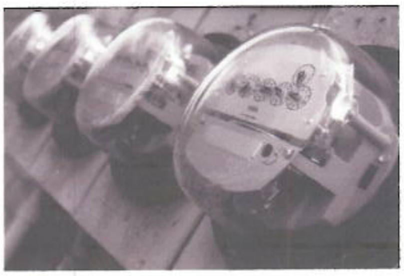
DISCUSSION PAPER –AUSTRALIAN ENERGY: MANAGEMENT OF REQUIREMENTS & RESOURCES

At the branch meeting on the 01/10/2008 I indicated that I would put forward a discussion/information paper on the subject of managing Australia's energy requirements and resources.

The information presented is the best I can find from extensive published data, but has limitations—technical, commercial and/or political. I have included my personal interpretations of complicated information.

I will address the issues under the following headings:

1. Brief audit of world's energy resources
2. Energy costs
3. World's arable land resources
4. UN population projections—world and Australia
5. Transport fuels
6. Suggestions for the future



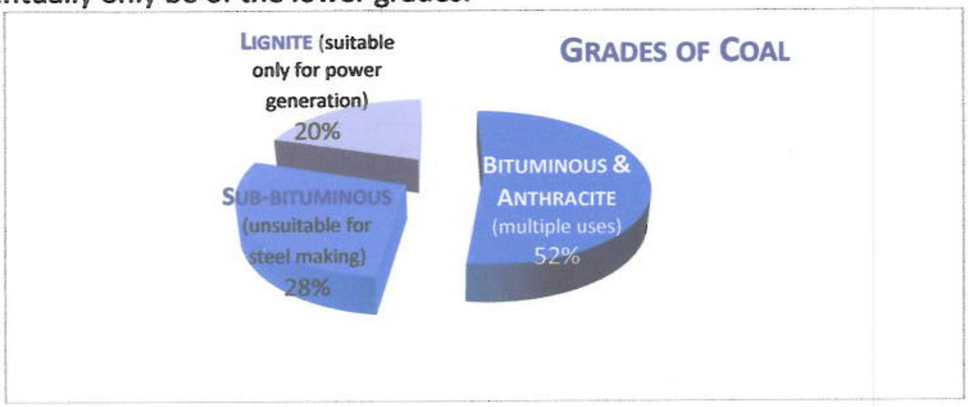
1. BRIEF AUDIT OF WORLD'S ENERGY RESOURCES

a. MINERAL FUELS – RESERVES & CONSUMPTION
b. OTHER MINERAL RESERVES
c. URANIUM RESERVES
d. WORLD NUCLEAR ENERGY PLANTS

a. MINERAL FUELS – RESERVES & CONSUMPTION

ITEM	PROVEN RESERVES	CONSUMPTION		TIME TO DEPLETE
OIL	1,326 trillion bbl	82.59 million bbl/day		45 years
NATURAL GAS	172.8 trillion m^3	2,819 billion m^3/year		61 years
COAL	998 billion tonnes	6195 million t/year		161 years
URANIUM	4.7 million tonnes	48564 t/year	primary reserves	98 years
			secondary reserves	47 000 years

Note: Australia has about 6% of world's coal reserves and 6% production giving the same depletion time of 161 years. However this may be deceptive: Coal is graded according to hardness and 'reserves' will eventually only be of the lower grades.



Comments:

On the positive side, it could be anticipated that additional discoveries would be made; but on the negative side, world demand keeps increasing. How long will oil and gas fuels last? Unknown, but some experts consider peak oil has been reached and output will soon decline. Probably less than 100 years.

Primary sources of uranium are cheap ($US 130/kg) when mined new out of the ground. Secondary sources are unknown deposits, lower grade deposits and reprocessing in fast breeder reactors at higher cost giving a time to deplete at 47 000 years.

If one is prepared to pay $US 300/kg there is a vast quantity available in the oceans not included in these estimates. Some experts consider the supply of uranium to be "unlimited" and that unlimited fusion energy (using deuterium in seawater) may one day be available.

If the energy supply becomes vast (except by cost) then mineral resources become the limitation.

b. Other Mineral Reserves

Some mineral reserves (major or primary minerals)

Mineral		Reserves	Production	Time to deplete
Copper		2.3 billion tonnes	16.2 million tonnes/year (2007)	
			9.5 million tonnes/year (1994)	142 years
Aluminium		5 billion tonnes	24.8 million tonnes/year (2007)	
			22.6 million tonnes/year (2004)	200 years
Iron Ore	World	330 billion tonnes	1 238 million tonnes/year (2003)	
			1 049 million tonnes/year (2001)	267 years
	Aus	40 billion tonnes	213 million tonnes/year (2003)	
			182 million tonnes/year (2001)	187 years

Production is easily measured but reserves can only be approximated. Recycling and new discoveries could extend the time before they are depleted.

c. Uranium Reserves

Uranium reserves

Major Suppliers	Reserves (tonnes)	Production (tonnes/year)
Australia	1462 000 (30%)	10 131 (21%)
Kazakhstan	961 000	7808
Russia	641 000	
South Africa	512 000	
Canada	497 000	11 148
USA	399 000	
Brazil	310 000	
Niger		2 976
World	4 780 000	48 564

d. World Nuclear Energy Plants

There are 438 nuclear energy plants in operation worldwide (including those listed below) & there are also 31 currently under construction.

USA	104
France	59
Japan	53
UK	35
Russia	29
Germany	19

Canada	14
India	14
Spain	9
South Africa	2
Australia	0

Note: France produces 78.8% of its electrical energy needs from nuclear power and 18% of EDF (Électricité de France) production is exported to Italy, Holland, the UK and Germany.

2. Energy Costs

a. Comparison of costs between nuclear & coal Power

b. Renewable Energy Costs

a. Comparison of costs between nuclear & coal Power

(reference: Wikipedia)		Nuclear $US/ megawatt hr	Coal $US/ megawatt hr
1	fuel	5.00	11.00
2	operation & maintenance, labour & materials	6.00	5.00
3	regulatory fees	1.00	0.10
4	pensions, income, taxes	1.00	1.00
5	property taxes	2.00	2.00
6	capital	9.00	9.00
7	decommission & waste costs	5.00	0.00
8	administration overheads	1.00	1.00
	total	30.00	29.10

Note: $10/megawatt hr = 1 cent/kilowatt hr

If we just consider operating costs (the above less items 6&7) nuclear is 1.6 cents/kW·h and coal 2.1 cents/ kW·h. Gas and oil are around 7-8 cents/ kW·h. (The gas-powered power station for the Hunter has been scuttled.)

Nuclear power is cost effective with other forms of electrical generation except where there is direct access to fossil fuels. Decommissioning and waste disposal costs are taken into account. Loss of agricultural land and carbon pollution costs should be (and will be) included in coal fired plant costs. When the social, health and environmental costs of fossil fuels are considered, then the advantage of nuclear energy is outstanding.

b. Renewable Energy Costs

Power Source		Cost per kW·h	
Wind	[on-shore]	3.2—11.0 cents/kW·h	
	[off-shore]	6.0—15.0 cents/kW·h	
Solar		20—30 cents/kW·h	[falling but needs to fall to ≤ 10c/kW·h to be competitive with wind]
Hydro		variable	[see below—Hydroelectricity]

Renewable energy costs and disadvantages are also subject to scrutiny. They are only effective if nature co-operates and are not suitable for base load power.

Hydroelectricity

Hydro power is cheap if the water is available. Cost may be difficult to calculate when the source is also utilised for domestic and/or irrigation needs. The large areas of land it requires for water storage can be good agricultural land.

Wind Turbines

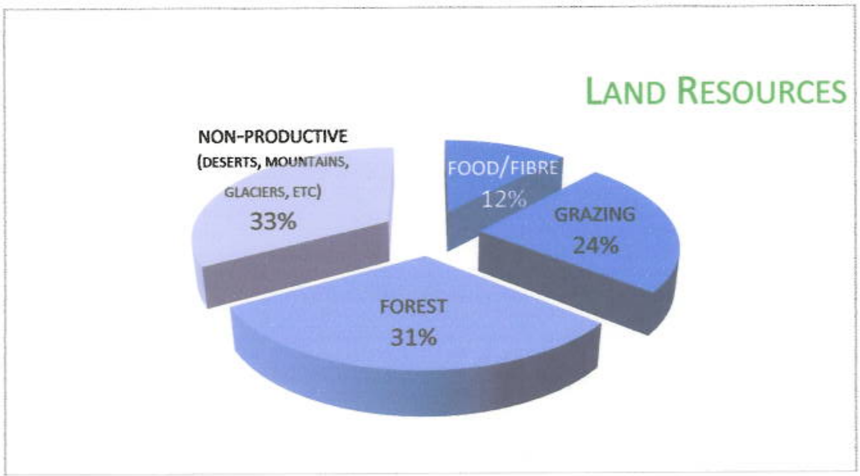
Wind-turbines have a short operating life of 20-25 years, less than ½ of that of power stations. Hundreds (even thousands) of wind- turbines, associated roads and power lines are viewed by many people (especially those living in rural areas) as ugly industrialisation of beautiful rural landscapes.

Wind-turbines can produce from about 1 to 3MW depending on the tower height, blade size, wind speed etc. A 3 MW turbine can be 415 feet high. One turbine can power about 250-600 homes exclusive of industrial, commercial and transport needs etc.

The wind-turbines installed in Australia (approx. 400) produce about 824 000 MW or 1% of electrical power needs. [Coal fired power stations produce 84%, the remaining 15% coming from gas, hydro and solar.]

The Federal Government's Mandatory Renewable Energy Target (MRET) is 20% of demand. Assuming that if we go to 10% wind this would require about 4000 turbines at present. If electricity demand doubles this century then around 8000 turbines would be required.

3. World's Arable Land Resources



The US Census Bureau (UN) predicts that the world's population will stabilise at about 9.7 billion by the end of this century. ***If*** all the resources are harnessed and adequate measures are taken to minimise soil degradation ***then*** sufficient food can be produced to feed the population in 2020 plus a few billion more. Using the FAO (UN) guideline of 2 persons/hectare of arable cropland, Australia would have a sustainable population of about 50 million people.
[see attached appendix]

4. UN Population Projections—Australia & the World

An appreciation of demographic demands is essential in order to plan for power needs. UN statistics give the world's population history briefly as follows.

Year	World Population	Australian Population		
100 000 BP	5.0 million	nil		
10 000 BP	10.0 million	300 000	population pre-1788 is unknown—300 000 is an educated guess	
1 AD	250 million	300 000		
1500	500 million	300 000		
1804	1.0 billion	300 000/ 10 000	Indigenous/ British	
1922	2.0 billion	5.5 million		
1959	3.0 billion	10.0 million		
1999	6.0 billion	19.0 million		
2008	6.7 billion	21.5 million		
2050	(projected) 8.9 billion	42.5 million	high	projections
		35.5 million	medium	
		30.9 million	low	
2100+	(stable) 9.7 billion	62.2 million	high	projections
		44.7 million	medium	
		33.7 million	low	

Notes: In the Palaeolithic world (100 000 BP—10 000 BP), with a hunter-gatherer society, growth rate was slow—approximately 1% every 1000 years. The growth rate increased after 10 000 BP with the agricultural revolution and increased again more steeply after 1800 with the industrial revolution.

World growth is now about 1.1% annually, and predicted to fall to 0.5% by 2050 and zero by the end of the century. If fertility rates stabilised to < 2.1 children/female, a slow population decline could be expected in the 22nd Century.

Some population geographers think the world will eventually only be able to support, at a 'good' standard of living, 1-2 billion people (with about 5-10 million of that in Australia).

Australia's population growth now is about 1.6% per year—about the average for the last 100 years. If this was repeated in the future we would have in

100 years 115 million people
200 years 612 million people
300 years 3 277 million people (ie: ≈3.3 billion people)

Clearly these projections will not happen—natural law will not permit it.

It can be noted that during 2007/2008 net overseas migration (NOM) was almost 200 000 people—the highest on record.

The workforce as a % of the population is expected to decline (under high-medium-low projections)
from 67% in 2008 ⇨ 59-61% in 2051 ⇨ 56-59% in 2101

High migration will not change the population ageing much (they grow old themselves). Only fertility increases.

Retired people (over 65)
from 13% of the population in 2008 ⇨ 22-24% in 2051 & ⇨25-28% in 2101

In actual numbers this is a rise from 2.8 million in 2008 ⇨11.2-12.5 million in 2101 (medium projection).

This will bring significant social and economic challenges as there will only be about 2.2 workers/retired person. People of retirement age will greatly outnumber children.

An excessively high migration program just fills out cities to a point where the infrastructure cannot cope and social problems multiply. I would suggest a 2/3 reduction of the 2007-08 figure of 200 000.

5. Transport Fuels

When considering electricity demand, a consideration of transport fuels is needed. As oil reserves decline, the price of oil increases (albeit with short term up and down variations).

Fossil fuels are:

- unleaded petrol
- LPG
- CNG (compressed natural gas) and
- diesel.

Biodiesel comes from vegetable oil or animal fat and needs agricultural land.

Ethanol also comes from plant material (corn, sugar cane) and also needs agricultural land.

The next generation of motor vehicles will be petrol/electric hybrids (HEV) and electric vehicles (usually with a distance limitation before recharging plus high battery costs).

The ideal solution sought is probably hydrogen (either directly or as a fuel cell), but there are significant technical and economic problems. Producing the hydrogen itself, plus transport, storage and distribution, all require a lot of energy making its use uneconomic. A hydrogen car is decades away—if one is manufactured at all.

As well as land transport fuels a modern society needs

- aviation fuels
- lubricating oils and
- road building materials (bitumen & asphalt)

} all of which are provided from oil.

Synthetic engine oils (usually from coal) are available currently at higher costs than from petroleum based lubricating oil (2-4 times).

Synthetic aviation fuels could come from coal to liquid (CTL) using the Fischer-Tropsch (F-T) process and natural gas to liquid (GTL) also using the F-T process.

Biofuels are the other route but there is competition with food production using arable land and water supplies.

Research on alternative aviation fuels is in its infancy with considerable challenges. Issues are—

- comparable fuel density
- energy efficiency and performance
- safety at altitudes with appropriate freezing point
- non-corrosion fuel systems or aero engine components and
- at no extra cost

Road building materials are a special problem. Most all weather pavements are flexible crushed rock/gravel/bitumen or crushed rock/gravel/asphalt combinations. Rigid reinforced concrete pavements are expensive and normally only used for heavy loads. Probably the only cost-effective solution is tar products again made from coal distillation. [This technology has fallen into disuse with cheaper and better petroleum products.]

6. Suggestions for the Future

Unfortunately the earth is not a magic pudding that instantly replaces each slice taken from it. I will make the following suggestions. (I won't call them recommendations as that is not the purpose of this discussion paper.)

I. That the electrical generating assets in NSW be sold to the private sector

The private sector is more flexible in responding to circumstances be it economic, technical or demographic with a lesser requirement for political expediency.

II. That nuclear power be gradually introduced to replace coal fired generators

A target of 40% in the short term (50 years) and 80-90% in the long term (100 years) is the suggestion. The purpose is to preserve coal reserves for alternative uses and the environmental benefits of almost zero carbon pollution. The high volume of coal and iron ore exports is an issue to be addressed as it appears to me that these 2 important resources are being depleted too fast.

III. That the MRET (20%) be reviewed with experience

I really can't see the purpose of 20% MRET other than as a "feel good" response to the need. It is more expensive, has technical limitations which exclude it from base load power and, frankly, is not worth the trouble (apart from hydro power where water supplies are abundant, and minor or specialised uses). The human mind seems to sometimes make the right decision only long after the original decision has been proven wrong.

IV. That social and economic policies be adopted (including a large reduction in migration) to stabilise the Australian population at no more than 33 million people in the next 100 years **(the low growth series option)**

This is ≈ 50% increase on the present population of 21.5 million, and about the same as the percentage increase in the world's population before it stabilises. The purpose is to address long term food and energy security, infrastructure planning certainty and social and economic challenges—and to be a responsible world 'citizen'. There needs to be a mature decision as to the number of people that this land can reasonably support.

M G Gane

29/01/2009

Appendix:

Notes from: Global Land Resources & Population Supporting Capacity

by Eswaran, Beinroth & Reich, 1999 (http://soils.usda.gov/use/worldsoils/papers/pop-support-paper.html)

Anticipated advances in biotechnology and sustainable land management in combination with the availability of high quality lands suggests a level of food production that will sustain twice the current global population. However, lack of political will, insufficient investments in modern agriculture, and a general apathy to the tenets of sustainable land management threaten food security in Third World countries and in some, contribute to poverty and famine. From a global land-productivity point of view the spectre of Malthusian scenarios seems unwarranted. Sadly, however, local and regional food shortages are likely to continue to occur unless mechanisms for equitable food distribution, effective technical assistance and infusions of capital for infrastructure development are implemented in some developing countries.

"Does human society want 10 to 15 billion humans living in poverty & malnourishment
or 1 to 2 billion living with abundant resources & a quality environment?"

...estimates [have been made] that to sustain the human population at an acceptable level, about 0.5 ha of cropland per capita is needed... Generally, total land area is used, and this results in erroneous or misleading conclusions. Per capita arable land is a better indicator...

The concluding report [of a meeting "Land Resources: On the Edge of the Malthusian Precipice?" 1998] indicates that, "if all the resources are harnessed and adequate measures taken to minimize soil degradation, sufficient food to feed the population in 2020 can be produced, and probably sufficient for a few billion more."

Tables 3 & 4 combined

LAND QUALITY CLASS	PROPERTIES	AREA (million km^2)	CUMULATIVE LAND AREA (million km^2)	% GLOBAL (CUMULATIVE)
I	This is prime land. Soils are highly productive, with few management-related constraints. Soil temp & moisture conditions are ideal for annual crops. Soil management consists largely of sensible conservation practices to minimize erosion, appropriate fertilisation, & use of best available plant materials.	4.09	4.09	3.13
II III	The soils are good & have few problems for sustainable production. However (& particularly for Class II soils) care must be taken to reduce degradation. The lower resilience characteristics of Class II soils make them more risky, particular for low-input grain crop production. However, their productivity is generally very high and consequently, response to management is high. Conservation tillage is essential, buffer strips are generally required & fertilizer use must be carefully managed.	6.53 5.89	10.62 16.51	8.13 12.64
IV V VI	If there is a choice, these soils must not be used for grain crop production & no grain crop production must be contemplated in the absence of a good conservation plan. Lack of plant nutrients is a major constraint & so a good fertilizer use plan must be adopted. Soil degradation must be continuously monitored. Productivity is not high & so low input farmers must receive considerable support to manage these soils or be discouraged from using them. In the semi-arid areas, they can be managed for range.	5.11 21.35 17.22	21.62 42.97 60.19	15.56 32.91 46.09
VII	These soils may only be used for grain crop production if there is a real pressure on land. They are definitely not suitable for low-input grain crop production; their low resilience makes them easily prone to degradation. They should be retained under natural forests or range. Biodiversity management is crucial in these areas.	11.65	71.84	55.02
VIII IX	These are soils belonging to very fragile ecosystems or are very uneconomical to use for grain crop production. They should be retained under their natural state. In Class IX, which is largely confined to the Boreal area, timber harvesting must be done very carefully with considerable attention to ecosystem damage. Class VIII is mainly the deserts.	36.96 21.78	108.8 130.58	83.32 100.00

Table 5. Idealised Land Use Pattern (% of land)				
Land Class	Agriculture (Grain crops)	Biodiversity Zones		Urban / industry / infrastructure
		Forestry	Wilderness	
I	70	20	5	5
II	60	30	5	5
III	50	35	10	5
IV	45	40	10	5
V	40	45	10	5
VI	30	50	15	5
VII	10	50	35	5
VIII	5	60	30	5
IX	5	30	60	5

Table 7. Population supporting capacity (/billion persons) of each Land Quality Class (Current global population: 6 billion persons)						
Land Class	Low Level Input		Medium Level Input		High Level Input	
	Optimal population supporting capacity	Cumulative population supporting capacity	Optimal population supporting capacity	Cumulative population supporting capacity	Optimal population supporting capacity	Cumulative population supporting capacity
I	0.982	0.982	1.472	1.472	2.45	2.45
II	1.371	2.353	1.959	3.431	2.351	4.801
III	0.884	3.237	1.178	4.609	2.695	7.496
IV	0.460	3.697	0.689	5.298	1.610	9.106
V	1.601	5.298	2.135	7.433	6.405	15.511
VI	0.861	6.159	1.292	8.725	4.305	19.816