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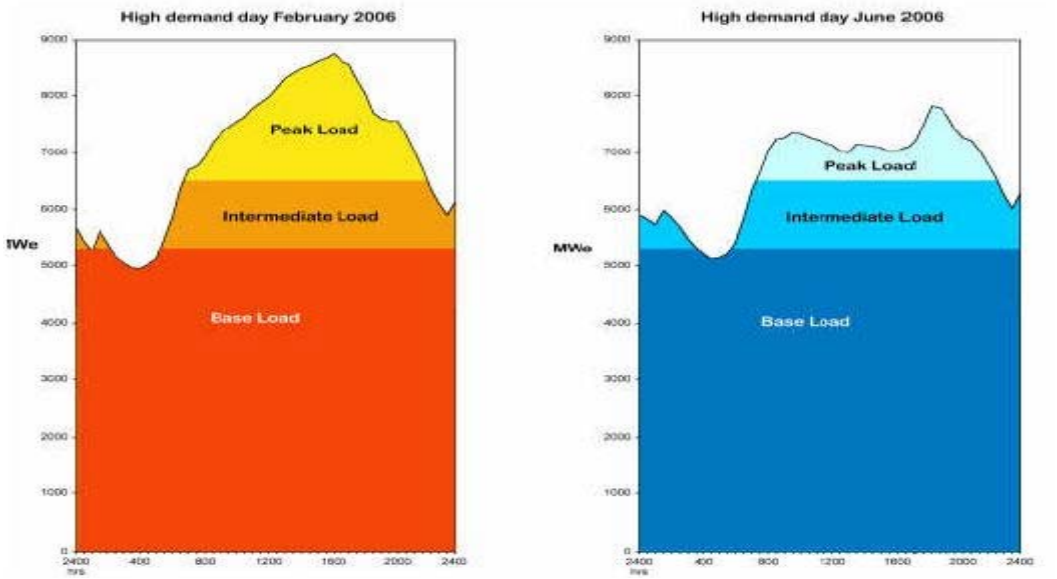
Australia's Electricity Supplies (adopted 20/10/12))

General
Electric power is essential to the functioning of the nation in the industrial, commercial, and domestic aspects. Electricity is supplied to Australia from a range of electricity generating stations via a 38,000km network of power lines. Currently this country has about 110 Coal fired, Natural Gas and Hydro power stations (of 50 MWe or greater) that supply most of the 56,000 MWe (i.e. megawatts of electric power) to the nation. The largest of these stations burn black or brown coal to obtain the heat energy to convert to electricity. In addition, burning natural gas is increasingly being used to augment supplies, while other sources of note are hydro power (i.e. using the energy of descending water), wind farms (using the energy of wind) and photoelectric panels (using the energy of the sun). Currently the distribution of these sources of electric generating capacity are: coal 54%, natural gas 26%, hydro 13%, and other renewables 4.5%, but in terms of the actual electricity produced (i.e. kilowatt-hours) coal provides 77%, natural gas 15.2%, hydro 4.8% and other renewables 2.7%.

Since Australia is such a large country it is not practical to have a single interconnected system to supply electricity nationally, rather Western Australia has its own separate system as does the Northern Territory whereas Tasmania and South Australia also maintain their own systems, but can import some power from the eastern states, if necessary. The remaining states: Victoria, New South Wales and Queensland are the main power generating states (75% of total capacity) and are interconnected through the National Electricity Market importing and exporting power to each other as required.

Distribution Determinants
The fundamental requirement of an electricity supply system is to satisfy demand. That is, the electricity demand within the area supplied by the electricity distribution system must be met second by second by the supply – not more, nor less.. Moreover, the demands will vary by time of day, season, weather, and year by year. The following figure shows the demand for electricity on two days in Victoria in 2006 illustrating the way the seasons affect demand with the summer having more use of air-conditioning in the afternoons and with the winter use of space heating and lighting in the evenings. The base-load demand (much comes from industry operating around the clock) is met by coal fired stations operating at constant power, while load following the peak demands is covered by hydro or natural gas fuelled plants.



LOAD CURVES FOR VICTORIAN ELECTRICITY GRID

This variability means several things: the overall electricity supply also must be variable; it must have excess capacity to allow for equipment shutdowns, planned or unplanned; and it should be provided at the least cost. It almost goes without saying that operating such a system is a complex matter involving highly skilled staff using sophisticated equipment and techniques to keep the system operational and to satisfy its varying demands.

Environmental Constraints

Various types of electricity generating plants are used or are under development around the world. In the past the decisions made on the types of plants to incorporate into a generating system depended primarily on cost and reliability. This is why the Australian system has been dependent mainly on coal. NSW and Queensland black coals are abundant and available close to the population centers. The same applies to Victoria with its brown coal assets. However, as is plain to those that have seen coal-fired plants in operation together with their open-cut (or underground) mines and ash disposal, that their detrimental effects on the surrounding areas is not inconsequential.

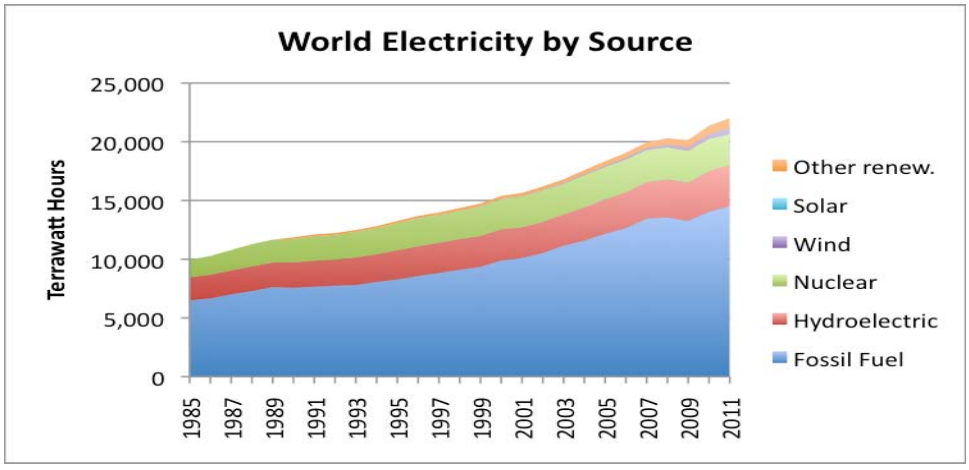
Emission from the exhaust chimneys of electricity plants came under scrutiny in the latter half of the last century. The first move was to limit the amount of fly-ash that exited the plants. Then came concern about emissions of nitrogen oxides and sulfur dioxide. Furthermore, governments are now moving to limit the effects of all industrial activities that produce so-called greenhouse gasses such as carbon dioxide. The following table provides a recent summary of the carbon dioxide emissions from various types of plants.

Lifecycle Greenhouse Gas Emissions

TECHNOLOGY	MEAN	LOW	HIGH
	tonnes CO2e/GWh		
Brown Coal*	1,054	790	1,372
Black Coal*	888	756	1,310
Oil	733	547	935
Natural Gas	499	362	891
Solar PV	85	13	731
Biomass	45	10	101
Nuclear	29	2	130
Hydroelectric	26	2	237
Wind	26	6	124

*carbon capture and sequestration was not included

The rest of the world too has responded to these goals by moving to alternative methods of generation such as the renewables solar and wind, but these approaches suffer from characteristics such as intermittency and cost. Hydro power is another renewable that has been extensively used in the past, but objections to this center on the problems with flooding areas behind dams. Nuclear is another proven option, but there are those that will not accept it including the Australian federal and state governments.



As can be seen in the above figure the world impact of non-hydro renewables in recent times is small but slowly increasing, whereas hydro itself is staying more or less constant as is nuclear. The major category to compensate for the increasing demand is that of fossil fuels – including natural gas, coal and oil in descending order.

Australian Electricity Production

The following table provides a breakdown of current Australian Electricity production in comparison with the world totals. As can be seen this country relies on coal more than the world does where the difference is made up by increased use of oil, natural gas, nuclear and hydro, whereas for the "other renewables", both about 2.5% of the total generation.

Electricity Generating Plant Characteristics

(Note: TWh = a terrawatt hour = a million million watt hours)

TYPE	Primary Energy Source	Pros/Cons	World TWh	Australia TWh
Coal	Black and Brown Coals	Widely used/high CO2 emissions,ash,land use damage	8,263 (40.8%)	198 (77.0%)
Oil		Used for small-scale remote plants/expensive	1,111 (5.5%)	2.8 (1.1%)
Natural Gas	Natural Gas	Widely used, quick response/moderate CO2 emissions, land use damage	4,301 (21.2%)	39.1 (15.2%)
Nuclear	Uranium/thorium/ plutonium	Widely used, minimal emissions/ banned in OZ for political reasons	2,731 (13.4%)	0 (0%)
Hydro	Descending Water	Widely used, good for peak power supplies and energy storage/ expansion is discouraged in OZ	3,288 (16.2%)	12.3 (4.8%)
Wind Turbines	Wnd	Minimal emissions/unreliable supply, low capacity factor	219 (1.1%)	3.9 (1.5%)
Solar PV	Sunlight	Good for small scale applications/ doesn't work when little or no sunshine	12 (0..06%)	0.2 (0.08%)
Solar Thermal	Sunlight	Still under development/very few used in the world	0.9 (0.004%)	0.004 (0.002%)
Biomass & Biogas	Vegetation	CO2 sequestration/completes with other land uses	271 (1.3%)	2.8 (1.1%)
Tidal	Sea Tides	Reliable primary energy supply/few costal zones compatible, corrosion	0.5 (0.003%)	0 (0%)
Geothermal	Heat from the earth	Used in few places (e.g. Iceland, NZ)/costly to establish if heat source hard to access	65 (0.3%)	0 (0%)
Totals			20,261	257

The total power of black and brown coal stations in Australia is 29407 MWe whereas the total annual generation from the above table is 198 TWh. Dividing the latter by the former yields 6733 hours, indicating that if all of the coal stations ran at 100% power for 6733 hours (76.9% of a year) the same total MWh would be produced. This 76.9% is called the "capacity factor" and is an indicator of plant reliability. For Australian hydro the capacity factor calculates to be 17.4% (i.e. used for peak power), and for wind the capacity factor calculates to be 23.9%,

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