Lighting Trust" to absorb all the gas and electricity companies, municipal or otherwise, in the metropolitan area. The Committee recommended that a decision should be deferred pending the decision of Parliament in regard to the Greater Sydney Scheme (SMC/TC 1911,187).

The SMC had to actively court the northern municipalities if it were to extend supply across the harbour, as Cardew recommended in his March 1909 report (SMC 1909,609). In September of the same year the northern municipalities indicated their intention to follow Balmain's example, by seeking the enactment of the identically framed North Sydney Electric Lighting Bill. The Electric Lighting Committee wanted Council to petition against the bill, as it had done against Balmain's bill, on the rather petulant grounds that the provision to contract out gave "...certain rights which had not been given to the City Council..." (SMC/TC 1909,169). The Council declined to oppose the Bill, however, possibly through awareness of the damage such action would have done to its standing with the municipalities. The Bill was stopped twice by prorogation of Parliament and, with the election in 1911 of a Labor government hostile to it, not reintroduced.

In 1912 some members of the North Sydney Council were still determined to contract with a private company, despite the fact that the Municipalities Electric Lighting Act gave no powers to do so (SMH 10.10.1912). In

March 1914 the council were addressed by Forbes Mackay and by W.H.Gosche of the North Sydney Electric Light and Power Corporation, which was supplying some private consumers in the area. Gosche argued that a local, private and smaller scale plant would be able to supply power at lower cost than the City Council, and offered to absorb the costs of any rates the local council may impose (SMH 17.3.1917,30.4.1914). Forbes Mackay countered with the case that the local tariffs would be tied to the City tariffs, which would soon be dropping. He was evidently successful: the northern municipalities entered into supply agreements within the year.

24. Percentage of gross capital expenditure, and revenues received, attributable to the suburban part of the SMC electricity supply system (Source: Smith & Johnson 1922,77).

	CAPITAL EXPEND	REVENUE
1913	32	16
1914	37	23
1915	42	23
1916	43	24
1920	50	43
1921	52	48

25. Generation at Ultimo was originally at 600 V DC at 25 Hz, but was changed to AC and the voltage increased to 6.6 kV in 1902. The 25 Hz frequency was retained because the technology of the time made it more convenient to rectify locally to DC (PWD/Upton 1982,42). This meant that, until the commencement of 50 Hz generation at White Bay power station in 1925, the rate of energy transfer between the railway system and the SMC was limited by the capacity of the mechanical frequency changers installed (RPT 1937,72,TED 1929,162).

26. The Act also authorised the Railways to supply buildings and industrial works belonging to the Crown without obtaining the consent of local supply authorities.

27. The early history of council is outlined in a 1932 commemorative publication, "Twelve Years of Progress" (SGCC 1932). In 1918 the adjoining municipalities of Bexley, Hurstville, Kogarah and Rockdale requested the SMC to extend reticulation to their area. The SMC, which had been unable to obtain plant during the War, advised that it would not be able to provide supply for at least 5 years. In 1919 the Railway Commissioners announced their intention to electrify the railway line passing through the district, and were approached by the Sutherland Shire for a supply of electricity in bulk (SGCC 1932,13).

At the instigation of the President of Sutherland Shire, the other four municipalities constituted themselves into a County District in late 1920 and negotiated a bulk supply agreement with the Railway Commissioners. Sutherland itself did not in fact join the county, since the Railway Commissioners declined to extend transmission there until 1925.

28. The Minister also acknowledged the influence of the water hyacinth:

"I may say that the establishment of county councils in this State was due to a small local circumstance. Some years ago, by a combination between municipal and Shire Councils in the Richmond River district, a voluntary joint board was established to deal with the Water Hyacinth pest in the Northern Rivers district, and the success of that body led to the introduction into the bill of the clauses which now give authority to establish the county councils, and which will govern you in your work" (SGCC 1932,21).

29. The SGCC raised a loan of L 100,000 in 1921 for the construction of the distribution infrastructure. The constituent councils levied a special rate in 1922 to cover the initial loans, but this was phased out by 1928, and all subsequent loans were repaid from revenue.

30. Average prices (d/kWh) paid by SGCC to the RD and received by SMC for bulk sales (sources: SGCC/TYP 1932,67, SCC 1935,25).

	Paid by SGCC	Received by SMC
1923	1.603	1.571
1924	1.221	1.517
1925	1.132	1.356
1926	1.323	1.434
1927	1.076	1.413
1928	1.094	1.411
1929	1.113	1.347
1930	1.038	1.096
1931	0.885	1.002
1932	0.847	0.992

31. This provision was again controversial, and again opposed bitterly by the Labor members who maintained that the municipality should be obliged to construct its own power station, or at the very least, contract for supply with the City Council. To this the member for Rozelle replied "No, they want local government!" (NSWPD 31.7.1906,742).

A draft contract was drawn up and presented to the ratepayers, who endorsed the measure by a majority of 3 to 1 at a referendum. The supporters of the bill pointed to its local popularity, and the urgent need for public electricity supply in the heavily industrial suburb of Balmain. They noted the inability of the council to raise the finance to undertake the work itself for the present, its right of ultimate purchase, and the fact that the provisions for contracting out limited local tariffs to no more than the City Council's. The measure was passed, ultimately, not because Labor was convinced by argument but because on this occasion they did not have the numbers, or the influence with the government, to successfully block it.

32. The ELPSC had to take some risks in order to take advantage of new technology and economies of scale in generation. Each step represented a far greater proportional increment than for the City Council: capacity was doubled by a single new 7.5 MW turbo-alternator in 1924, and new sets in 1928 and 1935 increased total capacity by 68% and 76% respectively.

33. If it had no rates or taxes to pay, the ELPSC could have retailed electricity at the same average price as the SMC and still returned a 6% dividend to shareholders (the approximate level of the prevailing bank interest rate). It was also efficient in terms of energy use. It supplied waste steam to a chemical plant on the adjacent site, and supplemented its fuel requirements with the disposal of about 50 tons of urban refuse per day, as required under the terms of its agreement with the Balmain municipality (RPT 1937,73).

34. Around 1949 the ELPSC acquired the Parramatta and Granville Electric Supply Co, which had been formed in 1913 and was taking bulk supply from the Railways. The ELPSC then supplied Parramatta in bulk from its Balmain power station.

35. Most accidents involved employees, but faulty building wiring and appliances increased the risks of fire, electric shock and supply disruption to the public. A "wireman" for the SMC stated in 1910 that faulty installations were the chief source of disturbance on the mains, and that

"Although the standard of work is much higher than it was 20 years ago, there is still plenty of bad work carried out and always will be while we have the jerry contractor with us..." (EAssNSW 1909-10,49).

36. The sponsor of the bill referred to recent events: a fire at Anthony Hordern's old building at the Haymarket had been caused by an electrical fault, and defective installations at both the Hotel Australia and the newly completed Mitchell Library had to be replaced. Petitioners for the Bill included the Electrical Employers' Association of NSW, the Society of Architects and the Master Builders' Association (NSWPD 4.8.1910,1405).

37. The question of licensing electricians was raised regularly between 1915 and 1924 by several organisations including the SMC, the Electrical Employers' Association and the Electrical Trades Union (NSWPD 9.12.1924,4280). Electricians had been licensed in Queensland since 1906, and in Victoria since 1918 (ibid,4281). In NSW, however, the only licensing powers were those given to county councils by the Local Government Act 1920, until the Electrical Contractors Licensing Act 1924 finally set up a general Board for that

purpose. Several amending acts were still required to make the scheme workable. The Board did not become fully operational until 1929, and did not acquire sufficient staff to carry out its functions until 1932, the year in which the Standards Association of Australia released the first SAA Wiring Rules (ECELBNWS 1932,4). The Board still complained of inadequate legislative power, especially its inability to prevent the sale of dangerous appliances (ibid,5).

38. Members said in debate:

"...there will be an amalgamation or a consolidation of companies, so as to provide one of those giant enterprises which will carry on the work of electrical contracting with one licensed employee in its employment" (NSWPD 2.12.24,4095).

"The only objection which has been raised against the licensing of employees comes from the employers. The employers say that if the employees are licensed they can create a closed corporation and regulate their working conditions and rates of pay" (ibid,9.12.24,4282).

The succeeding Lang Labor government amended the Act in 1927, to specifically include the licensing of individual electricians.

The composition of the proposed five member licensing board was another cause of opposition to the legislation. There was general support for appointments by the government, the SMC and the Fire Underwriters' Association. However, some members were uneasy about a representative of the contractors in the absence of any employees, and about the joint representative of the Local Government Association and the Shires Association:

"We may expect that to fill the position some tinpot alderman will be elected, of the type which has disgraced the Metropolitan Board of Water Supply and Sewerage for the last quarter of a century" (NSWPD 20.11.1924,3849).

Local government interests were by that time strongly identified with electricity distribution, however, and their representation on the Board appears reasonable.

39. One Labor member expressed a point of view which seemed eccentric in a debate on public safety, but which touched on the changes that electricity brought about in the relationship of individuals to the energy system. He maintained that "if a man has the capacity and the energy to install electric light in his own home he ought to be permitted to do so", and that the intrusion of licensed experts into every aspect of life was "destroying the initiative of our people" (NSWPD 20.11.24,3847-9).

Even with the operation of the legislation, there were 21 electrical fatalities in 1932/3 (compared with 27 in 1986/7, when there was far more electricity consumed in NSW). In recording the electrocution of a man while wiring an additional power point in his Hornsby house, the Board adds: "Incidentally committing a breach of the Act" (ECELBNWS 1932-3,4).

40. A strike of Sydney gas workers in March 1913, over the mechanism for fixing wages, led to the involvement of first the Minister for Labour and Industry, and then the Premier himself, in negotiating a settlement (SMH 13.3.1913).

41. In early November 1916 the Federal Government commandeered nearly all of the stocks held in NSW, except those of the railways, in order to ensure essential war-time naval services (NSWPD 16.11.16,2764). The SMC submitted a draft rationing bill to the Attorney General (NSWPD 17.8.17,625). On 16 November, when the SMC had only enough coal for four days and AGL for one week, the government introduced the Electric Lighting and Gas Emergency Bill 1916.

Debate on the Bill was coloured by the ideological issues surrounding the coal strike, and the fact that it took place only one day after the governing Labor Party had split and the premier, W.A.Holman, had formed a new National Party government in coalition with conservative members. The central objection advanced by the Labor Party faction now in opposition was that the government could resolve the situation directly by legislating for an eight-hour day for the miners, and so meeting one of their principal claims. Bills for this purpose had twice been passed by the Legislative Assembly since 1912, but stopped by the Legislative Council (NSWPD 16.11.16,2766).

It was argued that it would be preferable to bring matters to a head sooner rather than later, and that making the situation tolerable would prolong the strike (ibid). There was also objection to the rationing system proposed.

Street and domestic lighting were to be maintained in preference to power for factories, of which nearly 2000 were said to depend on electricity (ibid,2761). One Labor member said:

"As one of the representatives of the toiling masses, I want them to be retained in their occupation in preference to taking special measures to promote the convenience of the people at Potts' Point" (NSWPD,16.11.16,2775).

42. On 28 November a further bill was introduced, to extend the provisions of the emergency act to all electricity supply companies in NSW, and to constitute a separate control board for the purpose (NSWPD 28.11.16,3065). The restrictions were lifted on 12 December 1916, however, before the bill was returned by the Council (Anderson 1955,86).

43. In the meantime the SMC became rather attached to the Act, regarding it as a more satisfactory means of emergency load management than appeals to consumers. A City alderman MLC said that without the Act

"...we should be making farcical appeals to the people not to waste our resources by using electricity for which there was no real necessity. Instead of all that we ought to be in the position that we could put our hands on an automatic stop and compel the cessation of that waste" (ibid,626).

44. The government acted while coal stocks were higher than on the previous occasion, prompting Labor Party criticism that the action was precipitate, intended to alarm the public, and associated with a separate industrial dispute between the Electrical Trades Union and the Railway Commissioners (NSWPD 16.8.17,577).

In 1914 the ETU adopted the Labour Council policy not to strike during the war, but in 1917 it triggered a transport strike over the introduction of a "card system" to monitor the progress of jobs at the Randwick railway workshops. This led to the jailing of strikers, the sacking of unionists and the creation of a separate public transport electrical union (Pola 1982,28).

The bill was enacted on 18 August 1917. The restrictions, though less severe than in 1916, remained in force for almost 3 months (Anderson 1955,68).

45. Most of the electricity bills and acts of the 1880s had set a maximum price of about 12d/kWh. The Borough of Balmain Electric Lighting Act 1906 tied the Balmain tariff to the SMC's. The SMC's average revenue was 3.06 d/kWh in 1904 and decreased nearly 40% to 1.88 d/kWh by 1914 (Forbes Mackay, 1914).

By contrast, the decline in AGL's gas tariff over the period 1897 to 1912, when sales volumes more than doubled and gas making technology advanced significantly, was only 12%, from 51 d/1000 cu ft to 45 (AGL minutes).

46. It was introduced by A.C. Carmichael, the Minister for Public Instruction, who justified the need for such controls by citing AGL's remarkable record of profitability. For the previous 30 years it had paid an annual dividend of 15% on the nominal value of each L6 share invested in it, while building up reserves nearly equal to its legally authorised capital:

"That was not the only thing this happy company was able to do. We, in this House, imposed an income-tax. The company said to its lucky shareholders, "We do not want you to pay the income-tax. There is a fool of a public who will pay it for you. Out of the excess profits of the company we will pay you 15 per cent. dividend, and put L10,000 or L20,000 a year into the inner or hidden reserve, and, in addition to that, we will pay the income-tax..." (NSWPD 28.8.12,771).

47. This objection was eventually met by a provision for passing on any adjustments in wage awards to consumers, as variations in the standard gas price prescribed by the Act (SMH 6.12.1912). In the 1920s the gas companies were suspected of using the wage adjustment provisions of the Gas Act to pass on unjustifiable expenditures to the public. The judge hearing an application for a price increase by the Manly Gas Company in October 1924 gave the opinion that increased expenditures should be not only better documented but also justified (NSWPD 24.2.26,383). Accordingly the Lang government amended the Gas Act in 1926 to provide for investigation of the gas companies' accounts by officers of the Department of Labour and Industry, who administered the Act and so were better able than the Auditor General to unravel the intricate accounting practices of the companies (ibid,381). The amendment also made provision for a three person board of inquiry to hear applications for price increases, so releasing judges from a time consuming duty, and one for which they were not considered to be particularly qualified (ibid,384).

48. In March 1921 the SMC and the ELPSC were jointly granted a price rise by a supreme court judge. In the mid 1920s the Council voluntarily reduced its prices again in line with its non-profit policy (SMC 1929,80).

49. The Burrinjuck dam had been built to utilise the waters of the Murrumbidgee for irrigation purposes, and the Nymboida scheme was associated with water supply works for the towns of North and South Grafton (NSWPD 5.11.19,2413). The Burrinjuck scheme was completed in 1928 and operated by the PWD, which by 1936 was supplying power in bulk to 14 local government areas and the City of Canberra (RPT 1937,77). The Nymboida scheme was completed in 1924 and operated by the Clarence River County Council formed in the same year (ibid,79).

50. The first formal association which came to be directly connected with the industry in NSW was the Engineering Association of NSW, formed in 1870 (JIEA 1970,85). It was a forum for the discussion of all aspects of engineering, and its Proceedings printed several papers on electrical theory and design from 1886 on.

51. The Electrical Association of NSW combined with the Victorian Institute of Electrical Engineers in 1914 to form the Electrical Association of Australia (EAssNSW 1919,201). In 1919 the latter combined with the original Engineering Association of NSW, the Sydney University Engineering Society and the Western Australian Institute of Engineers to form the Institution of Engineers, Australia. In due course special interest groups were formed such as the Electricity Supply Engineers' Association of NSW, consisting of engineers in the smaller local government electricity undertakings (SMH 28.4.31).

52. This was by no means the only union in the industry in NSW: there were subgroups of electrical workers within the Postal and Public Transport unions. Relations between these groups, locally and federally, were not always harmonious (Pola 1982,29,73).

53. H.R.Forbes Mackay, general manager of the SMC electricity undertaking, was at the centre of these moves. In 1914 he became one of the first three members of the NSW council of the Electrical Association of Australia (EIANSW 1919,201). He was instrumental in the establishment of the ESAA in 1918 (Allbut 1958,89) and in the formation of the EDA in 1924, securing substantial financial support for it from the SMC.

54. The average value of imported electrical and wireless apparatus in each of the four years preceding the depression was L5.3 million (Windett 1933,194). This fell to L1.2 million in 1930/31, and in the following four years the value of Australian manufacture of those items increased from L3.4 million to L6.6 million (AYB 1937,806).

55. A factory established locally in 1931 was capable of meeting almost all of the demand for light bulbs, which alone had accounted for almost 12% of the value of imported apparatus. However the price per bulb was over twice the price of imports and the local manufacturers requested tariff protection (Windett 1933,198).

56. The Railway Commissioners estimated that the loss of business to private cars was equivalent to 10% of suburban trips and 17% of country trips in 1929/30 and caused over a third of the year's operating losses (RCNSW 1929-30,4).

57. The horse bus had been declining for decades under competition from the tram, and was finished off completely by the motor bus immediately after World War 1 (Hovenden 1981,31).

The motor vehicle overtook the horse in Sydney earlier than in the rest of NSW. Hovenden estimates that in 1916 45% of the state's 1148 registered cars and 71% of the registered trucks were in the metropolitan area, which had 41% of the population at the time (ibid,56-60). Between 1915 and 1935 the number of horses per head of human population in NSW halved, while the number of motor vehicles per head increased nearly ten-fold. Horses still outnumbered motor vehicles 2 to 1 in NSW in the mid 1930s, but most of these were in rural areas where they remained in use for traction and for personal transport until after the war:

HORSES AND MOTOR CARS PER CAPITA, NSW 1900 - 1936

YEAR	HORSES	YEAR	CARS	LORRIES
1900	0.35		*	0
1905	0.34		*	0
1910	0.40	1911	0.002	*
1915	0.39	1916	0.008	0.0005
1920	0.31	1921	0.013	0.0018
1925	0.28	1926	0.044	0.010
1930	0.21	1931	0.056	0.015
1935	0.20	1936	0.068	0.025

* negligible (Sources: YBA, NSW Commissioner for Motor Transport, 1980/1).

58. The electrification of industrial power was necessarily matched by the increase in central generating plant, though it must be remembered that such plant also supplied power to non-industrial users. The progressive centralisation of the state's energy system is indicated by the ratio of power in central plant to that in factories. This increased from about 0.23 in 1901 to 1.32 in 1936.

Another quantitative indicator of changes in the production process is the mechanical power available per factory employee, which increased from 0.83hp in 1901 to 2.27 in 1936. The latter was about the same as the British figure of the time, and half that for the USA (Woolf 1984,177). The ratio actually dropped between 1901 and 1906 as small-power electric motors were substituted for steam engines, and boosted artificially in 1931 by the reduction in factory employment during the depression.

59. The statistics do not separate major industries with different energy characteristics, such as steelmaking and general engineering, which are grouped as "Industrial metals, machines and conveyances". It is reasonable to attribute all industrial coke use to steelmaking, which was located then, as now, at Pt.Kembla and Newcastle.

60. AGL industrial sales for 1933/4 were 700m cu ft, equivalent 112 GWh. SMC sales for power (mostly industrial but including some old-tariff domestic sales) were 145 GWh, and 52 GWh for "kVA"(ie maximum demand metered) factory supply (SCC and AGL data).

61. ESTIMATED RESIDENTIAL ELECTRICITY CONSUMERS, SYDNEY 1933

	TOTAL	RESIDENTIAL	SOURCE
SCC	209,700	175,800 (84%)	SCC 1935
ELPSC	28,700	22,960 (80% est)	TED 1939
SGCC	26,000	23,400 (90% est)	SGCC1932a
SYDNEY	264,400	222,160	
AGL	250,794	na	

The ratio of connected households in the SCC area was nearly 97%, much higher than the rest of Sydney, 79% of the 280,063 dwellings in Sydney as a whole are connected to electricity

The number of AGL, NSG and MGC residential consumers in 1933 is not available. However, AGL recorded in 1928 that "Of the nearly 60,000 new building erected in the Company's area in the past seven years, the number of buildings served by gas increased from about 89% to 96% of the total existing" (Broomham 1987,123).

62. Radiators, kettles, irons, ovens, toasters and hotplates and motor appliances such as sewing and washing machines could all be purchased in Sydney from the mid 1900s (Building 15.6.1908,70). By the 1920s continuous hot water systems, refrigerators and vacuum cleaners, some of them Australian made, were also available (AET 27.4.22,190).

63. Statistics compiled around 1920 by a distributor of American appliances indicated that 75% of connected households in Australia had electric irons, 20% toasters, 7% fans and 2% vacuum cleaners. All other appliances were present in 1% or fewer (Batson 1927,22). A survey by the SECV in late 1925 found that 100% of new domestic consumers were purchasing irons, 11% kettles, and 6% grillers: all other appliances had lower penetration (AET 27.1.1926).

64. Estimated from Forbes Mackay's comment that the consumption of these consumers was "frequently L 1/10/- to L 3 per annum"; the tariff at the time was a flat 5d/kWh for lighting and 2d/kWh for power.

65. The need for publicity was naturally supported by the trade press, which lamented that "Australia is electrically backward" (AET 27.3.22,115). It was also supported in a 1927 report on marketing electrical equipment in Australia, prepared for the USA Department of Commerce:

"The use of electrical appliances in Australia is not increasing as rapidly as it should. To a large extent this is due to a lack of knowledge of the numerous advantages which electricity offers in the performance of household tasks" (Batson 1927,22).

While noting that promotion was increasing, the report continued:

"There have been further hindrances...The chief of these was the unreliability of electricity supply, the high price of appliances, and the high cost of energy, all of which are being rectified" (ibid).

66. In 1923 the rates for lighting and power were reduced to 4.75 and 1.7 d/kWh respectively. The tariff structure introduced in 1925 had a first block related to the floor area of the building, amounting to 100 kWh per annum at 5d/kWh for a typical 1000 sq ft bungalow. All additional consumption was charged at 1.25 d/kWh.

The average yearly bill for a 100 kWh/qr all-light user would have been reduced from L 7/18/4 to L 3/8/9, and for a 50kWh light/50 kWh power user from L 5/8/0 to L 3/8/9.

67. The SGCC established a showroom, held weekly cookery demonstrations, gave a trade-in allowance for old gas ranges, and made a contribution to electric cooker installation costs (SGCC 1932a,33). The SMC also contributed to the cost of over 5000 cooker connections during a 1934 promotion (Anderson 1955,120).

68. In 1913 the gas tariff was 42 d/1000 cu ft (=0.26 d/kWh) and the SMC power rate was 1.5 d/kWh (ie 5.8 times the price). In 1937 the gas tariff was 69 d/1000 cu ft (=0.43 d/kWh) and the SMC cooking rate was 0.7 d/kWh (ie 1.6 times the price). The greater conversion efficiency of electricity would have brought the effective prices even closer.

69. PERCENTAGE OF DOMESTIC SERVANTS IN THE NSW WORKFORCE, 1901 - 1933 (Source: NSWYB & AYB; censuses)

	1901	1911	1921	1933
As % of population:				
Male	2.8	2.2	1.9	1.6
Female	8.2	6.9	5.9	5.5
TOTAL	5.4	4.5	3.9	3.5
As % of employed:				
Male		3.3	2.9	2.4
Female	46.5	40.5	35.6	29.2
TOTAL	12.9	10.3	9.2	8.2
Ratio of "Domestics" to female "Dependents"	1:10	1:12	1:14	1:15

(Persons employed excludes dependent pensioners)

The category "domestic" included persons employed in hotels, hairdressers, boarding houses etc. The gradual decline in the proportion of women working as "domestics" may have masked a more rapid transfer of women out of the homes of their employers to centralised services (eg hairdressing, laundry) and into the accommodation industry.

Contemporary accounts suggest that household servants were becoming increasingly difficult to obtain after the 1910s (eg SMH 24.4.14) and certainly by the 1920s, though the large number of war widows may have increased the labour pool (eg The Home 1.6.20). The reasons given were that young women preferred other kinds of work with more freedom, such as the factory employment then becoming widely available. Even so the decline in

domestic work was very gradual. In 1933 it was still the largest category of female employment, well ahead of manufacturing (20%) and finance (18%).

70. AGL characteristically exploited this brief Indian summer for gas lighting by raising the rates from L 3/15/0 to L 6 per light in 1919, when the SMC was charging L 3/2/6.

71. There were also changes in the technology of gas production and distribution. As the lighting load declined and the cooking load increased in the 1910s, production methods and formulations were altered to enhance the thermal value of the gas rather than its illuminating value (AGL 1962,4). Carburetted water gas equipment, introduced progressively after 1901, allowed faster response to fluctuating demand, using as feedstock both oil and the surplus coke produced by the coal gas retorts. A network of high-pressure mains was constructed between 1908 and 1915 to increase the capacity of the distribution system radiating from Mortlake. The original Kent Street works were closed in September 1920 (ibid).

72. ELECTRICITY GENERATED, SYDNEY, REST OF NSW, AND AUST 1911-36 (GWh) (Source: NSWYB, AYB)

YEAR	SYDNEY	REST NSW	TOTAL NSW	AUST	SYD/ NSW	SYD/ AUST
1911	91.1	44.3	135.4		0.67	
1921	264.1	78.4	342.5		0.77	
1931	769.9	289.9	1059.8	2446.0	0.73	0.32
1936	1027.7	437.2	1464.9	3527.9	0.70	0.29

Note: estimates for ELPSC included

ELECTRICITY, GAS AND COAL PRODUCTION PER CAPITA, NSW 1912-35

YEAR	ELECT kWh	GAS cuft	GAS kWh	COAL tons prod	COAL domestic cons.
1912	95	2800	450	5.5	2.2
1922	180	4000	640	4.9	2.4
1928	370	4300	690	3.8	2.4
1935	510	3700	590	3.0	2.2

73. Compared with the rest of Australia, NSW was a gas-intensive state even more than an electricity-intensive one. In 1933 NSW produced about 52% of all Australian gas, and per capita gas production was about a third higher than the national average. In the same year the state produced about 42% of all Australian electricity, close to the national average per capita.

CHAPTER 5 NOTES

1. In 1920 the Storey Labor government received a report advocating the establishment of an electricity commission. This would have been consistent with party principle on state ownership of utilities, but nothing was done to give effect to this before the defeat of the government in early 1922.

2. In the 1920s clear distinctions emerged between the city and country-based conservative parties in the NSW parliament. The support of the country-based Progressive Party, whether informal or within a coalition, was essential if the Nationalists were to govern (Hawker 1971, 205). The views of the Progressives therefore carried weight with the majority parties in much the same way as those of a well organised Labor party had done in the 1890s.

It was intended mainly to bring down the price of gas, which previous judicial inquiries had been unable to achieve due to a narrow legal interpretation of the Gas Act 1912, which held that the "standard" rate of dividend was a minimum to be guaranteed, rather than a ceiling (NSWPD 17.3.32,8694). The 1932 Act provided for a permanent commissioner to inquire into prices at the minister's request, and electricity suppliers were included for reasons of completeness: of 137 electric light companies, only the SCC and the ELPSC had been subject to limited price control (NSWPD 28.2.32,7697).

The Act was framed to cover municipally owned as well as private electricity suppliers, though the former could be excluded from its provisions by the government. Not even a Labor government was satisfied that municipal ownership was of itself sufficient guarantee of an enterprise being managed in the public interest. This provision exposed differences between supplier and client municipalities. The Newcastle City Council was represented by counsel at the bar of the Legislative Council in support of its petition for exclusion, while the suburban municipalities in which it sold electricity favoured its inclusion (NSWPD 17.3.32,8708).

The clear intention of the legislation was to bring down prices to certain groups, rather than to encourage their determination by any systematic criteria. The commissioner was empowered to set lower prices for gas or electricity supplied for industrial purposes than for private purposes, and lower prices for electricity supplied for heating purposes than for lighting purposes (NSWPD 14.3.32,8509). There was also provision to ensure that any reductions in price would be at the cost of shareholders' dividends rather than the wages or conditions of employees.

4. The Labor opposition replied that the only reason the 1932 Gas and Electricity Act was not operating as intended was that it was under the control of an unsympathetic minister who would not administer it properly (NSWPD 6.3.35,6100). In its second and final annual report the Gas and Electricity Commission estimated the benefits to consumers since its establishment to be equivalent to a 1% decline in prices (CGE 1934,6). It is difficult to determine the Commission's own contribution to this, since some of its inquiries resulted not in lower prices but in increased employment in the gas industry (CGE 1934,2). Furthermore, several utilities reduced prices voluntarily to retain sales during the depression.

5. The formation of the Sydney County Council occupied the bulk of the very long debates on the bill. The other aspects were equally significant, and only slightly less controversial. Domestic gas prices were to be determined by special boards of inquiry, taking into account all costs including the dividend rate fixed by regulation, and subject to ministerial approval. This established a gas price setting mechanism which has remained in use with only minor modification ever since.

The act made the approval of the government a necessary condition for extensions of electricity franchise areas, the construction of power stations and main transmission lines. All proposals were to be referred to the Electricity Advisory Committee, which was required by the act to advise the minister.

The government had set up the Electricity Advisory Committee in July 1934, following the recommendation of a 1933 inquiry into electricity supply. The EAC had assisted in the drafting of the act and was given statutory status by it.

6. Spooner wanted local authorities to carry out rural electrification schemes in four regions: the upper north coast, the lower north coast from Newcastle to Kempsey, the south coast from Sutherland to Nowra and the inland district south of Wagga (SMH 10.3.36).

The minister's first target was the upper north coast, where the Clarence River CC had extended supply into neighbouring areas. He called a conference of the local authorities involved, and urged the creation of a greater county council (SMH 27.1.36). They were not particularly enthusiastic on the proposals, which had been prepared by the EAC, without independent expert advice of their own (SMH 17.2.36). A North Coast County Council bill was introduced in the Assembly in June 1936, against the wishes of many of the local authorities affected (NSWPD 18.6.36,4765). It lapsed with the end of the session and did not reappear.

7. Almost two years later Spooner's ministerial successor, L.O.Martin, still found it necessary to tell a conference of local government electricity engineers that he was not satisfied with some of the country councils: "They want the Government not only to provide the electric current, but also to see to its distribution" (SMH 5.3.40).

8. The EAC was put to work on the proposal with the assistance of Spooner, Deputy Premier Bruxner, and the consulting firm of Rendel, Palmer and Tritton. The latter submitted a report in December 1937 which found the scheme workable, and recommended the establishment of a statutory body to carry it out.

9. The LGA had always suspected the formation of the EAC as the first step along the route Victoria had taken, first to a generating body, and then a single controlling body for the entire state (SMH 13.1.36). The government was reported in January 1938 to be considering the inclusion of the co-ordination scheme in its policy for the impending elections (SMH 24.1.38). Instead it held over the release of details of the scheme until June 1938, possibly anticipating the hostile reaction which the local government interests immediately gave it (SMH 29.6.38).

10. The government was due to face another election in May 1941. It was anxious to have a strong electricity policy to counter Labor's emphasis on rural electrification, but drew such opposition from local government interests fearful of the erosion of their powers that, in March 1941, the Minister for Works and Local Government publicly denied that the formation of a central authority was under consideration (SMH 25.3.41).

11. There were plans for a unified Sydney electricity system within the Greater Sydney proposals first discussed in 1915, and revived by the government in 1941. The measure was delayed by the war and finally enacted in diluted form in 1947 (Spearritt 1978,180). By that time the government attitude to the control of electricity had changed.

12. McKell was said to have drafted the Electricity Development Bill himself after a cabinet committee consisting of McGirr, Cahill and O'Sullivan had proved lukewarm about it and had warned that city members would not take kindly to its cross-subsidisation elements (Kelly 1971,99).

13. According to Cahill the bill conformed with the recommendations of the EAC, which "itself was acutely aware of its own functional limitations", in all but two respects. The government had fixed the maximum rate of contribution from electricity suppliers at 7 times the level recommended, and proposed that local government representatives should constitute a minority on the Electricity Authority, and not a majority as the EAC had recommended (NSWPD 20.11.45,1329). The issue of control, and the lack of obligation on the government to contribute to the development fund, were the only features of the bill to which the LGA could object (SMH 13.11.45). The government gave way, and when four of the seven appointees to the EANSW in January 1946 represented local government interests, the president of the LGA expressed his satisfaction (SMH 24.1.46).

14. It nevertheless still tried: in mid 1946 the Railway Commissioners sought permission from the responsible minister, J.J.Cahill, to ration electricity because of low coal stocks, but were refused (SMH 28.6.46).

15. In April 1947 the government had asked the EANSW to report on the failures of electricity supply in Sydney earlier that year. The majority finding was that the failures were due largely to the condition of the SCC system but implied that many of the contributing factors were beyond control (EANSW 1947a,18). However the two representatives of local government electricity undertakings, E.B.Serisier and D.V.Cochrane, unequivocally blamed the SCC and recommended, in terms unusually forthright for an official report:

"An amendment of the Gas and Electricity Act (1935- 1946) to bring the Sydney County Council into conformity with Local government generally in New South Wales and, in particular, to end the autocracy of the General Manager", and

"The taking over by a Central Electricity Authority or Board of all the interconnected generating systems of the State so that the power now and hereafter available might be equitably distributed and the systems co-ordinated" (ibid, 23).

16. The government claimed expert support from the RPT report of 1937, the Cochran report of 1944, and the EANSW in 1948 (NSWPD 12.4.50,5708). The ECNSW was to be modelled on the state-owned Southern Electricity Supply which generated and supplied electricity in bulk to local authorities south of Sydney.

The interconnected Sydney electricity system was clearly a single entity, Cahill argued, and should be managed as such to realise the economic benefits of diversified load and a smaller reserve plant margin. The ECNSW was necessary to manage it and to manage the new power stations planned for Lake Macquarie, the metropolitan area and the Snowy Mountains.

17. There was some consolation for the SCC, which was promised the ELPSC's franchise area when in due course that company's generation assets were to be taken over by the ECNSW.

18. The SCC, which now included several Labor aldermen, was also divided. In March 1950 it decided not to support the LGA protests on its behalf, instead urging the government to put its proposals into effect as soon as possible (SMH 7.3.50,3). There was some remaining resistance, transparently self-interested and anti-Labor, in which the general manager played a prominent part.

19. The proposed commission was to consist of three persons, one of a technical background and two with business and administrative experience.

20. Several special committees were established. The one on electric power generation from black coal included representatives of NSW government departments, the SCC and the ELPSC. Although this committee chose to interpret most of the questions put to it on "efficiency" in electricity generation from a narrowly technical rather than an economic viewpoint, it made wider recommendations, which were incorporated into the Royal Commission report.

21. The state power boards were to consist of one or two engineers and an accountant, and would be assisted by the representatives of the existing generation and supply authorities.

22. The manager of the Clarence River County Council, N.V.S. Wilton, proposed that the state should be divided into 9 county council areas. The chief technical officer of each area was to be a member of a state advisory committee chaired by a government engineer, with statutory powers limited only to the settlement of boundary disputes (CGE 1934,5). This would give effect to local government desires that control should remain decentralised. The Sydney Division of the Institution of Engineers, on the other hand, wanted centralised statutory co-ordination based on the recommendations of the 1930 Royal Commission into the Coal Industry, but not full control along the lines of the SECV (*ibid*).

23. Because the committee was "representative of the whole industry" (ECELB 1933,5) its views may have been shaped by the need to offend no interest groups. Its recommendations on appliance safety were that administrative control be placed in the ECELB, whose complaints about limited powers to stop the sale of unsafe appliances (*ibid*) had contributed to the establishment of the inquiry.

24. The RPT report was criticised by one of the EAC members, W.H. Myers, who maintained that it was based on a misunderstanding of the British Central Electricity Board model, and that the obstacles to the formation of a central generating body were insuperable in NSW (Myers 1944).

Recommendations similar to RPT's were contained in a report prepared for the McKell Labor government in 1944 by S.F. Cochran, chairman of the Queensland electricity Commission. He had previously been engaged by the SCC in 1943, with the approval and assistance of the premier, to advise it on the purchase of the ELPSC's franchise (SMH 18.8.43). Cochran proved to be something of a Trojan horse for the SCC. After completing his report for the SCC he was retained by the premier to advise on electricity supply, including the possibilities of unified boards of control for the metropolitan area and for the entire state. It was reported in mid 1944 that Cochran had recommended to the SCC the purchase of the ELPSC and recommended to the government the establishment of area boards to control electricity supply (SMH 17.6.44). The same arguments for economy and administrative simplicity which served the SCC in its bid to acquire the ELPSC also worked against it when further applied at the state level. The Cochran report was used by the government in 1950 as one of its justifications for the establishment of the ECNSW (NSWPD 12.4.50,5708).

25. They built and operated many individual lighting plants at railway stations, wharfs and public buildings, until these were superseded by reticulated supply. The Railway and Tramway Construction Branch of the PWD built the first tramway power stations, including Ultimo Power House, then transferred them to the RD. Thereafter the PWD constructed power stations for the RD at White Bay (built 1913), Newcastle (1915) and Lithgow (1928).

Under the Government Railways (Supply of Electricity) Act 1922, the RD was empowered to generate for, and in effect to develop public supply, a policy strongly advocated by the Chief Railway Electrical Engineer W.H.Myers (RNSW Paddison 1955,118).

A few semi-government agencies also operated power stations, some of them constructed by the PWD. The Water Conservation and Irrigation Commission, which administered the Murrumbidgee Irrigation Area, set up a steam power station at Yanco in 1913 (RPT 1937,81).

26. Technical matters were referred routinely to the Electrical Engineering Branch of the PWD. Under the Gas and Electricity Act 1932 the DLG briefly lost some of its electricity regulatory functions to the Department of Labour and Industry, which had always supervised the Gas Acts, but regained them in 1934 (CGE 1934,1). The DLG also serviced the Electrical Contractors' and Electricians' Licensing Board, and the Electricity Advisory Committee.

27. The amalgamation of the two departments coincided with E.S.Spooner's term as minister. He increased his power through control of virtually all public works and unemployment relief to such an extent that he constituted a challenge to Stevens' premiership (Aitken 1971,226). After Spooner's resignation in 1939 the departments were again separated, possibly to reduce their potential as a power base for any future leadership challenge.

28. The SES system included both hydroelectric and thermal stations, linked by the highest voltage transmission lines in NSW (132kV). It was inter-connected with the Railways, SCC and Commonwealth systems, and exchanged energy with the Australian Iron and Steel works at Pt Kembla. The SES doubled its sales between 1942 and 1950, and reduced its average charges by 10% over the period while the SCC's increased by 15% - the average SES charge for bulk supply fell from 0.815 d/kWh in 1940/1 to 0.64 d/kWh in 1946/7 (NSWPD 30.3.50,5679). Over the same period SCC average charges for bulk supply increased from 0.687 to 0.788 d/kWh (SCC 1951, Tables C,D).

29. In 1929, with the Civic Commission due to be replaced by a new council, the Citizens' Reform Association urged premier Bavin to place the undertaking under the control of a commission. Bavin was sympathetic:

"Anything we can do to ensure that the electricity undertaking will be free from political control will be done" (SMH 30.11.29).

Early in 1930 the government was reported to be considering a three person board, constituted like the Railway Commission and subject to dismissal only by parliament, to take control of both the SMC and RD electricity systems (SMH 21.2.30). The government was defeated in September, however, and the succeeding Lang government was more interested in limiting gas prices than in reorganising the SMC.

30. There is no evidence that charges elsewhere were significantly lower than the SMC's during this period. Indeed, the SMC claimed to have the lowest residential rates of any mainland capital city (SMH 17.6.33).

In May 1933 a meeting of over 40 Sydney municipalities, called at the instigation of the mayor of Burwood, resolved to make representations to the SMC for lower bulk and retail charges (SMH 5.5.33). It was suggested at the meeting that the Civic Reform Association was behind it, to give the government ammunition for the removal of the undertaking from SMC control (ibid).

31. The president of the CRA argued that it would not end political interference but make it worse (SMH 2.6.33). It was pointed out that there were many alternatives which would resolve the difficulties on which the government based its case for a county council.

32. The SMC passed a resolution summarising its record of growth and low prices, and condemning the proposal:

"...it is seen that a change of the most drastic nature is proposed, such as one would have expected to find only upon the failure of the existing administration, but the success of the Council's management appears to be conceded by those sponsoring the Bill, and indeed the facts establish its success very clearly" (SMC 1935,97).

33. The government noted that all of the SMC's supply agreements with the suburban municipalities were due to expire by 1945, and that some municipalities were discussing the formation of their own county councils to seek bulk supply elsewhere (NSWPD 19.3.35,6348). It omitted to mention that the suburbs had been making similar noises since the 1920s. Furthermore, if the government objected to any new supply arrangements, it had ample power under the other provisions of the proposed act, and in the Local Government Act, to prevent them.

In response to the charge that the government had not foreshadowed such a drastic act in its policy speech at the opening of parliament, E.S.Spooner held up a rather vague reference to "lifting off the irksome yoke of socialistic legislation", taking it to mean the repeal of the Gas and Electricity Act 1932, and therefore necessitating some alternative legislation (NSWPD 12.3.35,6215).

34. The government had invoked the support of the EAC, which had "carried a unanimous resolution, after full consideration, that the undertaking should be transferred to a county council" (NSWPD 6.3.35,6906). Labor implied that the government was paving the way for the eventual sale of the undertaking to the private interests with which the members of the EAC were said to be associated (NSWPD 12.2.35,6223).

35. Spooner defended Forbes Mackay's integrity, pointing out that he had made it plain to his employers that he was going on the EAC not as their employee but as an independent expert (NSWPD 12.3.35,6211). Nevertheless several aldermen criticised Forbes Mackay for his failure to keep them informed (Anderson 1955,139).

The minutes of the EAC reveal that Forbes Mackay was particularly careful to make clear that he had no obligation to consult or report to his employers (EAC 23.8.34). They also reveal that the question of the reorganisation of metropolitan electricity supply was raised first by the EAC itself, and not referred to it by the government (EAC 19.10.34). The minister then asked the EAC to advise him "whether a board or a commission would be a suitable body to control the [SMC's] undertaking"; it was the EAC itself which suggested a county council.

36. It had been achieved at very little political cost. The SMC and its parliamentary supporters were more vocal than influential, and the government could count on the support of the suburban municipalities.

37. Two councillors were elected by the SMC, two by the 25 municipalities south of the harbour, and one by the 7 north of the harbour. The composition of the SCC from its inception to the beginning of 1949, when it was reconstituted and enlarged, was remarkably stable: there were only 12 councillors in all, 3 of whom had served on the SMC's Electric Lighting Committee. The northern municipalities had the same representative for the entire 1935-49. Labor councillors were in a majority only from 1935 to 1937, although they continued to be elected to the chairmanship until 1944.

38. The council had the right, subject to consultation with the government, to appoint three 'statutory' officers: the general manager (once Forbes Mackey retired), the chief engineer and the secretary. All other staff matters were the prerogative of the general manager, and the power of council to give any direction at all in administrative matters was called into question:

"...legal opinion has strengthened the general manager's contention that the council's prerogative is confined to making suggestions to the general manager, which he would, as far as he considered practicable, carry into effect. Members of the council claim, however, that their suggestions have not been generally given effect to; and that, so far as the administrative policy is concerned, they might as well not have been made; and that the powers are so limited that it is an impossibility for the council to function satisfactorily" (SMH 7.4.37).

39. In early 1937 the council rejected Forbes Mackay's recommendation for the selection of two high speed 50 Mw turbines for the proposed Bunnerong B power station. Instead it selected a tender for a lower speed turbine, despite the fact that both capital and running costs were substantially higher, on the strength of the views of three British experts that the slower-running machines were safer and more reliable (SMH 2.2.37). Forbes Mackay termed the decision "an unjustifiable waste of money", and the Australian Institute of Engineers called it

"...one which challenges the authority of professional experts in decisions on matters which experts alone are competent to judge, and in so doing, threatens the sound administration of one of the most important public utility services in Australia" (ibid).

The council rescinded its decision.

40. With the election of J.H.Gardiner (Labor) as chairman in 1938 the SCC changed its meetings from weekly to fortnightly (SCC 1939,5), and, incidentally doubled the chairman's allowance (SMH 25.1.38). This reduced the opportunities for conflict to arise. Furthermore, Gardiner adopted the policy of discussing contentious issues in private, "to prevent unseemly wrangles in public, which damaged the prestige of the council" (SMH 18.5.38). Despite his previous criticism that the powers of the general manager were too comprehensive (SMH 25.1.38), Gardiner seemed to arrive at a realistic understanding of his own role in relation to both Forbes Mackay and the government. He later said, with unconscious irony, that the chairman of the county council was "a sort of liaison officer" between the general manager and the Minister (SMH 1.11.39).

After Forbes Mackay's retirement, continuity in management style was assured by the fact that every succeeding general manager up to the present has been appointed from within the undertaking. With the exception of one, who joined in 1928, every general manager until 1965 had been with the organisation since 1916 or earlier. Even in the one area where it had clear jurisdiction, the appointment of statutory officers, the council was unwilling or unable to alter the established policy of the organisation.

41. It was not clear who was subsidising whom. Forbes Mackay stated that the bulk supply rate barely covered costs, while Cramer was under the impression that it was "one of the most profitable sections of the council's undertakings" (SMH 12.8.36). Gardiner said that street lighting was subsidising industrial sales, but Vine Hall denied it (SMH 17.3.37).

The council did make some attempts to review its costs and prices. In June 1936 it resolved to order an inquiry into the actual costs of supply to various consumers (SMH 3.6.36). Two weeks later, to the expressed astonishment of the original sponsor, the decision was reversed because councillors were unable to agree on the terms of reference (SMH 17.6.36). A report was eventually obtained from a chartered accountant, E.S.Wolfenden, after an investigation of barely four weeks (SMH 1.7.36, SCC 1936,11). In October the council requested the general manager to set up a committee

"...to thoroughly examine the rating to the various groups of consumers to:-

(1) simplify the system of charging so that it is readily understood by the average consumer

(2) adjust the rates in order that all groups of consumers are on an equitable basis of charge commensurate with the service rendered and the present and future needs of the Undertaking, and calculated to promote the widest possible use of electricity" (SCC 1936,11).

The committee rejected any major simplifications, such as the introduction of a flat rate of charge, on the grounds that some consumers would inevitably pay more, forcing them either to economise or, in the case of industrial consumers who received the benefit of very low marginal rates, to leave the system and generate their own electricity (SMH 4.2.37).

42. In March 1936 Forbes Mackay recommended that municipalities be charged for street lamps on a more cost reflective basis. The council deferred a decision, partly because no councillor wanted his constituents to pay more (SMH 25.3.36). The fact that the ELPSC's street lighting rate was only three quarters that of the SCC also concerned some councillors, who thought it was the duty of a public body to match it (SMH 3.6.36, 17.3.37).

43. The committee investigating tariffs did indeed discover that the "revenue from the commercial group of consumers is at present more than the apportioned cost" (SMH 4.2.37). However, when one of the councillors thereupon concluded that commercial charges were too high, Forbes Mackay merely pointed out that there had been a substantial reduction in the commercial rate four or five years ago, and that no business could supply itself with power as cheaply as it could purchase from the SCC (SMH 5.2.37).

44. As average consumption increased, more energy was consumed in the lower cost 'secondary' blocks, so lowering the average price of all energy sold. The introduction of off-peak water heating tariffs in the late 1930s also reduced average prices. These mechanisms reinforced the further increase in sales.

45. The categories of sales which increased the most between 1933 and 1951 were residential and bulk supply, which itself represented the predominantly residential load of the outlying suburbs. Sales growth in the latter areas was assisted by reductions in the bulk supply tariff in 1936 and in 1938. These reductions probably did not reflect actual declining costs of supply, and may have been prompted by the need to prevent client municipalities defecting to the RD or the ELPSC, or to allow the further promotion of residential sales in those areas.

46. In August 1943 the council instructed its general manager, R.Vine Hall, to report on how a "substantial reduction might be made in all charges" (SMH 4.8.43). Vine Hall, however, recommended against reducing charges because of the possibility of coal shortages, and hence electricity rationing and revenue losses, in the following year (SMH 14.8.43). Nevertheless the council decided to reduce bulk supply tariffs in December 1943 and again in March 1944 (SCC 1944,7). This was to allow the outlying municipalities to match the 10% reduction in the tariff for primary units which the SCC had granted to its own residential consumers in early 1944 (SMH 1.3.44). At the same time the SCC imposed a maximum rate which had the effect of further reducing the fixed charge recovery from the residential sector (SCC 1944,1,7).

In December 1944, one month before the SCC elections, the council again asked the general manager, D.J.Nolan, to reduce tariffs, and were again advised that it would be unwise in the face of the uncertain coal situation (SMH 6.12.44).

47. The coal shortages of which the management had warned, and industrial problems at Bunnerong power station, intensified in 1945. Production costs were driven up by poor coal quality and the need for supplementary oil firing, while revenue was lost through rationing.

48. Figure 6.2 shows the trend in the "C" series index of prices from 1939 on, and indicates that the average of all SCC electricity prices was about the same in 1951 as it had been in 1939.

49. By March 1940 suburban showrooms had been opened in Burwood, Campsie, Crows Nest and Bondi. The zeal of the SCC's promotion at first caused concern even to the councillors. In April 1936 they disapproved the display of a 1911 gas stove in the SCC showroom as "unethical" (SMH 22.4.36).

50. In 1938 ranges and instantaneous water heaters were offered as a combined package. The market for major electrical appliances was still relatively modest, and the SCC's contribution to it was considerable. It sold nearly 88% of all cookers connected to its supply in 1938 (ibid). In 1939 it was able to increase sales of cookers without any special offers, noting that

"Electric ranges are now common and accepted household equipment and no special inducements are necessary to ensure their extensive use" (SCC 1939,16).

51. This resulted in over 2000 orders within a 3 month period (SCC 1939,17), a significant intervention in a market where national sales amounted to only 20,000 units in 1938, many of them absorption models powered by gas (A.Spearritt 1983,39). To counter the campaign AGL offered hire purchase arrangements on gas refrigerators and a discount on gas used for refrigeration (SMH 9.8.39). The SCC also hired out water heaters and wash boilers from 1938.(SCC 1938,16).

52. The council's promotional activities were not restricted to residential consumers. A showroom displaying and eventually selling commercial and industrial heating, cooking and motor equipment was opened in November 1936 (SCC 1936,18). Here again, the emphasis was on areas of thermal energy demand in competition with gas. Advisory services and equipment sales were complemented by promotional tariffs, such as a special flat rate for all electricity used in heating, ventilating and air conditioning (SCC 1936,18). Special rates were also available for industrial heating, cooking, bread making, metal melting and steam boiler installations (SCC 1939,15).

53. The estimates of increased energy sales attributed to the Sales Branch are almost certainly optimistic, possibly because of the need to defend the branch against criticism from councillors, who called into question its cost- effectiveness from time to time (eg SMH 5.4.39).

54. In 1942 the SCC reported:

"Restrictions placed upon the production of electrical apparatus for civilian use resulted in a marked curtailment of the Council's selling activities during the year" (SCC 1942,7).

Only in 1943 was there an "almost complete cessation" (SCC 1943,6).

55. Off peak water heating was the focus of activities, although there was a refrigerator campaign towards the end of 1947 (SCC 1947,11).

56. The first 50 MW generator at Bunnerong was installed in September 1939, within a few days of the outbreak of war, only 3 1/2 years after Forbes Mackay's formal recommendation to the Council. The next one was installed in January 1941, only a few months later than its original target. The next generator was put in service in February 1947, some 7 years after management recommendation, and the following two took 12 and 10 years respectively.

No new 50 Hz plant was installed at White Bay between 1939 and 1948 (see TED). The ELPSC installed a "superposed" 32.5 MW turbine set in 1947 (Sykes 1947), but retirement of old low pressure plant meant a net increase in capacity only from 43.75 MW to 49 MW (TED).

57. In March 1936 and September 1939 some councillors were reluctant to approve the installation of more plant at Bunnerong, a site they considered vulnerable to enemy attack (Anderson 1955,161,SMH 20.9.39). Forbes Mackay's assurances were sufficient on those occasions, but as the world crisis deepened, so did the councillors' apprehensions. When the next general manager sought approval in July 1940 to order plant for the rebuilding of the ageing Pymont power station, the Council referred the matter back to him and then to the EAC. By the time the original recommendation was finally adopted, nearly a year later, the production in Britain of all equipment not directly necessary to the war effort was subject to indefinite delay. Despite representations from the Australian High Commissioner, the British government did not give approval until late 1947 for this order, and an identical one placed later, to be scheduled for production (Anderson 1955,195-3). A later inquiry by the EANSW concluded that one of the causes of the chronic post war interruptions was "Delays in the installation of new plant, to which delays in the ordering of the plant may have contributed" (EANSW 1947a,18).

58. All of the boilers at Bunnerong were equipped with supplementary oil burners in 1946 (Anderson 1955,200), and in 1947 large oil storage tanks were constructed at the power station (SCC 1947,8). Two oil-fired steam boilers ordered in 1947 increased the steam output by 15 MW each, when installed in 1950 and 1951 respectively (SCC 1951,14).

59. Attempts in May 1944 to introduce regular shift maintenance were opposed by the unions, on the grounds that the rates offered were much less than those in other power stations (SMH 14.5.45). Despite clear directions from the Industrial Commission on several occasions and the involvement of the prime minister himself, management and workers could not agree on the introduction of shift maintenance until October 1947 (SCC 1951,207).

In 1945 the SCC was able to deflect blame for rationing on to the strikers at Bunnerong and the coal situation in general, both popular targets of the conservative press. The SMH editorialised in 1945

"The issue at Bunnerong is as clear cut as few industrial disputes are. The strikers have been rebuked and the motives of those backing them impugned in terms rarely employed by leaders of the Labour Council...The Communists are out to smash arbitration. They would rejoice to see it suffer a reverse in the Bunnerong case, and would revel still more in the kind of upheaval now threatened" (SMH 9.10.45).

The Bunnerong issue became less clear cut with time. When disputes persisted even after shift work had been introduced, a special investigating committee set up by the SCC in December 1947 found that management had contributed to the tension (Anderson 1955,210). In April 1948 the two Labor members of the SCC moved for an independent inquiry into the management of the undertaking. The general manager, G.S.Boyd, alleged that it was an attempt to discredit him and have him dismissed. He said

"If Councillors Byrne and Gardiner want to retain their positions they must hold and keep the support of a powerful section of the Bunnerong employees...these men are their bosses, and [they] have to do what they are told. They are simply working to instructions in these moves to remove me and senior officers from office... These tactics have been used by other people. They are the tactics of the Communists" (SMH 48.4.48).

60. The Commonwealth government had become involved in emergency electricity planning, with the appointment of a Commonwealth Controller of Electricity Supply in October 1942, to ensure priority of supply to vital installations in the event of disruptions (SMH 8.10.42).

61. In July 1945 councillors unanimously "objected strenuously" to a scheme which was reportedly worked out at a meeting chaired by its own general manager, on the grounds that it did not impose equal sacrifice on gas and electricity consumers (SMH 4.7.45).

62. Neither voluntary restraint, random blackouts nor rationing pleased the community. When members of the Housewives' Association were told at a meeting in June 1945 that restrictions would be imposed on the "honour system" they asked "Why should there be honour among housewives with small children when there is no honour among miners?" (SMH 23.6.45). Business consumers and the unions were equally unhappy about restrictions leading to curtailments in production, hours worked or wages earned (SMH 25.6.48).

63. H.G.Conde had been general manager of the ELPSC since 1938. In 1942 he was appointed Deputy Regional Controller of Electricity Supply in NSW (SMH 3.5.49). W.H.Connolly, a Victorian, was appointed his deputy, but was prevented from taking up the appointment for some time due to illness. S.F.Cochran, Queensland Electricity Commissioner, was appointed in the interim (SMH 5.5.49).

64. Relations between the two Labor members on the one side, and the three conservatives and the management on the other, became increasingly polarised after the 1945 SCC election. Block voting on the election of the chairman and other major issues was common (SMH 10.7.46,21.1.48).

65. Instead of 5 councillors representing 3 constituencies, the SCC elected on 9 February 1949 consisted of 9 councillors representing 4 constituencies. The representation of the City decreased from 2/5 to 3/9, of the municipalities north of the harbour from 1/5 to 2/9, and of those to the south from 2/5 to 4/9 (SCC 1949,3). Suspecting that the government's intention was to ensure Labor control of the SCC, the SMH commented

"Whatever the result of the election may be, the prospect is that partisan influence or party conflict will only be perpetuated by the enlargement of the council. Recent experience has shown that the considerable difficulties of Sydney's electricity supply have been aggravated, and their removal obstructed, because the political interests of the state Government have clashed with the council's endeavours. Though the return of a predominantly Labor council may end this conflict, it by no means follows that the public will be better served. On the contrary, the evils of political interference with the operation of a public utility could thus flourish unchecked" (SMH 9.2.49,2).

Labor did not gain a majority, despite the election of three councillors by the Labor-controlled City Council.

66. The Labor party nominated the secretary of the Municipal Council and Shire Employees' Union to a casual City vacancy in May 1950. The fact that he was not an alderman underlined the SCC's polarisation along state party political lines - clearly a development for the worse in the opinion of chairman W.P.Henson, who said that the by-election "... emphasises the complete domination the Trades and Labor Council has over all Labour selections" (SMH 2.5.50).

67. Councillor P.D.Hills (Labor) reportedly described the minute as "... 'Calamity' Cramer's swan-song and...the opening of the Liberal Party's by-election campaign" (SMH 21.5.50).

68. Boyd authorised the mass printing of a pamphlet exhorting consumers to "Voice your protest against any extension of Government control of your electricity supply and services", without first showing it to all councillors (SMH 23.3.50). When Councillor Hills criticised the expenditure as "political" and "improper", Boyd lectured him on his duty:

"You took an oath to uphold this council, not to destroy it...you should bear in mind the oath you took and not make this council a plaything of politics" (SMH 4.4.50).

The pamphlet was distributed on the majority vote of the Council.

70. Increase in motor power per factory employee (NSWYB):

	All Machinery	Electrical Machinery
1921-36	66%	256%
1936-50	48%	41%

71. The preferred option emerging from discussions between the SCC and the Chamber of Manufacturers was a regular rotation system. Industries would be without power for, say, one day out of five and could plan production accordingly (Anderson 1955,214). The SMH commented:

"Instead of leaving the suburban areas to bear the brunt of the crisis, Mr Boyd [SCC general manager] intends to extend the blackouts to industrial areas after intimating, the day before, what deprivations are to be expected. What this will cost in production goes unstated, but the loss will inevitably be heavy. The best that can be said for such an expedient is that consumers need not now be taken wholly unaware. It will not prevent a great deal of waste and confusion. The plan is an exceedingly poor substitute for a truly co-operative rationing system. This requires the goodwill of industry and the industrial unions together with courageous action by the State Government (SMH 11.2.49).

Measures considered by the government included a blanket 30% reduction in industrial output, and a proposal from the Metal Trades Employers' Association for a system of 'off-peak' working hours at night and on weekends (SMH 29&31.3.49). Those which led to loss of wages or to unsociable working hours were opposed by the unions.

72. During 1951, the year before the SCC transferred its generation to the ECNSW, it purchased 119.9 GWh from the RD, ELPSC and SES systems, and 22.4 GWh from private generators. This was a small component of the SCC's total energy output of 1444.3 GWh, but was strategically important at peak load times.

73. Other thermal uses (water and room heating) tended to follow the cooking fuel. The SCC recognised the importance of the electric range, "the focal point of home electrification", in penetrating the household thermal energy market dominated by gas and had made it the focus of its pre-war promotions (SCC 1938,16). The SCC also promoted increased energy consumption for lighting through its "better light" campaign (SMH 25.2.39).

74. The census enumerated the principal cooking fuel and equipment type (range or hotplate/gas ring) by local government area. A mere 9.2% of single family homes within the SCC cooked with electricity, and 84.9% with gas. The highest rate of electric cooking was among the group of outer LGAs supplied in bulk by the RD, where gas connection rates were half that in the inner area. Even there, however, households cooking with gas (32.4%) and solid fuels (31.6%) outnumbered those cooking with electricity (21.5%). Gas exerted its strongest grip in the inner western suburbs supplied by the ELPSC, where it had fully 90.8% of the cooking market, and electricity (2.5%) ran a poor third to solid fuels (5.2%).

75. In other Australian capitals 98.6% of dwellings were connected to electricity, but barely 4.5% cooked with it (see Table 5.7). National manufacture of cooking ranges in 1939-40, the peak year before the war curtailed production, was 49% solid fuel, 40% gas and 11% electric (Department of Post War Reconstruction 1949a,11). In 1947-48, with production recovered from the war-time lull, it was running 46% solid fuel, 35% gas and 18% electric (ibid).

76. In 1945-46 gas and kerosene refrigerators accounted for 65% of Australian production, but within three years it was down to 41% (ibid,1949b). Over the same period the production of element powered absorption units fell to 25% of electric production. Absorption units typically cost about 15-30% less than compressor units of the same storage capacity, but consumed more energy (ibid,11). In 1949 the SCC still offered an electric absorption model on easy terms (ibid,6). During the 1950s the electric absorption type rapidly disappeared from the market, and fuel absorption sales were restricted largely to country areas not yet connected to the grid.

In 1949 the Department of Post War Reconstruction was still equivocal about the future of the refrigerator

"The extent to which the domestic refrigerator succeeds in establishing itself as a necessity will have an important bearing on the future of the industry. While the refrigerator is regarded as a luxury item by a large section of the community the industry will remain very vulnerable to economic fluctuations. The refrigerator is at present in a transitional stage and is coming to be regarded as a near-necessity, although the developing use of ice-chests [!] is a moderating influence here. Continuance of the present trend towards the adoption of a five day week by food vendors could be an influential factor in fixing the machine in the minds of the public as a necessity, particularly in the warmer temperate zones" (ibid,7).

77. Annual Australian electric radiator production in the late 1940s was about half that for refrigerators, suggesting a penetration rate of 15-20%. The Sydney electric heating load was troublesome even when energy supply was adequate because the system was chronically demand constrained from 1948 to 1952. Apart from regular winter prohibitions on radiator use between 7 am and 7.30 pm there were unprecedented summer blackouts in 1948-9, brought on by sudden cold snaps while the SCC was overhauling plant in preparation for the coming winter.

78. The SCC found that little coal was saved during periods of restrictions on residential electricity use (SMH 30.4.46). During the last quarter of 1946 a third of residential consumers actually increased their consumption compared with the previous year, when there had been no restrictions (SMH 12.2.46). The SCC attributed this to householders' success in shifting time of use when requested (ibid).

Letters to the editor of the SMH suggested that householders were only partially observing restrictions on gas and electricity use, despite the threat of large fines (eg SMH 8.7.42). Some also resented the emergency powers of inspectors:

"This demanding to inspect the homes of a British subject [sic] is not law - it is just not done. I hope all housewives will think twice before they allow any of these so-called inspectors to enter their homes" (SMH 9.7.48).

The Minister for Local Government, J.J. Cahill, was so concerned by public disobedience of rationing that he raised the idea of a campaign in schools, to emphasise to children why their parents should obey the regulations (SMH 31.3.49).

Another reason for the limited success of restrictions may have been that householders found it difficult to grasp the concept of an integrated electricity system serving different energy markets simultaneously, where energy production could not be stored for later use, and which was at various times subject to constraints on energy, demand or both. Furthermore, unlike their oil and solid fuel using predecessors, householders had no ready way of knowing the relative energy consumption of their appliances. Newspapers regularly ran articles to explain that thermal appliances drew more current than lights or radios, and why they could be used at some times but not others (eg SMH 27.3.49).

79. Some reports blended futurism with sound forecasts of economic trends and consumer preferences:

"In the realm of refrigeration, the "deep freezer", already widely used in America, seems likely to have a popular acceptance in Australian homes. In it large quantities of perishable goods may be kept throughout the year for use as required and advantage can be taken of market gluts to buy at wholesale rates...The refrigerators of tomorrow will also utilise the ultra- violet ray lamp to preserve food and kill bacteria..." (SMH 4.8.45).

A 1944 survey found that

"considerably more women favoured electricity for domestic uses than any other fuel or power. In the country the preference was particularly noticeable" (ibid).

80. Even when promotion of household appliances was curtailed in the mid 1940s the SCC's sales of commercial cooking equipment rose from year to year (SCC 1946,10), and large off peak water heating installations were introduced into restaurants and hotels (SCC 1938,17).

81. During times of restrictions the use of grid electricity for commercial display lighting was usually prohibited outright or severely curtailed (SMH 23.6.45,21.1.49). The state government permitted display lighting from private generators, but the Commonwealth government prohibited the purchase of oil to run generators for that purpose (SMH 27.5.49). Interior lighting was restricted to 0.75 watts per sq ft in shops and showrooms and 0.2 watts per sq ft in warehouses (ibid).

Some restaurants made a virtue out of necessity and used candles as the sole means of lighting (SMH 3.7.48). Commercial consumers were also receptive to ways of increasing their efficiency of use, and fluorescent lamp manufacturers took the opportunity to point out that their products could supply three times as much light per watt as incandescents (SMH 27.5.49).

82. Estimated electrified public transport trips, millions (Sources: Spearitt and Wells 1984.):

	Suburban Rail (NSW)	Electric Tram (NSW)	Total Electrified Modes (Sydney)(a)
1945/6 (peak)	248.4	417.3	636.5
1955/6	269.0	175.0	431.8

a. Excludes Newcastle tram trips & country rail trips (est)

83. In one case the replacement mode used the same form of energy: an electric trolley bus replaced the Kogarah to San Souci tram in 1937 (Spearitt 1978,154).

84. As in other sectors transport energy users turned to short term substitute fuel sources, the most common being charcoal-burning gas producers. Town gas bags were also used (Petroleum Information Bureau 1960,72).

85. In order to ensure security of supply, a system should have in reserve enough generating capacity to cover the failure of the largest unit in use: for example, a power station serving a 75 MW load with three 25 MW turbines should have a further 25 MW machine standing by. If two such power stations and their loads are interconnected, a single standby generator will cover both, and the combined capacity will drop from 200 MW to 175 MW. Furthermore, if the peak loads on the two systems occur at different times (say one is predominantly traction and the other industry) then the co-incident peak may well be less than 150 MW: if less than 125 MW a further generator is saved. If the two power stations have different operating characteristics, say one is thermal and the other hydro, or one newer and more efficient, then the outputs and relative operating times can be balanced to give the lowest operating cost. Finally, as demand grows the combined system has greater choice of type and timing of new plant.

86. Hughes categorises regional systems of the period as either 'planned' or 'evolutionary':

"... the evolving networks... because of the generally less orderly character of historical change, usually were more complex in form. The planned grids represented the pooling of energy from utilities that preserved their legal identities, primarily as distributors of the pooled energy. In some instances, a separate corporate identity owned and managed the grid; in others, the utilities presided over the grid, or pool, using a committee structure. Because the participating utilities preserved their corporate identities and because they often negotiated decisions about the operation of a power pool, such grids were analogous to confederations of nation-states" (Hughes 1983, 324).

87. In their 1937 report on electricity development in NSW, Rendel, Palmer and Tritton identified 8 major regional systems. These were centred on Sydney, Newcastle, Pt Kembla, Burrinjuck, Lithgow, Clarence River, Tamworth and Yanco (RPT 1937,4). Their characteristics are summarised in Table 4.6. Only the Newcastle and Clarence River regions operated more than one power station in full co-ordination. Five of the systems had only a single power station, and in Sydney there were three separate utilities, with low capacity links between the SMC and RD systems. Because the systems were independent each had to make a considerable investment in reserve capacity, amounting in toto to 65% over and above the summed peak loads (RPT 1937,iv).

The Burrinjuck and Pt Kembla Electricity Construction Act 1938 enabled the PWD to connect those two systems with a 132kV line in 1940. The formation of the Southern Electricity Supply in 1942, also incorporating Yanco, gave administrative effect to the physical interconnections.

88. The SMH commented:

"Since both the County Council and the Railway Commissioners, in varying fashion, seek loan money under the Government's sponsorship, it is the duty of the Government to assure planned economy in their development. Capital expenditure in the expansion of these power stations must be heavy and constantly renewed as demand increases. The luxury of separate, and even competing, enterprises in power supply, and of separate administrations over them, is one which the community can no longer permit..." (SMH 30.12.38).

Co-ordination in development, if not in administration, was also supported by Forbes Mackay, who noted that each year that a 50 MW generator costing L 1 million could be deferred represented a saving to the SCC of L 80,000 in capital charges (ibid). This represented about 2.5% of the SCC's 1939 gross revenue.

The Chief Railway Electrical Engineer, W.H.Myers, was also a keen advocate of co-ordination, not only on a regional but on a state level. In 1941, as the systems were being linked for emergency support, he calculated the potential cost saving from full system integration to be L 2.5 million over the following 13 years, or nearly 24% of the total cost of separate expansion (SMH 28.3.41).

89. In early 1939 the SCC and RD began discussions on larger scale interchange and the ELPSC also expressed interest (SCC 1939,45). Before the negotiations were completed the minister directed the EAC to investigate and report on the war time precautions necessary to ensure supply in the munitions manufacturing centres of Sydney, Newcastle, Lithgow and Pt Kembla. Within two months the EAC had worked out a scheme of interconnection which it considered justifiable on economic as well as security grounds, and began discussing the costs with the utilities (SMH 17.3.39). The SCC immediately voted L 240,000 for work on the metropolitan links (SCC 1939,15).

90. The inter-urban links took a little longer, much to the impatience of the SCC (SCC 1940,19). The Commonwealth government, which had been consulted on the project in March 1939, would not allow capital to be spent on it because it could not be regarded as a war item (SMH 11.2.39,28.10.40). In January 1941, after personal representations from the NSW premier, the Commonwealth conceded that the project was of national importance, and authorised the expenditure of L 225,000 on 66 kV links from Sydney to Newcastle and Pt Kembla (SMH 4.1.41).

91. The Council had accepted Forbes Mackay's recommendation in January 1938 that two further 50 MW units should be ordered, for installation at Bunnerong in 1942 and 1943 to coincide with the shutdown of Pyrmont for rebuilding (Anderson 1955,162). Government approval was obtained, but the orders were deferred. In February 1940 Vine Hall reported that, depending on the growth of demand and the performance of the interconnections, the SCC may be in a position to meet demand up to 1944, after which new plant would be necessary. In effect, the reserve capacity provided by the links had enabled the SCC to defer its planned expansion programme by two years.

92. In 1945 the SCC drew up to 20% of its maximum demand from the RD. From 1949 the peak hour energy flows were in the opposite direction, not because of improvement in the SCC system but because of increased support from the ELPSC, which did not have direct links with the RD.

93. The SCC had courted the ELPSC on several occasions, despite the coolness of the latter's constituent municipalities (SMH 19.3.36). Its interest revived with the physical linking of the two systems in December 1940, but in March 1941 the ELPSC's directors declined to sell (SMH 1&14.3.40). In 1943 the SCC again commenced negotiations with the ELPSC, and obtained the premier's approval for a government investigation of the proposed merger (SCC 1943,5,SMH 13.10.43). The negotiations lasted well into 1944 but came to nothing.

One of the ELPSC's concerns during the first half of the war was that government profit limitations would restrict dividends to 4%, down from the 6% which it had been able to maintain despite a steady decline in revenue after 1939 (SMH 28.7.42,17.6.44). In mid 1944 it was concerned that the impending shortage of coal may lead to electricity rationing, and a further revenue fall which it could not absorb (SMH 5.7.44).

94. The chairman of the Joint Electricity Supply Committee, representing the ELPSC municipalities, was understandably displeased:

"Our area has never had blackouts. Sydney's blackouts have been caused by lack of vision and poor administration. Our area should not have blackouts forced on it because of the dog-in-the-manger attitude of people who, not being able to supply their own customers, object to more fortunate people enjoying a good service" (SMH 16.6.48).

95. The non-grid generation (calculated from subtracting the known output of the four major systems from the state total in NSWYB) may well be an overestimate. Allbut (1958,31) estimates that immediately before the war about 95% of total NSW electricity was supplied by the major systems.

96. It also placed orders for a further two units in addition to the two 50MW generators ordered during the war for installation in the new Pyrmont power station (Anderson 1955, 178).

97. The long delayed fourth 50 MW Pyrmont unit was commissioned in 1955, and in 1956 a 25 MW unit was installed at Balmain and a 50 MW unit at White Bay (ECNSW 1962).

98. Gas was of course restricted to the towns with gas works, while electricity extended to many rural districts. Figure 5.3 indicates that NSW was the most electricity-intensive mainland state, as measured by electricity production per capita, throughout most of the period 1940 to 1952. The NSW share of annual national electricity energy production remained at about 42% throughout the period 1936-50 (see Table 5.11). It dipped to 39.5% in 1950, at the height of the Sydney supply constraints.

Per capita electricity production by state: kWh/cap (Source AYB 1954,1058):

	1941/2	1951/2	Increase(%)
NSW	944	1379	46
Victoria	865	1288	49
Queensland	464	1017	119
SA	635	1080	70
WA	731	897	23
Tasmania	3025	3835	27
AUSTRALIA	879	1323	51

99. Gross revenues for 1948 (Sources: SCC 1951,29,RCIGI 1949,22)

	L '000	%		L '000	%
SCC: Industrial (HV+LV)	2310	41.9	AGL: Industrial	345	13.3
Commercial	921	16.7	Commercial	258	9.9
Residential	2098	38.1	Residential	2004	76.8
Street Lighting	180	3.3			
TOTAL RETAIL SALES	5509		TOTAL	2607	

100. In the late 1940s gas use during coal shortages was generally restricted to one to two hour periods at meal preparation times (SMH 23.1.48).

Gas supply was also subject to some capacity constraints. In 1942 AGL had to purchase gas from the NSG, and in 1943 the two systems were fully interconnected as a war-time emergency measure (Broomham 1987,154). Unlike the electricity suppliers AGL was able to keep pace with demand by installing relatively simple locally fabricated plant. Additional automatic water-gas units were installed by AGL in 1938 and 1947-48 (SMH 9.3.49).

101. It had very wide terms of reference, covering technical adequacy, safety and industrial relations as well as the particular cessation of supply in May 1948 (RCIGI 1949,5). The terms of the inquiry were extended in February 1949 to dividend, accounting and other issues central to AGL's pricing and profitability (ibid,15).

102. The SMH's opinion, coloured as usual by its close association with AGL, was the following:

"Sydney's gas companies are being subjected to a kind of capital levy by instalments designed to protect the shrinking goodwill of the McGirr Government against public resentment, already aroused by sharp increases in the charges of other public utilities. The Australian Gas Light Company reports that it is losing money at the rate of L200,000 year - because Cabinet cannot bring itself to authorize a palpably overdue increase in prices.

"...The hesitancy where a private undertaking is involved is very different from the procedure followed in governmental and semi-governmental undertakings. In less than two years the Sydney County Council has increased electricity charges by about 35 per cent. The railways in the same period have raised their fares and freight by up to 40 per cent...The 15 per cent sought by the gas companies is modest by comparison and is being unfairly withheld" (SMH 14.2.49).

The government did not dispute that production costs had risen but wanted to ensure that all possibilities for their absorption were explored before they were passed on to consumers:

"Monopoly companies may cause a Liberal Government to bow down and pay homage when they crack the whip and allow prices to skyrocket to return dividends to their exclusive supporters. That, however, does not apply to my Government." (SMH 9.3.49).

The government claimed that automation had increased labour productivity by a factor of 30:1 (AGL admitted 10:1) and thought there was scope for payment of dividends from funds accumulated in special accounts (*ibid*). AGL had indeed paid dividends out of reserve funds in 1948, but claimed to have exhausted them (SMH 12.2.49). The government also wanted the Royal Commission to investigate any discounts from standard maximum prices which consumers may be receiving, presumably to discover whether those discounts could be removed before the standard price were raised (SMH 9.3.49).

The Royal Commission found that discounts amounted to barely 4% of revenue, and the rest of its findings were generally confined to the obvious or the inconclusive: eg "The reason for this stoppage was a strike on the part of an important section of the employees of the Company" (RCIGI 1949,15). Nevertheless it served its purpose of delay and the government managed to avoid granting any increases until after the May 1950 elections, to the growing chagrin of the SMH:

"...the A.G.L. was missing from the dividend list this year for the first time in 112 years of its history. It seems as if the State Cabinet will at last be hoist with its own petard. It has incurred widespread odium over the Gas Company's inability to pay a dividend. Now it no longer has any shadow of excuse for preventing a higher price for gas. To ignore the recommendation of the Board of inquiry would be an intolerable aggravation of an already scandalous situation" (SMH 14.4.50).

103. The only major organisational change was the amalgamation of the Manly Gas Company with the North Shore Gas Company in 1938, prompted by the difficulties of the former in expanding its plant at Manly (Keating 1974,77). The merged company accounted for 14% of metropolitan gas sales, and AGL for the rest.

104. The Royal Commission found that "dissatisfaction exists with regard to wages and general conditions of employment, repeated comparison being made with employees in the Electricity Undertaking" (RCIGI 1949,9).

In a 1941 lecture the manager of the NSG took pains to point out the contribution of the gas industry to the war effort, particularly in its efficient utilisation of coal. He noted that the industry recovered 28% of the energy content of coal as gas, and 41% as saleable coke, whereas only 24% of the energy content was converted to electricity at Bunnerong (Smedley 1941,32).