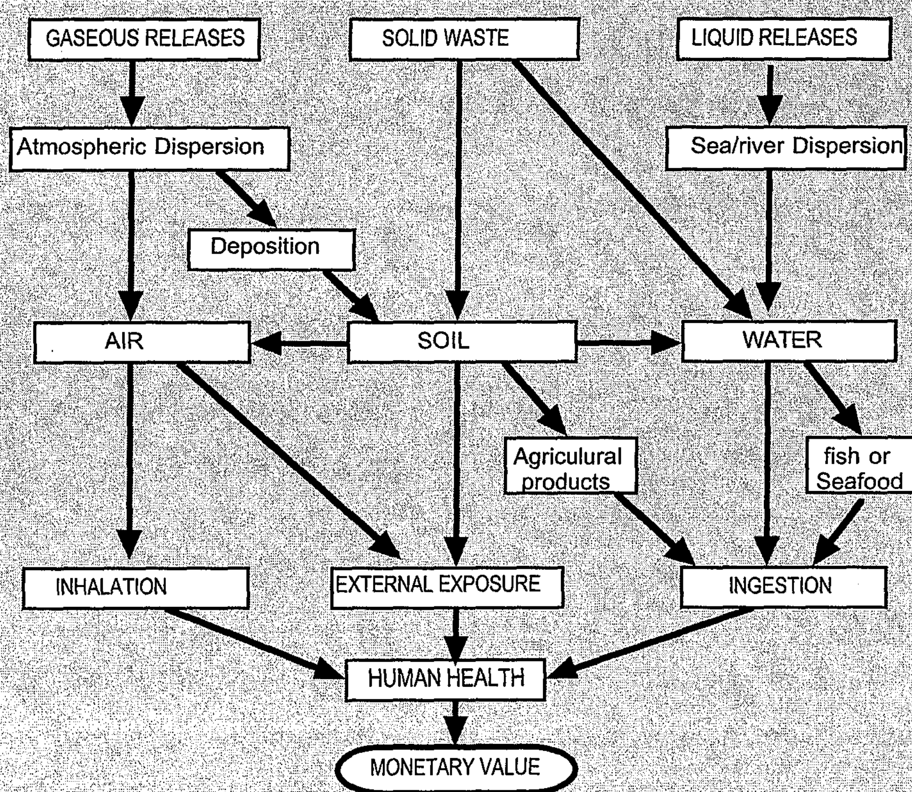
Submission to the HOR Standing Committee of Industry and Resources Inquiry into the development of the non-fossil fuel energy industry in Australia

Case study into the strategic importance of Australia's uranium resources

By Alan A. Parker 16th May 2005

Radioactive releases from the nuclear energy chain



A schematic representation of radioactive releases from the nuclear energy chain is shown. The priority impacts for the general public are radiological and non-radiological impacts due to the routine and accidental releases to the environment. The sources of these impacts are the releases of materials through atmospheric, liquid and solid waste

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INTRODUCTION.

Nuclear fission is a concentrated energy source, such that 1 kg of uranium yields the same amount of energy as 22 000 kg of coal, or 15 000 kg of oil, The electricity supplied to the grid from one 1000 MW nuclear station with a life of 50 years is equivalent to that of 2000 large 2 MW wind turbines with a 50 year life if the intermittent nature of wind power is accounted for. There are 441 nuclear electricity generators around the world and 27 more are under construction and the International Atomic Energy Agency says 60 more will start up over the next 15 years and many of these will be in China.

Australia has the the dubious distinction of being the world's highest per-capita emitter of greenhouse gases, higher even than the US. Australia has 45% if the world's reserves of uranium - and of thorium, which some see as a promising alternative fuel for nuclear power. This submission argues that if the Asian nations in our region are to survive the peaking of affordable oil production they will need hundreds more nuclear power stations to survive. Australia should ensure that enough uranium and thorium is available to our regional trading partners who are not well endowed with either oil or uranium reserves.

In the western world there is paradox in peoples attitudes to nuclear power. The most appealing aspect of nuclear power is that uranium fuel in the reactor does not produce the greenhouse gases, ozone depletion and or the acid rain produced by fossil fuel power stations. The carbon dioxide (CO2) emissions from uranium mining and processing are small and comparable to the CO2 emitted in creating and maintaining wind farms The less appealing side of nuclear power are the radioactive emission from mining and reactor nuclear waste (see front cover). There is the fear of radiation poisoning from a reactor accident or terrorist attack which the general public (but not the industry) perceive as a significant problem. One route to overcoming peoples fears is to show how the nuclear industry has greatly improved since it early development and while fusion power is still a dream, the latest models of fission reactors using uranium are reliable and infinitely safer: To quote one nuclear engineer.

"The new high grade uranium mines coming into operation in Northern Saskatchewan in the early years of this century are a case in point. They are underground operations which need to disturb relatively small amounts of host rock given the high grades. Environmentally, they are capable of demonstrating a very high standard which any mining operation world wide would have difficulties beating. The high standards of radiation protection achieved by the large French reactor programme are another example where best practice needs to be extended throughout the world." (Kidd,S 1998)

For the mining and processing of uranium. international protocols and agreements already exist for safely storing the radioactive waste products from reactors and uranium mining and processing. The public needs to be aware of these and other safeguards that are now in place. National governments set in place energy security policies that show why nuclear power is needed for their own ecologically sustainable development by:-

"Decoupling economic growth from the growth in oil consumption and the use of non renewable resources". (NEPP 3 1998)

This submission argues that unless far more nuclear power is used instead of fossil fuels, a few years after the peaking of conventional oil production around 2008, billions of barrels of oil and billion of tonnes of CO2 will be produced mostly in Canada and the US from tar sands, shale, contaminated sour oil fields and oil fields in deep water. Should this happen it will generate so much extra CO2 and methane, compared to conventional oil, that it may induce irreversible "runaway" global warming that will melt all the glaciers and the ice caps, rising sea level by 5 meters by around 2100. This would put large areas of the worlds coastal cities under water, destroying essential infrastructure and low lying farmland.

Even if "runaway" global warming does not eventuate but maintains warming continues it's slow linear increase the synergetic interaction with oil depletion and other environmental "time bombs" that have been ticking away for many years and will result in world food production peaking and then declining at a rapid rate creating mass starvation unless the developing nations have access to safe nuclear power.

Nuclear electricity generation has a great future in Asia but not in US or UK .

Perhaps the greatest fear of nuclear power comes from the loss of confidence in the Nuclear Non-Proliferation Treaty and nuclear safeguards. Former US secretary of defence McNamarra,. who helped to avoid a nuclear war over Cuba, says that current U.S. nuclear weapons policy is "immoral, illegal, militarily unnecessary, and dreadfully dangerous" (McNamarra 2005) and Former President of the Soviet Union Gorbachoff and many experienced western diplomats agree with him. The problem that US has is that it is its own worst enemy that is jeopardising the peaceful spread of nuclear power and the export of Australian uranium and thorium.

Today the fear of an accident like that Chernobyl is no longer justified, but the threat of a suicidal team of muslim Kamikaze taking out a nuclear power reactor and its nuclear waste store, with a tactical nuclear weapon, a big truck full of explosives, a large aircraft or a LPG tanker, cannot be ignored. Nobody can confidently say it is not going happen to one of the 104 US reactors or one of the 31 UK reactors. Such a catastrophe would create a radioactive cloud that could kill tens of thousands of people, cause the evacuation of 20 to 40 million people and knock out the electricity power grids over much of the USA. It could be worse than the accident at Chernobyl where the fire was contained within the reactor building preventing a total melt down into the earth. A well planned attack could be catastrophic with a meltdown of the reactor cores and explosive release of radioactive fallout.

The ugly truth is that the future of the nuclear power industry, which has the skills to safely run and maintain reactors, has been jeopardised by US foreign policy and covert military operations that funded, trained and built infrastructure in Afghanistan for Bin Laden and his supporters who now have genocidal intentions. Inspired by successful 9/11 surprise attack on the US, there are thousands of educated muslim young men who would consider it an honour to be a Muslim Kamikaze. Even when Bin Laden is dead his soul will go marching on. The development of high security defences for existing reactors and the post 9/11 restrictions

to civil liberties will merely create mass opposition to new nuclear reactors".
Australia's is also at risk from terrorist attack, which why the greenies and left wing groups will bring down any government that builds nuclear reactors. Its reasonable to assume that the Nuclear Power Industry has no secure future in the USA, the UK and Australia. We know China, India, Japan and Indonesia will will need nuclear power if they are to survive and Bin Laden's muslim Kamikaze terrorists have no quarrel with these nations, indeed they see them and other asian nations as being either being neutral or the victims of US imperialism.

NUCLEAR POWER IS NEEDED TO MAINTAIN ASIAN FOOD PRODUCTION

The nuclear power industry and the Australian uranium mining industry has a great potential market in Asia and Australia should sell its uranium to the nations in our region who can use it to help them to avoid an economic meltdown and declining food production due to the ongoing shortages of affordable oil from around 2008 to 2012. The greatest longer term threat to Asian national security, is that Cheap oil production is declining in the same 30 year time frame as increased drought, storm damage and rising sea levels due to global warming; a decline in fresh water availability and quality; increasing salinity and soil loss. If the Asian economies stop growing the demand for Australian Uranium and Thorium steel, iron ore and other many other commodities will dry up.

Evidence is presented in this submission to show that the synergetic interaction of oil depletion with other environmental "time bombs" that have been ticking away for many years will result in world food production peaking and then declining at a rapid rate. However, the generation of more nuclear electricity will not be available to help combat this problem unless international action is taken within a few years. How nuclear electricity can be used to substitute for oil in the transport sector is explained later (see pages 8, 24, 34 and 38). A lot is known about environmental problems in isolation but there is great uncertainty about how they will interact with one another and how increasing costs of oil will constrain efforts to deal with these problems. We know that cheap oil powers farm machinery such as tractors, generators for refrigerated food storage in rural areas, trucks to take the food to village markets and nearby cities and most fertilisers and pesticides are petroleum (oil) based.

Assuming adequate food production, the population of the world has been predicted by the U.N. to grow by 1.2% per year from 6.3 billion in 2003 to 8 billion by 2028; ie 1.7 billion more people to feed in 25 years. The problem is that world cereal crop production has been shrinking on a per capita basis since 1984 and world tonnage of grain production and grain reserves have been dropping from 1999 to 2004. By 2008 most grain will be consumed almost as quickly as it is produced. The poor nations of the world will suffer because there is not enough grain nor is it equitably distributed. (Vital Signs 2003) World food production is likely to decline from around 2008 and a billion people or more could starve to death a few years later because affordable oil is not available to deal with the following five problems.

1) Oil to power-assist labour intensive farming in poor countries is not affordable
Wealthy OECD countries will buy all the high cost oil to keep their car dependent transport systems going and for their oil intensive agricultural practices. For example U.S. food

production consumes ten times more fossil fuel energy than it produces in food energy. In 2003 there were 224 million motor vehicles and 4.8 million tractors in the USA for a population of 290 million people, but for 2,571 million living in China, India and Indonesia there were only 31 million motor vehicles and 2.5 million tractors. (www.nationmaster.com) The Asian nations need not only more tractors but a new generation of petrol/electric hybrid vehicles of all kinds. In marked contrast the US is grossly over mechanised so that four litres of oil are expended each day to feed each American. Because power "comes out of the end of a gun" carried today's gas guzzling armoured vehicles, the US and other rich allies will get priority in accessing oil supplies.

This will deprive the poor countries of the oil needed, to power assist their labour intensive food production, with small tractors and light agricultural machinery, and to transport their food to regional markets. (Simms 2004) There is no international agreement to ensure oil at an affordable price is available when the cheap oil is no longer available, nor is there any such agreement being considered by the UN or WHO.

2) Oil for the mitigation of the world wide depletion of soil is not affordable

Cheap oil is needed to power the machines and desalination plants which are needed to combat enhanced desertification and salinization of the fresh water supply along the coastal areas due to rising sea levels and enhanced erosion of arable land. Due to desertification, 8,800 square kilometres of formerly productive land and 25 billion tons of topsoil will be lost globally each year, due to misuse or overuse of the land. Arable farmland has been shrinking by over 1% every year, as an ever-larger proportion of the world's population live in cities Which are built on what was formerly productive farmland. Soil's long term value as a renewable resource that will hold water and produce food, fuel and fibre is ignored by free market ideologues. As with oil we are depleting the soil at a much faster rate than it is being rejuvenated. (CFAN 1999).

The countries at most risk from soil depletion are the poorest or most populous developing nations. For example, the four land rich developed countries of the U.S. Russia, Australia and Canada have 400 million hectares of arable and permanent farmland with a combined population of 487 million or 0.82 hectares per person. The most populous developing nations of China, India, Indonesia, Pakistan, Bangladesh and Nigeria in total also have 400 million hectares of arable and permanent farmland to feed 3 billion people or 0.13 hectares per person. China has been using twice the amount of fertiliser per hectare than the US, and when the cheap oil to make affordable fertiliser has gone, crop yields will greatly reduce. (www.nationmaster.com)

Part of the problem of soil depletion in India, China and Asia is that because there is so little electricity available for heating, lighting, cooking or operating or gardening aids like mulching machines. Approximately half the energy consumed nationally comes from poor people using waste, firewood and dung instead of using these materials for compost or mulched which can fertilise the soil. (IEA 2002) If electricity from nuclear power plants coupled with modern wind turbines wind was available in the the rural food producing areas deforestation could be greatly reduced and the quality of soils enhanced. For example around 2000 the imposition of

US sanctions and the collapse of the Soviet Union greatly reduced Cuba's access to both oil and fertiliser and has subsequently proved that organic agriculture can support a nation. (Pfeiffer,D.A.2003). However if India and China are going to survive the end of the age of cheap oil they are going to need both nuclear energy and organic farming.

3) Water for agriculture in most parts of the world is being used up

According to the UN, in 2001 30 nations faces water shortages; by 2020 that will increase to 50 nations with empty wells, polluted lakes and rivers that will run dry. Cutbacks in grain harvests will occur in many countries due to world's largest aquifers being depleted in China, India, and the U.S. These countries collectively account more than half of the world's grain harvest. (www.nationmaster.com)

Because it takes a thousand tons of water to produce a ton of grain, fresh water, its acquisition and delivery will become critical for many more countries in the next decade. Water scarcity, once a local issue, is creating conflict as major rivers are being damned in one country and depriving water to countries down stream. Nuclear energy is needed if such conflict is to be avoided and water resources equitably shared In 20 years, southern Australia will experience severe drought and permanent water shortages. Australia has perhaps the most nutrient deficient soils in the world, especially in the south-west corner of W A. Present crop production practices have only succeeded through extensive use of fertilisers and diesel fuel but in the future water shortages will decimate grain production. (Pearce 2004) (Brown 2003) (Flannery 2004) (Fleay 2003)

4) Climate change depletes or destroys land and produces a tidal wave of refugees

The oceans are warming and warmer water is slowly spreading towards the poles. Violent cyclones, floods, drought, tornadoes and violent storm surges will increase in frequency and intensity. This will destroy crops, plantations, terrace agriculture and other irrigation systems that have taken decades to be productive. In low-lying coastal areas sea level rises will flood farmland. In the longer term, sea water will permeate through the ground and waterways further inland destroying even more productive farmland. The interaction of hunger and sea-level rises in vulnerable low lying areas in the developing world could produce up to 800 million refugees fleeing from starvation. (Brown 2003).

200 of the world's leading climate scientists - meeting at Tony Blair's request at the Met Office's new headquarters at Exeter - issued the most urgent warning to date that dangerous climate change is taking place, and that time is running out. The the biggest-ever study of climate change, based at Oxford University, reported that it could prove to be twice as catastrophic as the IPCC's worst predictions. And an international task force - also reporting to Tony Blair, and - concluded that we could reach "the point of no return" in a decade. Worse, leading scientists warned of catastrophic changes that once they had dismissed as "improbable". The meeting was particularly alarmed by powerful evidence, that the oceans are slowly turning acid, threatening all marine life. Professor Chris Rapley, director of the British Antarctic Survey, presented new evidence that the West Antarctic ice sheet is beginning to melt, threatening eventually to raise sea levels by 15 ft: 90 per cent of the world's people live near current sea levels. " (McCarthy 2005)

And that is not the worst case scenario for climate change that was described in a US Pentagon study. (Schwartz and Randall 2003) However the US is one of the largest emitters of greenhouse gases like carbon dioxide (CO_2), but rejects most scientific opinion that mankind is largely to blame for climate warming and has refused to join the Kyoto Protocol on curbing emissions. Australia has also refused to sign probably because their per capita emissions of carbon dioxide are around 20 tonnes per year compared with 2.7 tonnes in China and 1 tonne in India. See table 1

5) Global warming spreads tropical diseases over more inhabited areas.
It is predicted that the diffusion of respiratory disease will occur as the world warms and that around 600 million more people will die. For example, in Australia airborne vectors carrying malaria and Japanese encephalitis will head south into productive farming areas.

The above 5 scenario's suggests that world wide a billion or more people could be reduced to unemployment and poverty in the not so distant future. In the longer term perhaps there could be a Malthusian die-off from starvation. Australia is not immune to this gathering global storm but has the capacity and resources to survive with a more frugal lifestyle and use of more energy efficient renewable energy which will become more cost competitive as the energy return on energy invested in extracting oil, gas and declines. It is argued that the strategic importance of Australia's uranium resource is to substitute for oil that is needed for essential uses for which there is no alternative.

HOW A LESS OIL DEPENDENT NUCLEAR ELECTRIC TRANSPORT SYSTEMS IN ASIA CAN HELP MAINTAIN FOOD PRODUCTION.

What Australian has in common with our Asian neighbours is a need to create energy efficient transport systems within cities and between cities that use far less energy, are less polluting and are far more reliant on electricity.Rather than speculating on a revolution in transportation based on the use of nuclear energy to produce hydrogen, a thermodynamically inefficient fuel requiring an altogether new infrastructure. As will be explained later mass produced low cost hydrogen fuel cell cars and their fuelling infrastructure are at least 20 years away. The Uranium Inquiry should recognise the transportation revolution - that is based on electricity and existing technology - has already begun and needs to be encouraged.

It is argued that transport systems that are mostly powered by nuclear electricity will be crucially important between 2008 and 2024. The economy of hybrid petrol electric vehicles of all kinds, car trucks and buses is proven beyond any doubt. This is only one transportation alternative for car, trucks and LCV's, that is relevant to survival when oil is too expensive or unobtainable, which is already less expensive per km driven than oil-based transport. We are already seeing a rapid embrace of hybridisation by car makers and consumers who intend to provide for overnight charging in future hybrid models which suits our base load power stations which need more night-time, off-peak demand to increase their efficiency.

In Asia there is also a need to extend diesel/electric hybrid technology farming equipment and Asian vehicles which fulfil the role of the Australian ute in rural areas. With exception of Japan and the current copy cat approach of Asian governments is the adoption of the internal combustion engine as the model for the development of car, trucks , LCV's. and stationary farm equipment.

In few years a large fraction of our routine personal transportation in cities could be comfortably met with today's electricity storage and drive technology. This doesn't mean every car will or must or should become all-electric. None the less, a large fraction of the worlds transportation market can, in ten to 15 years, could be transferred from oil to electricity.

Developing Asia needs to learn from world best practice in electric traction. For example electric urban passenger trains and trams have been in Australian cities for 90 years and high speed 230 km per intercity expresses have been working safely in Japan for decades. Electric buses and delivery vehicles were used for over 50 years in many European cities. Ten years ago Japan created the electric power assisted bicycle to substitute for short car trips and in 2005 factories in China will produce 6 million electric bicycles. This is not common knowledge in Australia but the electric bicycle is intended to replace many millions of polluting two wheelers with dirty 2 stroke internal combustion engines in China's largest cities which are very badly polluted.

Why any sane politician would want to commit the next generation of city dwellers to breath the airborne filth from internal combustion engines is very strange but many do. The brown haze of airborne filth seen over Sydney and Melbourne is nowhere near as bad as in Asia's major cities especially those 12 Chinese cities with over 5 million population. However, the external health costs are ignored in most of Asia, except for Japan where the electric traction transport revolution is well developed and has potential for diffusion throughout of Asia.

In 2004 the Chinese minister for transport released data that showed that by 2030 there would be 300 million more motor vehicles in China. If their primary energy source is oil then Chinese cities will continue to be the most polluted in the world. and there economy will fall apart long before 2030. Hopefully in the future, factories in China and India will producing millions of electric vehicles and hybrid vehicles of all kinds, and Australian uranium will be producing much of the energy needed for extracting and processing the raw materials required for their construction, fabrication and machining the parts and in their assembly.

Energy security is the most positive externality of nuclear power according to the Nuclear Energy Agency report on the external costs of nuclear electricity generation. (NEC-OECD Annex 1 2003) Therefore the strategic importance of Australian uranium to the Asian regional economy lies in the production of relatively clean off-peak nuclear electricity for many essential purposes and the manufacture and use use of hybrid petrol electric vehicles and to electrically power assist other machines and vehicles.

Will uranium reserves last long enough to survive the end of the age of oil

World uranium consumption by reactors is around 64,000 tonnes per annum, and there are 1.32 million tonnes of low cost proven reserves which suggest that these reserves will only last 20 years. However, that is misleading It is not known how long the reserves will last because the funding of uranium exploration is many years and billions of dollars behind and no where near as comprehensive and complete as exploration for oil and gas. Indeed some of richest uranium deposits have only recently been discovered whereas all the really big oil field where discovered over 40 years ago It is likely that many more high grade uranium deposits will be found and it has been estimated that the ultimate resource base is far larger.

Table 1 Major Uranium ore reserves/grades and production capacity

Up dated 29-10-2004

Mine	Proven Reserves	Average Ore Grade	Annual Production
	(tonnes U3O8)	(% U 308)	(tonnes U3O8)
Rabbit Lake (Canada)	5,680	1.29	32
Cluff Lake (Canada)	2,130	2.50	1,519
McClean Lake (Canada)	16,650	1.80	2,737
McArthur River (Canada)	159,000	26.63	6,877
Ranger (Australia)	27,900	0.20	4,667
Olympic Dam (Australia)	69,000	0.06	3,993
Rossing (Namibia)	117,900	0.40	2,036
Akouta Arlit (Nigeria)	90,720	0.46	3,150
Krasnokomonsk (Russia)	90,720	0.15	2,270
Highland (USA)	9,000	0.15	450
WORLD AVERAGE		0.15%	

In addition to uranium ore reserves shown on table 1 Canada has three projects under development: **Cigar Lake** (20.6% U3O8, 102,900 tonnes proven reserves), **Midwest** (4.5% U3O8, 16,300 tonnes proven reserves), and **Dawn Lake** (1.7% U3O8, 5,800 tonnes proven reserves). Cigar Lake is expected to produce 8,200 tonnes/yr. starting around 2007, and Midwest is expected to produce 2,600 tonnes/yr. starting in 2005. With these two mines operating it is predicted that Canada will be be producing half the world's uranium ore supply. In 1999 it was announced that a high-grade uranium deposit had been discovered at **La Rocque Lake** in Saskatchewan, with a U3O8 grade between 8% and 30%.

The Red Book (OECD/NEA/IEA 1996) assesses the current uranium resource base at 11 million tonnes, if less well-proven, speculative and higher-cost resources are included. This means that uranium reserves are like to last 170 years at current rates of consumption or around 50 years if a lot more reactors are built. Even so we do not how many new reactors will be built to reduce greenhouse gas emissions, to replace oil when oil production peaks around 2008 or how much more fissile materials will be obtained from decommissioned nuclear weapons.

There is also uranium in phosphates and sea water, but the concentrations are so low that the energy required to extract it would exceed many times the energy obtained from any nuclear power resulting. < www.oprit.rug.nl/deenen/ > Regarding Australian uranium, it would be prudent for this inquiry to assume that it is a finite resource until breeders reactors are capable of safely extending the productive use of uranium and it's radioactive bye-products.

In the longer term as the reserves of affordable and abundant ores with 1 % or of more of uranium are gone, carbon dioxide emissions may increase because much higher volumes of low grade ores will have to be mined to get the same amount of uranium. In time the projected increase in demand for nuclear power may require the exploitation of the leaner ores that greatly increase carbon dioxide emissions. At ore grades below 0.01% for 'soft' ores and 0.02% for 'hard' ores more CO2 more energy is absorbed in the cycle that is gained in it. (Busby, J 2005) Hopefully, many years from now, the use of very lean ores can be avoided by the reprocessing of nuclear waste and by new and safer breeder reactors.

The first generation of Breeder reactors were a failure.

The clean and safe use of breeder reactors to provide an infinite supply of plutonium - which is one the most poisonous materials known and in the past was mostly used to produce nuclear weapons- is very much in doubt. The extreme heat produced in the confined space of the breeder reactor means that molten metal or liquid sodium is required to remove the heat which makes them susceptible to serious fires and long shut downs.

France which gets 78% (2003) of its electricity from uranium reactors and Britain with its 24 % of nuclear electricity, have both pursued breeder reactor programs for many years but have no future plans for building breeder reactors. Japan which produces 25% of its electricity fro nuclear reactors closed down its Monju breeder reactor due to a sodium fire in 1999. Two MOX reactors have also been built, one in France and the other the UK, that use a mixed oxide of uranium and plutonium made from reprocessed spent fuel. Both have turned out to be financial and environmental disasters. (see <www.sortirdunucleaire.org>) It would therefore be prudent for the HOR inquiry to assume that uranium is a finite resource until a breeder reactor is built and has been safely running for at ten years.

One of the newest designs is the Pebble Bed Modular Reactor which is being built in China and it will be a few years before its safety performance can be assessed in practice. It seems unlikely that Australia will need much nuclear power as it blessed with abundant renewable energy resources, of wind, solar and geothermal power and vast unpopulated areas that could possibly be used to store nuclear waste.

Nuclear power produces one twelfth of the CO2 than black coal power stations.

The International Energy Agency predicts that without reducing the demand for oil global emissions of greenhouse gases will increase by over 60% between 2002 and 2030. Emissions would reduce by 33% even under a scenario in which governments impose tougher environmental policies to reduce emissions.

In the UK about 290,000 tonnes of carbon dioxide per GW-year of nuclear-powered electricity generation, that is about 0.035 kg/kWh, compared (for example) to 0.41 kg/kWh for the overall average emissions for UK electricity generation. (Slessor 2005). That is less than one tenth of the carbon dioxide emissions of gas and black coal fired power stations. This is because the nuclear electricity fuel chain embodies some fossil energy which produces CO2 emissions but nuclear reactor does not emit CO2. A "cradle to the grave" analysis of CO2 emissions from mining uranium ores, milling and enrichment of the ores, in fuel can preparation and the construction of the station, its decommissioning and demolition, handing of the spent waste and its reprocessing and the disposal of mine tailings, reveals that the embodied CO2 emissions are similar to those of wind power and solar electric power. This is so, because only high grade ores are being exploited world wide, and CO2 emissions are an order of magnitude less than to gas and black coal fired power stations (NEC-OECD 2003)

Table 2 External and direct costs of electricity generation in the EU (m /kWh)

External costs	Coal & Lignite	Oil	Gas	Nuclear	Biomass	Solar PV	Wind
Austria			11-26		24-25		
Belgium	37-150		11-22	4-4.7			
Germany	30-55	51-78	12-23	4.4-7	28-29	1.4-3.3	0.5-0.6
Denmark	35-65		15-30		12-14		0.9-1.6
Spain	48-77		11-22		29-52		1.8-1.9
Finland	20-44				8-11		
France	69-99	84-109	24-35	2.5	6-7		
Greece	46-84	26-48	7-13		1-8		2.4-2.6
Ireland	59-84						
Italy		34-56	15-27				
Netherlands	28-42		5-19	7.4	4-5		
Norway			8-19		2.4		0.5-2.5
Portugal	42-67		8-21		14-18		
Sweden	18-42				2.7-3		
UK	42-67	29-47	11-22	2.4-2.7	5.3-5.7		1.3-1.5
Direct costs	**32-50**	**49-52**	**26-35**	**34-59**	**34-43**	**512-853**	**67-72**

Like other energy sources, nuclear energy has risks and benefits that need to be fully recognised and assessed to evaluate its external costs. In the process, it is essential to analyse the direct economic costs of nuclear-generated electricity in order to delineate accurately the boundary between economic (internalised) costs and potential external costs, and to indicate the potential impact on total costs if the external costs were internalised. (NEC-OECD 2003)

Tables 2 shows that nuclear electricity generation cost estimates, both for internalised (direct) costs and externalities, vary from country to country. Similar variations are observed for alternative technologies. Table 3 summarises external cost ranges for different technologies obtained within the ExternE study (EC, 1999), and presents, for comparison purposes, direct cost ranges that are an average in European Union countries drawn from the Green Paper of the European Commission (EC, 2000).

Although both direct and external costs vary within rather wide ranges, some generic findings may be drawn from the overall comparison of direct versus external costs for each technology. For fossil fuels and biomass, external costs may be of the same order of magnitude as direct costs. On the other hand, for nuclear electricity, solar photovoltaïc and wind power, external costs are at least one order of magnitude lower than direct costs. (NEC-OECD 2003)

A study on power generation in Germany (Voss, 2002) illustrates the type of findings that may be obtained from external cost analysis. If the external cost estimates from that study are combined with direct costs, nuclear, which is already nearly competitive with coal and cheaper than natural gas, becomes the lowest cost option for base load electricity generation in Germany. A "cradle to the grave" analysis of nuclear power shows that it is as clean and as efficient as wind power, until the high grade uranium is depleted. The strategic role of Australian uranium in reducing greenhouse emissions and coping with a decline in world oil production is clear enough.

THE "ECOLOGICAL FOOTPRINT", OIL USE AND OTHER INDICATORS OF FUTURE NUCLEAR ENERGY NEEDS IN SELECTED COUNTRIES

Table 3 is ranked in order of per capita national ecological footprint from the smallest to the largest (Venetoulis, Chazan.and Gaudet 2004) This is an important tool for measuring and analysing natural resource consumption and waste output within the context of nature's renewable and regenerative capacity. The ecological footprint is a quantative assessment of the biological area required to produce the resources (food, energy and materials) and absorb the wastes put out by the population of a country, state or city over the period of one year.

From the ecological perspective, if we remove more from nature that can be provided indefinitely we are on a unsustainable track. The average Australians footprint is about the area of seven soccer fields and is five time more than the average Chinese. Table 3 also shows per capita, GDP, oil consumption, carbon dioxide emissions, and motor vehicle ownership and the years of oil self sufficiency at 2003 rates of national oil consumption. The inequitable distribution of the oil resources and the vulnerability of the populous poorer countries and many of the high per capita GDP countries to any disruption in oil supplies is shown.

Table 3. The Ecological footprint, GDP, motor vehicles , CO_2 emissions & oil data for 32 major oil producing and consuming countries

Country	Ecological Footprint: hectares per capita Year 2000	GDP per capita US$1000 per year 2001 +	Motor vehicles per 1000 population 1997 CIA	Carbon Dioxide tonnes per capita 2000 +	Oil consumed, per capita barrels per year +	Proven oil reserves billion barrels 2003 #	Proven oil reserves barrels per capita 2003 #	Years of oil self sufficiency with 2003 usage #
Bangladesh	0.5	1.7	2	0.21	0.2	<1	<1	<1
India	0.76	2.5	12	0.96	0.7	4.9	4	6
Indonesia	0.98	3	21	1.21	1.6	9.4	30	18
Nigeria	1.1	0.8	1	0.35	0.7	25	197	281
China	1.36	4.6	10	2.69	1.4	24	21	15
Cuba	1.53	2.7	-	2.78	5.3	<1	5	<1
Algeria	1.67	3.6	87	2.26	2	14	407	203
Iraq	-	2.3	50	3.18	6.8	62	4485	659
Iran	1.85	6.7	23	-	6.6	60	1367	207
Azerbaijan	1.91	3.6	51	3.76	6.3	13	75	12
World BP	**2.18**	**7.8**	**111**	**6.12**	**4.42**	**1148**	**182**	**41**
World #	**2.18**	**7.8**	**111**	**6.12**	**4.42**	**780**	**124**	**28**
Turkey	2.2	7.2	67	3.3	3.6	0.3	4.4	1
Brazil	2.39	7.6	81`	-	4.4	2	46	10
Venezuela	2.42	5.3	110	5.54	6.7	35	1406	209
Mexico	2.59	8.8	138	3.67	6.7	22	144	21
Libya	3.21	6.1	234	7.68	12.1	29	5282	44
Italy	3.26	25.1	566	7.7	11.8	<1	10	1
Netherlands	3.81	27.1	417	10.82	20.2	<1	5	1
Japan	3.91	28.7	543	9.62	15.5	<1	<1	<1
Saudi Arabia	4.05	11	336	11	20.4	144	10145	496
Germany	4.26	26.2	488	10.16	12	<1	4	<1
Russia	4.28	9.7	124	10.65	6	60	356	59
UK	4.72	25.4	426	9.28	10.3	9.3	155	15
Denmark	5.32	28.8	408	9.53	13.6	1	227	17
France	5.74	25.9	438	6.03	11.9	<1	2	<1
Australia	**7.09**	**26.6**	**619**	**16.84**	**16.13**	**4.4**	**184**	**11**
Sweden	7.95	26	411	5.2*	10*	<1	<1	<1
Kuwait	8.01	16.9	330	28.8	48.6	60	43266	890
New Zealand	8.13	19.8	560	14.4*	14*	<1	22	2
Norway	8.17	32.8	494	7.76	16.05	14	2155	134
Canada	8.56	29	563	16.2	22.6	6	157	7
U. A. E	8.97	21.7	193	29.1	51.8	49	14412	278
U.S.A. 48 st	9.57	36	782	19.8	24.8	25	86	4

Data Sources: Ecological Footprint 2000, see www.RedefiningProgress.org
= Association for the Study of Peak Oil (ASPO) Aug 2004 No 44 newsletter.
+ = www.Nationmaster.com. CIA = Central Intelligence Agency Yearbook.

NOTE: World BP(Beyond Petroleum) data and for World # (ASPO) data oil differ for reserves and self sufficiency. World # data is for regular oil that includes condensate, but excludes heavy oil, oil from deep water/polar and natural gas liquids (NGL) from gas fields).

The developed countries with the largest ecological footprint are those those who have been industrialised for at least 100 years who h ave produced the most CO_2; which is still changing the climate in way that will reduce the capacity of developing nations to feed themselves. In the last 30 years the major oil producing nations have increased their per capita CO_2 to a similar level as the USA and Australia.

The worlds total footprint in 2000 was at an unsustainable level and is judged to be well above the earths carrying capacity and reason why one sixth of the human race is chronically under nourished and another sixth are suffering from obesity. Indeed, some earlier footprint data suggest the carrying capacity of the planet was exceeded in the late 1970's. and continued to increase till 1997 before levelling out. The economic growth of the developed nations ceased to be sustainable many years ago. It is far above the world average being from 7 to 20 times higher than the poorest nation, Bangladesh. It illustrates what kind of climate destabilising mess the developed worlds energy use and industrialisation has produced. There is a need to reduce the 'ecological foot print' of nations by reducing per capita use of fossil fuels.

In year 2000 the US became the became the nation with the largest per capita footprint. and one of the largest emitters of carbon dioxide. By 2004 US motor vehicle ownership per capita had increased 782 motor vehicles per person but the energy efficiency of the vehicle fleet decreased by 10% due to the growth in the proportion large cars and SUV's in the vehicle fleet The US has the highest per capita oil consumption and is responsible for 25% of the worlds greenhouse gas emissions even though 20% of it electricity come from nuclear power stations. If the US had to survive on its own oil reserves without imports it could only do so for four year. This is why it has invaded two nations to improve its own access to oil and used enormous amounts of fuel in the process.

Table 3 shows that most developed nations have a much more wasteful footprint than the rest of the world, nearly all have high per capita COO emissions, all have high per capital oil consumption levels, but most of them are not self sufficient in oil and some are totally dependent on oil imports. However, there are some interesting exceptions as follows:-

- Japan, Italy and the Netherlands have ecological footprints around one third of that of the USA and half that of Australia probably due to the fact that there agriculture is very productive and in the case of Japan it generates 26% of its electricity from nuclear power. Both Netherlands and Japan have got very efficient public transport system and high levels of walking and bicycle use. These nations and many others in Europe will have to use more nuclear energy as they have few other fossil fuels and limited renewable energy.

- France and Sweden have the lowest per capita carbon dioxide emissions. France generates 78% nuclear electricity and only 6 tonnes per capital of CO_2 of . Sweden with 50% nuclear electricity and 32 % renewables has only 5.2 tonnes per capita of CO_2 compared to 20 tons of CO_2 in the USA and higher still in Australia of emissions from land clearing are added to the 17 tonnes of CO_2 in the table.

- However the USA and Canada are sitting upon huge non-conventional sources of oil and have an opportunity to develop much cleaner technology to extract oil from tar sands and shale oil and more costly oil from within the Arctic which should keep North America functioning. but will be of relatively little use to ease growing demand in the rest of the world (for reasons given later).

The ecological footprints of India, Bangladesh, Nigeria, Iran, Iraq, China and Indonesia indicate that over a billion people now live in dire poverty in these countries despite increasing economic growth. The data presented later about about the lack of affordable oil creating reduced food production and usable farmland.

The growth of the nuclear energy will be needed just to survive in the developing countries. Nations without oil reserves and limited supplies of other fossil fuels and limited renewable energy resources will have to go nuclear if they can afford it and gain access to uranium. To avoid a Malthusian die-off that is what needs to happen.

Carbon emissions from oil use will increase from 2004 to 2024

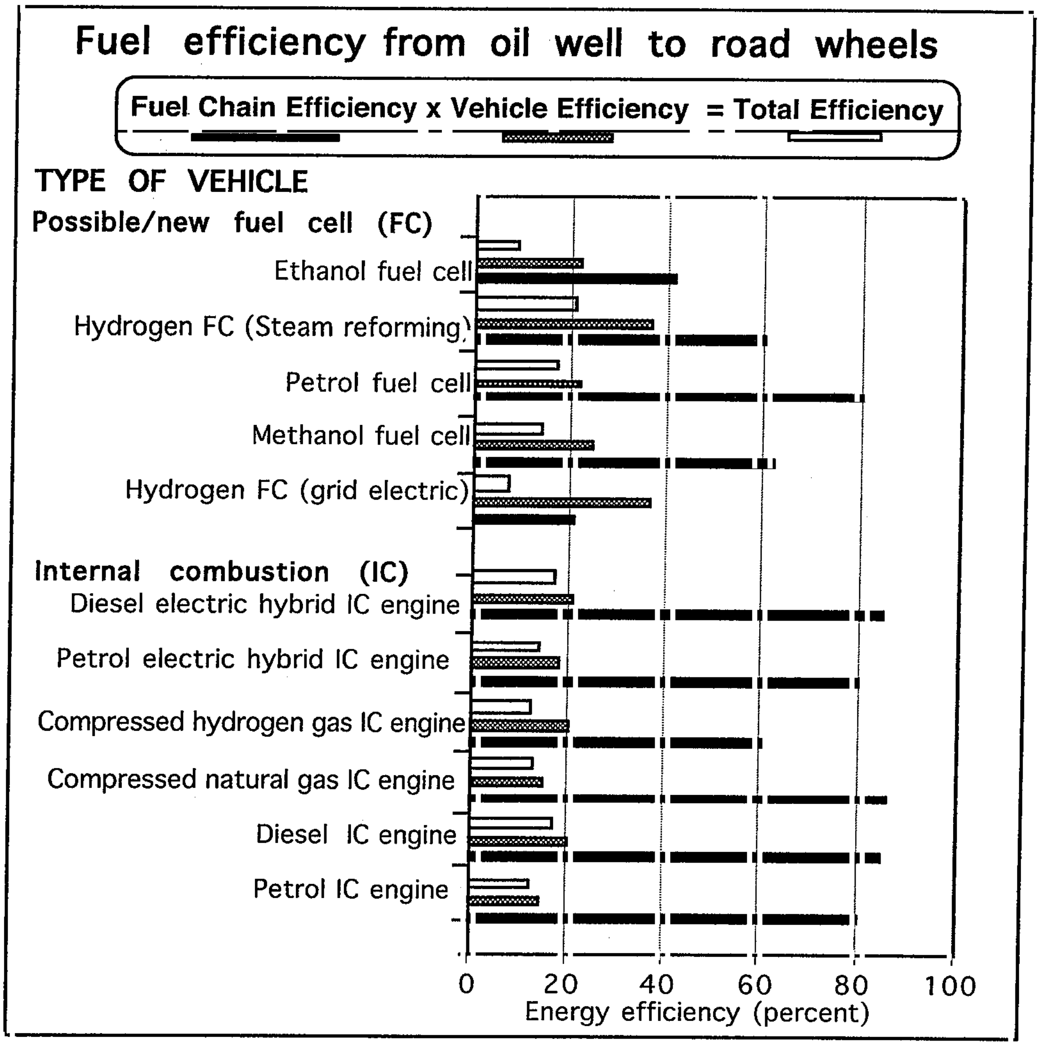
To put the need for energy efficient vehicles (mostly hybrids) of all kinds that are mostly reliant on night time battery charging from grid connected electricity supplies it is necessary to establish base data for **total energy efficiency** of oil powered vehicles to accurately assess the future of both vehicles and vehicle fleets and of the passenger transport system as a whole. (Fuel chain efficiency x vehicle efficiency = total energy efficiency)

Once that is done it is then possible to assess the effect of the diminishing energy return on energy invested in future oil supplies. Fuel chain efficiency is determined by the physical energy costs of discovering, extracting, refining and transporting oil to the point of combustion. It is measured by the energy return on the energy invested (EROI) Fuel chain efficiency over the lifetime of today's passenger vehicle and freight vehicle fleets are usually ignored in calculations of total vehicle fleet energy efficiency by economists but not by scientists.

The total energy efficiency of today's internal combustion engines and fuel cells using fossil fuel in 2004 is shown on Figure 1 and takes no account of the decreasing energy efficiency in the production of oil based fuels over the lifetime of vehicle fleets. This is 12 years for cars, 4WD's and LCV's; 15 years for trucks B-Doubles and road trains; 20 years for buses and aircraft; and 25 years for diesel trains and many special purpose vehicles.

The problem is that existing vehicle fleets powered by internal combustion are not energy efficient nor are there possible fuel cell replacements including those using hydrogen made from fossil fuels. Note that nearly all hydrogen in use today is, itself, being "produced" by stripping hydrogen from natural gas through steam reformation of methane. A car using hydrogen derived from brown coal-fired electricity is actually several times more polluting than a petrol-powered car.

Figure **1, US Fuel Chain Efficiency, Vehicle Efficiency and Total Efficiency 2004**



Source: Wald, M.L. (2004) Scientific American May 2004 p 42 to 47

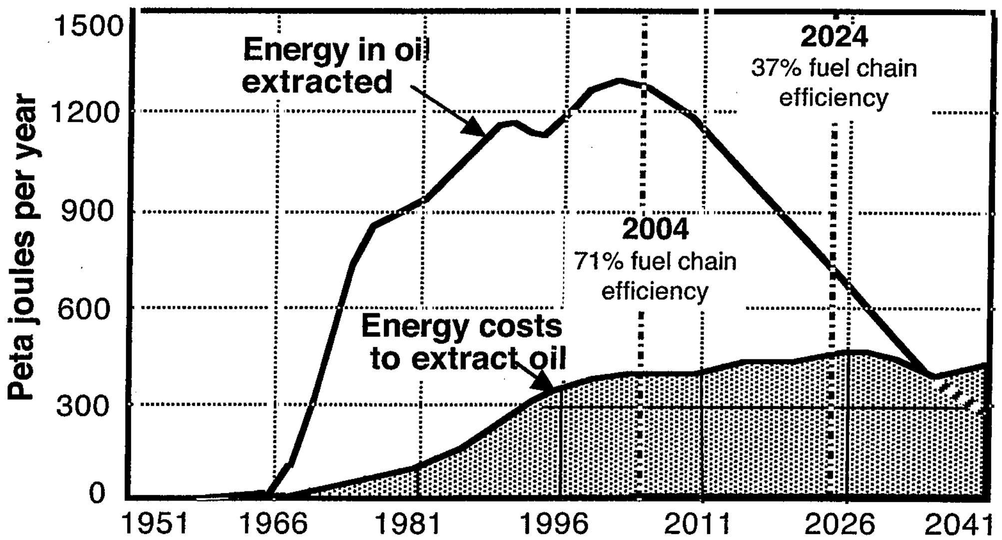
The definition of total energy efficiency is accurate for 2004 but is fundamentally flawed if used to estimated the total energy efficiency for vehicle fleet 20 years from now because it fails to take into account the large increase in real fuel chain costs within the life of existing vehicle fleets. Nor does it take into account the oil needed to manufacture motor vehicles and to maintain them, build the roads and parking spaces which will have a lower **energy return on energy invested** (EROI) 20 year from now (Parker 1995)

The term EROI (Cleveland et al ,2000) and 'energy profit ratio'(Fleay, 1995) were used by CSIRO scientists, who recommend that physical energy profit accounting procedures should complement monetary accounting procedures for all important energy companies and national accounts. (Foran and Poldy 2002 B) The failure to consider the **"energy return on the energy invested"** (EROI) 20 years from now for vehicles using more expensive oil, which will hopefully be discovered in deep waters beyond the continental shelf, is a very serious methodological error. The biggest change is for petrol and diesel IC engines whose **total energy efficiency** drops by 50% due to the predicted increase in the energy costs to extract, refine and transport crude oil in 2024.

A CSIRO study "Dilemmas Distilled" states the following:-

The critical importance of energy use to the maintenance and growth of our economic system is not properly acknowledged in most national analysis (that have a short term focus). Long run analysis suggests that energy use is responsible for 50% of production in a modern economy but but represents only 5-10% of the cost. This tension between physical and economic realities effectively blocks the transition to a physical economy with low carbon energy sources". p 28. (Foran and Poldy 2002 B)

Figure 2 Energy costs and benefits of oil extraction 1951 to 2041



Source: Foran and Poldy (2002) Chapter 5 "The future of Energy" from "Future dilemmas: options to 2050 for Australia's population, technology, resources and the environment", by CSIRO Sustainable Ecosystems, Working paper series 02/01
Note: fuel chain efficiency notes added by Alan Parker

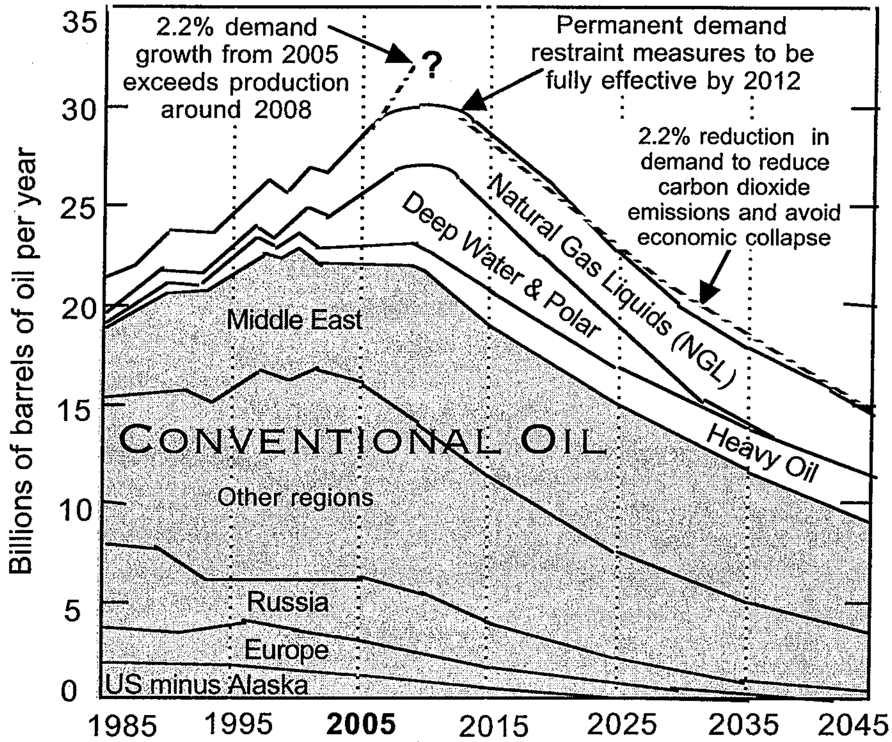
Indeed, it does and commits national economies to use more carbon energy sources. The physical realities are clearly shown on figures 2 and 3, and no amount of simplistic economic theorising about how, supply and demand will change the geophysical realities, because we are dealing with a finite resources.

The changing global mix of oil resource production from 1985 to 2045.

Figure 3 shows the changing global mix of oil production from 1985 to 2045. The shaded area I shows conventional oil, natural gas liquids (NGL) It also shows the increasing proportion of heavy oil, oil from deep water and oil from the polar regions which require more energy to extract and refine.The heavy oil shown on figure 3 are an estimate of what is likely to be extracted with current technology . The peak in world oil production is between 2008 to 2012 followed by a 2.2% per annum decline in production to 2045. The reduction in demand needed to balance it with oil production is as follows:-

- 2005 to 2008; average reduction of 715 million barrels a year.
- 2009 to 2020; average reduction of 660 million barrels a year.
- 2021 to 2030; average reduction of 616 million barrels a year. .
- 2031 to 2040; average reduction of 515 million barrels a year.

Figure 3 World Oil and gas liquid production from 1985 to 2045: 2.2% demand restraint to cope with declining production



Source: Oil production data from the April 2005 newsletter of the Association of the Study of Peak Oil www.asponews.org

Figure 2 could change if sequestering CO2 in oil fields that are sealed increases the volume of oil that can be extracted by a small but significant amount and that is not shown on figure 3. The same applies to new technolgy for treating heavy to make it less viscous and extractable, to kerogen extracted from shale or oil produced from tar sands. The potential of these resources all of which created more CO2 and pollutants are dealt with later.

IEA oil emergency demand restraint measures for developed countries are needed.

If world demand for oil is not to exceed production in the next 30 years so that the price of oil becomes unaffordable for basic necessities and food production in many countries, then demand restraint measures (see table 4) which are detailed in an International Energy Agency report will be required.(IEA 2005)

Table 4 . Summary of oil saving effects of demand constraint policies for passenger transport summed across all IEA countries

Potential oil saving by measure	Measure
VERY LARGE 370 million barrels a year	**Car pooling:** large program to designate emergency car pool lanes along all motorways, designate park-and-ride lots, inform public and match riders.
	Driving Ban: Odd even license plate scheme. Provide police enforcement appropriate information and signage.
	Speed limits: reduce highway speed limits to 90 km/hr. Provide police enforcement or speed cameras appropriate information and signal.
LARGE 185 million barrels a year	**Transit**: free public transport (set fares to zero)
	Telecommuting : large program, includes active participation of businesses, public information of of benefits of tele commuting, minor investment in infrastructure to facilitate.
	Compressed work week: Program with employer participation and public information campaign
	Driving Ban: 1 in 10 days based on license plate, with police enforcement and signal.
MODERATE More than 36 million barrels a year	**Transit**: 50% reduction in public transport fares.
	Transit: increase week end an off peak service and increase peak service bh 10%.
	Car pooling: small program to inform public and match riders.
	Tyre pressure; large public information programme.
SMALL Less than 36 million barrels a year	**Bus Priority**: convert all existing car pools & bus lanes to 24 hour bus priority usage and convert some other lanes to bus only lanes

From 2005 to 2040 a reduction of 15.5 billion barrels of oil and NGL (that's 55% of 2005 world OIL consumption) is needed to stabilise prices. It's theoretical possible to make that happen, through demand restraint measures which are summarised on table 4 and detailed in

International Energy Agency(IEA) report "Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport" which is available as a pdf (IEA 2005 B) file on their web

The IEA report provides a new, quantitative assessment of the potential impacts and costs of oil demand restraint measures in transport, under the conditions of a supply disruption or other oil-related emergency. In short, there appears to be opportunities to achieve substantial reductions in transportation oil demand quickly and cheaply – if national leaders are prepared to act and sell politically unpopular demand constraint measures to their people.

The IEA has recommended technical solutions for the restraint of mostly urban road transport that could could reduce oil demand on their own without any restraint of intercity freight and air travel of fixed sources of oil use. (See table 4) However, the political reality is that you cannot have your cake and eat it. Many national leaders like Bush and Howard think they can have have continued economic growth above 3% per year without any demand restraint measures to reduce urban car use. and the growing dependence on oil.

Fortunately many IEA member countries and non-member countries alike are looking for ways to improve their capability to handle market volatility and possible supply disruptions in the future. This report aims to provide assistance. Some measures may make sense under any circumstances; others are primarily useful in emergency situations. All can be implemented on short notice – if governments are prepared. The book examines potential approaches for rapid uptake of telecommuting, "eco-driving", and car-pooling, among other measures. It also provides methodologies and data that policy makers can use to decide which measures would be best adapted to their national circumstances.

This demand restraint "tool box" may help countries to complement other measures for coping with supply disruptions, such as use of strategic oil stocks. It would be prudent to introduce these restraints now well before crude oil prices go way beyond US$ 105 per barrel around 2007/8 because there is serious risk of economic chaos and 1930's levels of unemployment. The longer national governments wait to introduce IEA demand restraint measures the greater the risk to the economic security of all nations.

The IEA recommendation for reducing the demand for oil are excellent short term measures. However in the electricity and transportation sectors, these obvious long term means for reducing the probability of interruption of electricity generation or fuel supplies exist:

- diversity of generation technologies and input fuels;
- and stockpiling of fuels.

Diversity of fuel supplies acts as an insurance against various kinds of problems. Diversity of plant technology, for example, reduces the risk that basic design flaws in a certain technology might cause a large share of the total generation capacity to be shut down for repair or retrofitting. Similarly, diversity of fuel types or sources of supply can minimise the impact in case the supply of one fuel or from one source is interrupted.

Green taxes to decouple the growth in oil consumption from the growth of GDP

The growth in the number of 4WD's and SUV's in the Australian and US car fleets, used as single occupant commuting and shopping vehicles, is a most energy wasteful (and dangerous) trend that has already contributed to a 10% increase in oil consumption between 1994 and 2004 with more to come. There is a way of reversing that trend. The national peer review of the Netherlands transport system by the OECD (European Conference of Transport Ministers) identified the Netherlands as being the best passenger transport practice for the EU (ECMT 2001). Indeed the Dutch have been moving slowly towards ecologically sustainable development with their National Environment and Policy Plan by:-

"decoupling economic growth from the growth in fuel consumption and finite resources. (N.E.P.P. 3. 1998)

As these plans evolved the Dutch greened their tax system as well as providing the infrastructure to improve the performance of their transport system. NEPP 3 makes it very clear why non-motorised travel is considered to be so important and why the car, which in the 1960s and 1970s was regarded as a sacred cow and still is in Australia, is now subject to many regulatory constraints. The transport objectives of the NEPP are:-

- Vehicles must be as clean, quiet, safe and economical as possible.
- The choice of mode for passenger transport must result in the lowest possible energy consumption and least possible pollution.
- The locations where people live shop, work and spend their leisure time will be co-ordinated in such a way that the need to travel is minimised.

Without the NEPP it was expected that car kms would increase by 72% over the period 1986 to 2010. With the NEPP this increase will be lowered to 48%, a positive step towards ESD. Dutch experience with implementing the NEPP suggests that there is the potential for a shift of at least 10% of all "drive alone" commuter trips to multiple occupant trips.(Parker 2001) This is in addition to using bicycles to substitute for short, highly polluting car trips. (Wellemen 1999) When considering economic efficiency in the passenger transport sector the overall energy efficiency strategy should be focussed on the transport objectives of the NEPP as stated above. Monitoring the growth rate of car kms and light commercial vehicle kms every two years in Australia would be a useful way of measuring any reduction in energy wasteful activity.

The Dutch only generate 4% of their electricity in nuclear reactors and 90% of their electricity come coal fired stations used most heating in their colder spring, autumn and winters so their per capita CO_2 emissions are high. However their per capital CO_2 emissions in the transport sector is around 40% that of Australia's. Their experience shows that Greening the tax system could provide incentives and constraints to use cars less so that tax reform results in the conservation of oil reserves and a reduction in greenhouse gas emissions by all levels of government. It would be based on the principle that the polluter must pay and that the overuse of petrol and diesel fuels is harmful to the environment and the economy. It would be applied within the context a "National Energy Security Plan" in the following ways:-

1. The internalisation of environmental costs. The future costs of oil depletion need to be built into the price of diesel, petrol and aviation fuel so as to encourage fuel conservation, the purchase of more fuel-efficient cars, LCVs, trucks and aircraft.
2. Reduce the long lead times in adapting to oil depletion by increasing fuel taxes every year to pay for the introduction of alternative fuels, particularly gas, and to build the infrastructure needed to encourage walking cycling and public transport.
3. For those who cannot do without cars for essential purpose in business, or are disabled, provide tax incentives for the ownership of more energy efficient cars and disincentives to the ownership of large cars and 4WDs in urban areas.
4. Provide incentives for telecommuting; informal and formal sharing of cars; and innovative forms of car leasing such as the Dutch "Call-a-Car" scheme. Eliminate subsidised car parking and provide incentives for commuting by bicycle.
5. Establish the general principle that car travel to and from work is a personal expense. Salary packaging for commuting, or for vehicles owned by other family members, will not be subsidised. Season tickets on public transport and the provision of bicycles for commuting and/or work business should be salary packaged instead.

The achievement of the 'big picture' planning and transport outcomes induced by the Commonwealth "Greening" of the tax system, would be dependent on state funding and investment being radically changed so that they reinforce and complement these tax reforms.

For example, the Japanese, the Dutch and Dane's have put in place energy efficiency policies over the last 15 years that have resulted in many short single occupant car trips in urban areas being replaced by bicycle trips and many long single occupant car trips in urban areas being replaced by bicycle/train trips, or bicycle/train/bicycle trips. The end result is a per capita reduction in oil use and more efficient use of fuel by their respective car fleets and the more efficient use of railway rolling stock and public transport generally. The Dutch in particular been very successful in using bicycles to replace car trips, short peak hour bus trips and moving much of the car and LCV fleets over to the use of natural gas. (Parker 2001).

In comparison wasting Australia's dwindling oil reserves, using high performance large cars or SUVs designed to carry four of five people for short single occupant work and shopping trips trips is not an example of energy efficiency. The specific IEA demand restraint measures recommended for Australia and all other IEA members shown on table 2 are all short term measure which need to be supplemented with longer term measures that encourage the use of efficient road vehicles.

Two thirds of the existing cars and trucks on the worlds roads will still be there in 2008. The number of hybrid vehicles or fuel cell powered vehicles will be no more than a few million by 2008 unless governments act to encourage their use and phase out large cars and other vehicles which are energy wasteful.. With some encouragement in the form of lower taxes and charges for cars that use less oil and the introduction of mandatory standards for the improved fuel efficiency of cars, utes, light commercial vehicles. the efficiency of car and SUV fleets can be improves

Mandating standards for the improved fuel efficiency of cars and SUVs

The US mandatory standards was very effective when introduced in the USA by President Jimmy Carter (Energy Policy and Conservation Act of 1975) which required car companies to double the fuel efficiency of their car over phased period of years. When introduced in 1975 the average fuel efficiency of the US car fleet was 18 litres /100 km in 1985 and by 1987 average fuel efficiency of the US car fleet improved and was 9 litres /100 km. The average fuel efficiency of the US car and SUV fleet reduced to 9 5 litres /100 km in 2004. This was due to the increase in the growth in sales of SUVs which were not covered by the car standard but the standard for light truck which was and still is 11.4 litres/100 km (Bezdek & Wendling 2005).

Bezdek & Wendling have recommended that for new cars a new standard be phased in to ensure that by 2015 average fuel consumption of the car fleet would be 5.7 litres/100km and for the SUV and light truck fleet to be 7.6 litres/100 km. giving an overall 50% increase in fuel efficiency. Compared the petrol electric hybrids on sale in 2005 which have fuel consumption of 5 litres/100 km and which may improve to 3 litres/100 km in few years we may start to see the petrol versus electric ratio shifting in favour of electricity in some models.

Adding battery capacity and plug-in capability for overnight charging are simple modifications to an already-hybridized vehicle. In fact, hybrid owners are already making these modifications <http://www.calcars.org/priusplus.html> themselves and manufacturers have indicated that Plug-in Hybrid Electric Vehicles (<http://www.iags.org/n032805t2.htmpih.htm>PHEVs) may be manufactured as soon as the 2007 model year.

Some models of hybrids vehicles evolve from being gasoline-based with electric assistance into being electricity-based with relatively minor gasoline backup. Why will this happen? Because electricity is cheaper. Electricity is very unlikely to relinquish transportation market share once it has gained it. Electricity is clean, efficient, safe, familiar and cost-effective. An EPRI study found that the majority of people surveyed preferred plugging in a vehicle to fuelling at the gas station <http://www.iags.org/n032805t2.htm#5>

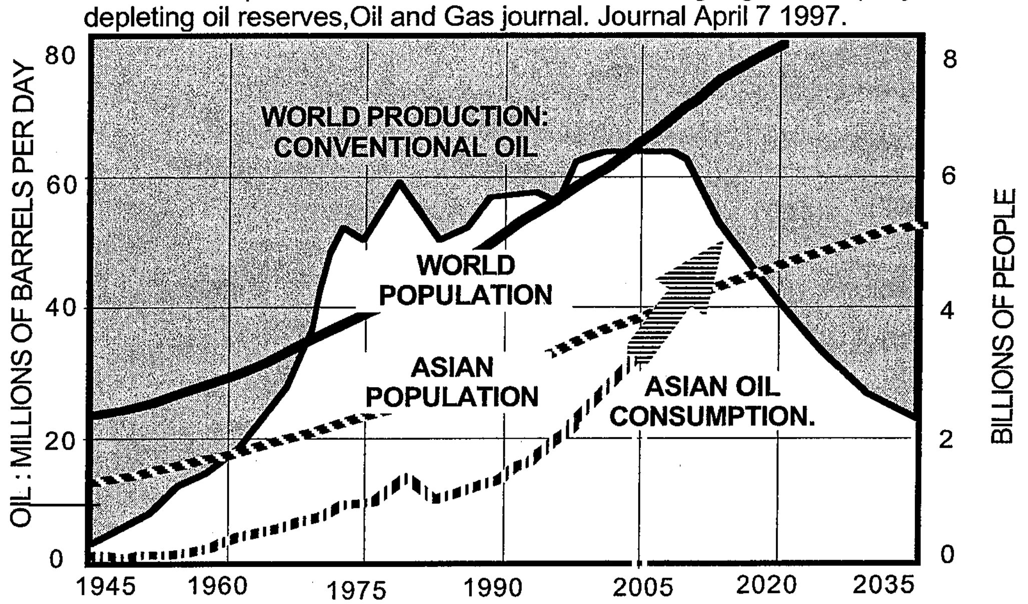
GLOBAL PERSPECTIVE : THE END OF THE AGE OF AFFORDABLE OIL

The world's population is increasing by around 70 million people a year but without affordable oil the current patterns of trade, travel are unsustainable. Figure 4 shows that as oil production went up so did the world's population. Cheap oil enabled the human population to increase from 2.2 billion in 1938 to 6.3 billion in 2003; the greatest increase in world history. The world's fleet of tractors, cars, trucks and buses has increased from around 15 million in 1938 to 800 million today.(Vital Signs 2003). All this only made possible by the increased production of cheap oil from 2.5 billion barrels in 1938 to 26 billion barrels in 2003.

Cheap oil made possible the green revolution which introduced new strains of higher yielding crops, that could be planted more than once a year, but needed more and cheaper fertiliser made from oil and gas. Cheap oil enabled poor people to transport and trade their produce and to eat better. (Vital Signs 2003). Unfortunately nuclear energy is not suitable for making fertiliser or insecticides and without limited electricity power grids is of little use for powering electric vehicles or farm equipment in rural areas of developing countries.

Figure 4 World population growth made possible by cheap oil 1938 to 2004

Source: Campbell, C. J. 1997. Better understanding urged for rapidly depleting oil reserves,Oil and Gas journal. Journal April 7 1997.



Soon we shall be forced to adapt to a world without cheap oil, also known as conventional oil. Before that day arrives we will have to learn to live with the world oil supply not satisfying world demand , estimated to be 82 million barrels per day (bpd) in 2004. (Douglas Westwood Ltd 2004) (Wood Mackenzie RADAR 2004) (Skrebowski 2004) This is an increase of around 4.3 million bpd or 5.5 %per annum in the past two years and it is predicted to continue to grow at this` rate in 2005 by the Reserve bank of Australia (Dickson & Holloway 2004) That growth cannot go on for much longer because the oil discovered in the last ten years is not sufficient to keep pace with demand. Around 2008 Australia will be vulnerable to increasing costs of imported oil, even with new oil discoveries in deep water around Australia; the oil will cost more. (Geoscience Australia 2004)

Since the mid-1990s the average value of oil discoveries has fallen and discoveries from new fields have replaced only 40% of production. Saudi Arabia, which has the largest oil reserves, has been drilling for oil since 1938, but now discover much less. Of the first 60 productive wells drilled from 1938 to 1969 Aramco found 300 billion barrels within 24 fields. Of the last 60 productive wells drilled from 1978 to 2003 Saudi Aramco found only 13 billion barrels within 50 fields. Another serious problem is that, after oil production peaks, proportionally more of the oil will be sour oil, which gets more costly to extract and refine as oil field outputs drop. The world's four largest oil fields are Ghawrer and Burgon in the Middle East, Cantarrall in Mexico and DaQuing in China. Together they produce 1/10th of the world oil production and the three largest of these are past their peak, producing lower quality sour oil. This reduction in the amount of oil discovered, together with the much smaller oil fields now being discovered, was inevitable. Oil is a finite resource; the more oil that is found the less oil that remains to be found.

Perhaps the best example of what is occurring is in China which exported oil as late as 1992, but has become a net importer, due to a steady decline in indigenous oil reserves. By 2003 oil consumption was growing by over 10% a year and had reached 5.4 million barrels per day. China is now the world's second largest oil consumer after the US, which is consuming 20 million barrels per day. China will import more oil to fuel its runaway economic boom which will generate a demand for oil of 14 million barrels a day by 2010. This will be required for oil-fired electricity generation, all kinds of motor vehicles and a car fleet predicted to increase, from 16 per 1000 population in 2001 to 267 per 1000 by 2030 (IMF 2005) which given the predicted population of 1450 million would mean a Chinese car fleet of 387 million.

If we take into growth the car fleet growth in India and other Asian tiger economies then even the universal use of more efficient petrol electric hybrids cars there would still a huge increase in the demand for oil. According to IMF world demand will increase from 82.4 mbd in 2004 to 139 mpd in 2030

The European Union (EU) has predicted an increase in road traffic of 50% and an increase in air traffic of 90%. in Europe by 2010 Similar increases are expected in the USA. It is also likely that by 2006, many countries in anticipation of oil production peaking, will build up strategic stocks of oil and that will also drive up the price of crude.

Over the top of a bell shaped curve, known as the Hubbert curve

Around 2008, when the world wide demand for oil outstrips global oil production, "the big rollover" will have begun. This is the point at which world oil production goes over the top of a bell shaped curve, known as the Hubbert curve, which is shown on Figures 3, 4, and 13. This curve is named after King Hubbert, a Geologist who pioneered the science of predicting the peaking of oil fields in the 1960s and the peaking of mainland US oil production in 1976. (Deffeyes 2003)(Douglas-Westwood Ltd 2004) .

By 2003 Hubbert curves had been plotted by researchers for all the 95 countries that have or can produce significant volumes of oil. 52 of these countries, including the US, are already well past their peak (greater than 5 years) while another 16, including the UK, Norway, Australia, and China, are at peak or will reach it soon. The remainder will peak within the next 25 years.

Table 5 shows the major oil producing countries that are past their peak oil output, those with the ability to expand oil production a and those with questionable capacity to produce more. Indeed since table 1 was compiled there are now several report suggesting that Saudi Arabia is past its peak output. .

In February 2004 a Texan oil analyst (Simmons 2005) with impeccable credentials stated :-

It is hard to find oil producing countries that can add significant quantities to the global supply in the near-to-medium-term future. The list of key oil producers that appear to have reached a production plateau or even moved past their peak oil output is becoming quite lengthy. It includes key producers, Table 5. Collectively, these 14 countries produced over 25 million bpd in 2004. A few of these countries, such as Libya, could see a jump in oil output from their current base, but none are likely to return to peak levels. The list of key oil producers that still may be able to significantly expand capacity, assuming key investments are made, is far shorter. It includes Algeria, the UAE, Qatar, Brazil, Angola, Ecuador, Chad, Sudan, Equatorial Guinea and Malaysia. These countries currently produce less than 10 million bpd.(Simmons 2005)

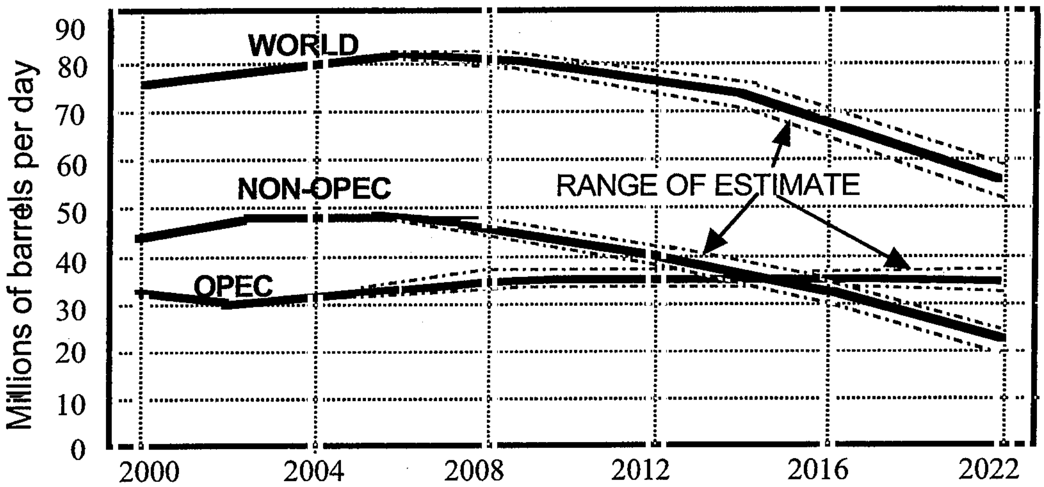
TABLE 5. The major oil producing countries and those past peak output.
be broken into three categories according to capacity

Past peak output	With ability to expand capacity	With questionable capacity
Australia ,	Algeria	China
Colombia	Angola	India
Egypt	Brazil	Mexico
Indonesia	Chad	Norway
Iran	Ecuador	Russia
Iraq	Equatorial Guinea	Saudi Arabia
Kuwait	Malaysia	
Libya	Qatar	
Oman	Sudan	
Syria	UAE	
UK.		
US		
Venezuela		
Yemen		

World and Opec oil production is shown on Figure 5 which is taken from the paper by a senior expert in the corporate planning division of the National Iranian Oil Company (Samsam-Bakhtiari 2004). The problems created by the slow decline in world oil production could be survived given a modicum of oil conservation and demand management but oil demand is surging upwards with no recognition of the need for oil conservation as a sensible means of risk management. The resulting shortages will be permanent and not due supply constraints, as with previous oil crises. This estimate of world production by a insider in middle east is quite at at odds with the IMF.

The demand for oil is surging upwards, the resulting shortages will be permanent and not the result of deliberate supply constraint, as with previous oil crises. *"The problem is not with the tank but with the tap,"* said a retired geophysicist who spent 37 years with Total Oil. (Laherrere 2004) If the developed nations could decouple the per capita growth in oil consumption from increases in GDP it would reduce the flow from the tap on the world oil tank and the remaining oil would last a lot longer.

Figure 5 OPEC and rest of the world oil production outlook (WOCAP) model
Source: Samsam Bakhtiari (2004) Oil and gas Journal 26th April 2004



The May 2003 Association for the Study of Peak Oil (ASPO) Conference held in Paris evidenced a growing consensus on a scenario of world oil depletion of 5-10% per year; a recognition that oil reserves had been deliberately overestimated by the oil industry; and that there are unlikely to be more major significant reserves to be found. Most delegates agreed that nearly all of the private multi-national and national oil and gas companies have over estimated their gas and oil reserves to maximise either private company share values or to attract overseas investment into their national economies. The ASPO Conference held in Berlin in 2004 confirmed the previous over estimates of oil reserves and ASPO provided its own estimates that are revised regularly and can be accessed at: http:/www.asponews.org

Table 4 shows crude oil consumption by sector of the world economy and some of the major national consumers of oil for the year 2001. Assuming the current rate of increase in oil demand world oil production would need to double in the next 10 years. If the developed nations could reduce their oil dependency by decoupling the per capita growth in oil consumption from increases in per capita GDP the world's reserves of cheap oil would last a lot longer. That is not likely so it is imperative for Australia to keep a large strategic reserve of cheap oil in the ground.

To put it another way, that is enough oil to keep the US, the world largest consumer, supplied for four years or China supplied at current 10% GDP growth rates for the next ten years. This would mean that OPEC will not be able satisfy even a modest increase in the world demand for oil and supports Bakhtiari's prediction. Even that conservative organisation (IMF2005) concluded that "once non-OPEC production peaks around 2010, there will likely be a strong upward pressure on Prices. To make matters worse the International Energy Agency stated *Energy companies are also under investing in new oil and gas production capacity by up to 20 percent (IEA 2005 A)*

Polluting alternative resources of non-conventional oil and gaseous fuel

Using heavy oil, oil from polar regions and from deep water, tar sands and shale oil are all more expensive and create more emissions than conventional oil. Some of the technologies for exploiting these oil resources are well developed others are not.

Heavy oils make up half of the worlds known oil reserves much of it is left in the ground after discovery especially when saturated with sulphur compounds and toxic contaminants. Even when heavy oil can be extracted refining it costs more and produces more CO2 emissions. As the proportion of conventional oil decreases once oil fields have passed their peak more energy is needed to extract it as it become sourer and with more impurities. It is costly to in pump in sea water, emulsions etc. to thin-up the heavy oil and enable it be extracted and them separate the oil from the additives. The heaviest oil is what is left behind after the cheap oil has been pumped out and the wells are sealed off.

That so much was left underground did not seem to matter even ten years ago, but today with much higher crude oil prices in 2004 and 2005 and with even higher prices to come, the development of new techniques to thin-up more of thick heavy oil is worthwhile. One fascinating area of research is focusing more on using new bio science techniques trialled in laboratories with bacteria that literally eat the thick dirty dregs of heavy oil and turn it into something that is less viscous making it possible to open up old oil wells extract more oil or to postpone the closing down of oil wells. The oil industries is now turning to micro biologists for practical help. (Pearce , F. 1999)

Some bacteria can live happily underground devouring the thickest crude contaminated with sulphur compounds and heavy metals. Some of the best bugs for doing this have been discovered in sulphurous environments of slag heaps and boiling mud holes in New Zealand. In theory the process is simple enough it involves mixing a water-soluble catalyst, with the bugs air and water. Most oil fields are awash with water coming up with the oil so you add bugs and stir. Once the process is fully developed with a range of range of bacteria specifically adapted to consuming different types of heavy oil it will be possible to inject them into oil fields. It like a microscopic version of worms turning a pile of crude composting materials into soil, only the bugs produce a extractable liquid with a high oil content. This not a new idea it goes back to experiments in the 1940,s and the best description of more recent

development was a New Scientist feature article. (Pearce , F. 1999)
However, there are other sources of oil or combustible gases which may be even more expensive, create more water pollution and greenhouse gas emissions. The technology of extracting oil from shale and tar sands has greatly improved in the last 20 years and production costs in 2004 are one third of what they were in 1984. The USA has 72% of the worlds major oil shale reserves and has one trillion barrel's of proven reserves. Canada has similar amounts of oil reserves in tar sands. Sequestering CO_2 is new development that the international oil industry has begun to research that may increase the volume of oil extracted from existing oil fields and wells that have been closed down by a small but significant amount

Another gaseous energy resource that is many more years away from mass exploitation and about which even less in known about then hazardous environmental implications are "Methane Hydrates". which are are under Arctic tundra or in deep water.

The problem with enhanced extraction of heavy oil

The sea water, emulsions and chemicals use to enhance the extraction of heavy oil all produce waste and contamination when pumped back to the surfaces. This also applies to the use of bacteria for this purpose. The waste from this biological process will have to be removed. The bacteria will need to be filtered out of the water for recycling and the waste water containing sulphur and organic salts will have to go somewhere.

The problems with the extraction and processing of Tar sands

Misuse of resources: it costs a lot of money and natural gas to unstick the oil from the grains of sand so the net energy gain is small with minimal energy return on energy invested. In the book "*The Party's Over*" which looks at future energy supplies and the consequences of using tar sand sands, it states that :-

"the waste water pond of one of the tar sands processor, Syncrude, is 4.5 miles in diameter and twenty feet deep..... it would take 350 similar plants to meet the world's oil needs"

That would require 14,410 square km of Pond or a water area 7.4 times as big as Port Phillip Bay with an average depth of 6.5 metres. The other problem are as follows:-

- Climate change: the greenhouse gas emissions from uncovering, extracting, refining, upgrading and transporting tar sands oil are many times more than they are for conventional oil and gas, or even coal.
- Environmental destruction: Shell's tar sands process requires the stripping of the soil and rock from hundreds of thousands of acres of land to get at the bitumen 200 feet or more under the surface. Forests, wildlife habitat and water sources are ruined. when the used water is discharged causing oil and phenol contamination far beyond the strip-mine site.
- Air pollution: discharges from the processing and refinery upgrade facilities can spread large amounts of toxic and carcinogenic compounds over a wide area.

• Water pollution: A lack of water and disposing of polluted waste water will limit tar sand processing. and while the reserve are huge they can only be extracted slowly.

The problems with the extraction and processing of shale oil

Shale oil has similar environmental problems and according to the World Energy Council what is contained in shale is not oil at all but kerogen which requires hydrogen to be added to it and large inputs of energy to cook it at high temperature to produce a useful fuel:-

> *The term "oil shale" is a misnomer. It does not contain oil nor is it commonly shale. The organic material is chiefly kerogen, which can be converted into a substance somewhat similar to petroleum. However, it has not gone through the "oil window" of heat (nature's way of producing oil) and therefore, to be changed into an oil-like substance, it must be heated to a high temperature. By this process the organic material is converted into a liquid, which must be further processed to produce an oil which is said to be better than the lowest grade of oil produced from conventional oil deposits, but of lower quality than the upper grades of conventional oil..... Perhaps oil shale will eventually find a place in the world economy, but the energy demands of blasting, transport, crushing, heating and adding hydrogen, together with the safe disposal of huge quantities of waste material, are large.* < www.worldenergy.org/wec-geis/ global/downloads>

At present, shale oil is not being produced in the US, and large-scale commercial production was not expected for 20 to 30 years until recently when the price of crude tripled . But it's not for a lack of reserves and eastern US oil shales also contain notable quantities of metals, including uranium, vanadium, molybdenum, and others which could add significant by-product value. In November 2004 the U.S. government said it was ready to resurrect oil shale drilling in the Rocky Mountains, a technology heralded 30 years ago to boost America's energy output until it failed financially. I t also failed in Queens land in 2003, so it seems likely that on a small scale, and with good geological and other favourable conditions, such as water supply, oil shale may make a modest contribution. within a few years but it cannot replace declining conventional oil production, without air and water pollution, huge shale tailing dumps and a large increase in greenhouse gas emissions.

The problem with sequestering CO2 emissions

Sequestering CO2 emissions from coal fired power stations into dying oil fields that are well passed their production peak and have a large proportion of heavy oil remaining that gets more and more difficult to remove. The assumption is that this would dispose of the CO2 and make the thick gooey crude (often full on impurities) less viscous and free flowing thus enabling more oil to be extracted. I don't know how feasible that is, but the environment movement should be looking at this potential means for extracting more oil which can be sold to reduce the cost of sequestration. If the volume of oil that can be go out is large enough then there is more chance of a sequestration program going ahead.

For example sequestration of CO2 from Hazelwood Brown coal Power station into dying oil fields via the exiting pipework infrastructure that links the nearby Bass Straight oil rigs to the mainland oil distribution facility is a better option than what we are doing now. Whether or not sequestration would be less costly with an upgrade of the generating facilities would require a feasibility study.

Their are technical problems with sequestration but m ore formidable are the political problems due to the privatisation of the brown coal power station. The Allen Consulting Group did a study for the Victorian Department of Infrastructure (DOI 2004) "Greenhouse Challenge for Energy" in which they looked at the costs of achieving various levels of reduced emissions through incentives like carbon trading.. They give figures of $40/tonne for the cost of geosequestration, and $50/tonne for the price of carbon required to make it worth replacing old inefficient power stations with new ones. Clearly, unless the emission of carbon dioxide into the atmosphere actually cost something, power station operators have no incentive to reduce them. However, if new studies show that sequestration of CO2 in oil fields enhances the volume of oil extracted the by 2008 when the "inflation adjusted" real price of crude oil is around US $105 a barrel that sequestration will have much better cost /benefit ratio.

The problems with the extraction and processing of Methane Hydrates

Methane Hydrates remain a most unusual energy source as the box on the next page with an article from the Guardian Newspaper in the UK shows. Indeed we know very little about Methane Hydrates as an energy resource and even less the extent of the environmental damage that could be produced. While deep sea research suggests that Methane Hydrates are plentiful, there is also evidence to suggest that significant concentrations are rare.

US IN RACE TO UNLOCK NEW ENERGY SOURCE (Methane Hydrates)

David Adam, science correspondent The Guardian Monday April 4, 2005

More than a mile below the choppy Gulf of Mexico waters lies a vast, untapped source of energy. Locked in mysterious crystals, the sediment beneath the seabed holds enough natural gas to fuel America's energy-guzzling society for decades, or to bring about sufficient climate change to melt the planet's glaciers and cause catastrophic flooding, depending on whom you talk to. No prizes for guessing the US government's preferred line. This week it will dispatch a drilling vessel to the region, on a mission to bring this virtually inexhaustible new supply of fossil fuel to power stations within a decade. The ship will hunt for methane hydrates, a weird combination of gas and water produced in the crushing pressures deep within the earth - literally, ice that burns.

The stakes could not be higher: scientists reckon there could be more valuable carbon fuel stored in the vast methane hydrate deposits scattered under the world's seabed and Arctic permafrost than in all of the known reserves of coal, oil and gas put together. "The amount of energy there is just too big to ignore," said Bahman Tohidi, head of the centre for gas hydrate research at Heriot Watt University in Edinburgh. "It's not easy, but it's not something we can say we can't do so let's forget about it." Britain may miss out on any future methane hydrate boom - the North Sea is too shallow and no deposits have been found in the deeper waters further north - but other countries have recognised their potential. Japan, India and Korea. as The United States, are investing millions of pounds in hydrate research.Ray Boswell, who heads the hydrate programme at the US department of energy's national energy technology laboratory, said the US was determined to be the first to mine the resource. "Commercially viable production is definitely realistic within a decade. The world is investing in hydrates, and one reason for us to do this is to maintain our leadership position in this emerging technology."

Its new project will see the drilling vessel Uncle John spend about a month in the Gulf of Mexico, where it will bore down to two of the largest expected methane hydrate deposits in the region. Scientists on the ship will collect samples for experiments to see how the methane might be freed and transported to the surface. This is harder than it sounds. In some deposits the crystals occur in thick layers, in others they are found as smaller nuggets. Puncture one hydrate reservoir and the giant release of gas can disrupt drilling, pierce another and getting the methane out is like sucking porridge through a straw. This unpredictable nature means energy companies traditionally view hydrates as a nuisance. This gives them a joint interest with the US government as both sides want to know where the crystals are - one to avoid them and the other to exploit them. Mr Boswell said: "We have a marriage of near-term industry interests and longer-term government interests. If they develop the ability to detect hydrates for the purpose of avoiding them, that's useful for people who want to do the exact same thing for the purpose of finding them."

Devinder Mahajan, a chemist at the US department of energy's laboratory in Brookhaven, is looking for ways to encourage subsea hydrate deposits to release their methane. He has developed a pressurised tank that allows scientists to study hydrate formation. "You fill the vessel with water and sediment, put in methane gas and cool it down under high pressure. After a few hours, the hydrates form, you can actually see it. They look like ice, but they're not," he said. "This is a very important issue, tied to our future national energy security." Hydrates on land are easier to get at, and in 2003 a team of oil companies and scientists from Canada, Japan, India, Germany and the US showed it was possible to produce methane from the icy deposits below Canada's Northwest Territories. BP and the US government are carrying out similar experiments in Alaska.

While deep sea research suggests that Methane Hydrates are plentiful, there is also evidence to suggest that significant concentrations are rare. Beyond that, they require a sophisticated technology to extract. The energy return on the energy invested to extract methane hydrates on a large scale would be very low and at present, it requires far .more energy to extract it and process it , than would be obtained by burning it as a fuel. However, its too early to pass judgement on what may be achievable after ten years of intensive research and development except to say that world convention oil production will have certainly peaked by then

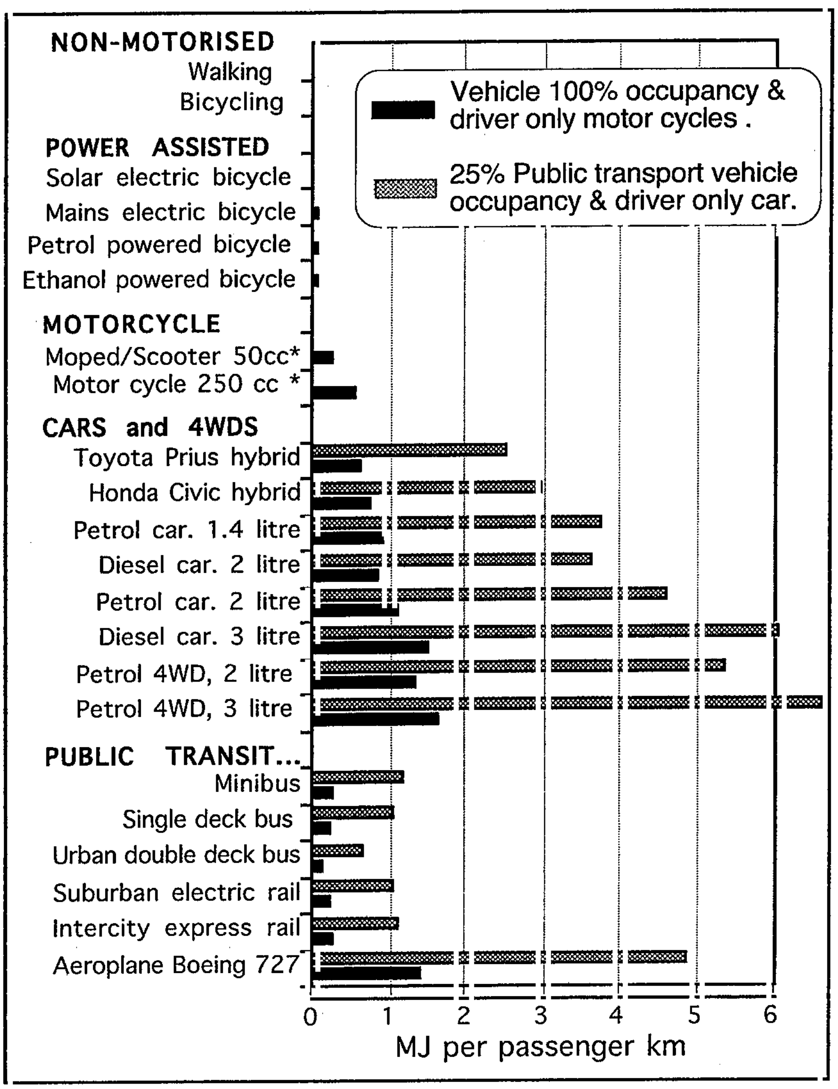
Another problem is methane leakage into the atmosphere. As a greenhouse gas, atmospheric methane has ten times the effect of carbon dioxide. There is also a rather remote possibility of disturbing ocean floor methane to the point that it comes out of suspension and is released in large quantities into the atmosphere. Finally, there is the potential for ecological damage of the oceans themselves. (Masutani, 2005) Paul Johnston, a scientist in the Greenpeace laboratory at Exeter University, warned that disturbing hydrate deposits under the seabed was a risky strategy.

The potential for modal substitution & more energy efficient vehicles 2004 to 2014

The ABS Census data for commuting and other transport data reveal that the energy wasteful use of the Australian car fleet is likely to continue to 2011, unless the potential for modal substitution to conserve energy and more energy efficient vehicles are introduced between 2004 to 2014. (Parker 2004 B)

Figure 6 shows vehicle energy efficiency (not total energy efficiency) to illustrate the potential for mode shift and choosing 'horses for courses'. The vehicle energy efficiency of public transport vehicles is shown when they are fully loaded and 25% loaded. The vehicle energy efficiency of single occupant cars is very low compared to fully loaded cars. Power assisted bicycles (petrol and electric battery powered) are available on in Japan the EU, the USA and Canada. Unfortunately, the safest electric bicycles cannot be purchased in Australia because of road rules that result in restriction of free trade by preventing Australians from buying the safest electric power assisted bicycles (Parker 2004 A). Even so there is scope for using power assisted bicycles to substitute for many short single occupant car trips of less than 10 km and they would use between one twentieth and one sixtieth of the fuel used by cars per km.

Figure 6 Petrol, diesel, ethanol & electricity energy use of vehicles and aircraft



The latest electric power assisted bicycles weigh only a few kilograms more than bicycles which give power assistance only from on-board rechargeable batteries. They have electronically controlled power assistance via sensors in the cranks linked to a computer chip. There is no no clutch to worry about after switching the power assist system on with a key like that of a car which then operates automatically on starting, going uphill and combating headwinds. Power cuts out at 24 km per hour so can be safely used on shared footways. For the able bodied in the hilly suburbs of cities they are a practical substitute for many urban car trips of less than 10 km. and extend the range of bicycles. On main road bike lanes they would significantly increase bikelane usage and make them safer as a consequence.(Parker 2004 A)

The use of electric power assisted bicycles, coupled with roof mounted solar electric panels for recharging, has been proven to be practical in Japan. The electric power assisted bicycles coupled with roof mounted solar electric panels for recharging, is the most energy efficient motorises road vehicle ever made. This applies to able bodied people making urban trips of 10 km or for lame or partially disabled people or elderly people make trips of less than 5 km. The mass production of petrol electric hybrid cars by Toyota and Honda has started with 70,000 petrol electric hybrids predicted to be sold in the USA in 2004. Not only that, but a more efficient version of the small petrol engine in the hybrid vehicle is being developed.

Australia is also dependent on aircraft for long distance passenger travel and tourism; on light commercial vehicles and trucks for freight; and on shipping for international trade. Highly efficient engines powered by natural gas are commercially available for long distance trucks, B-doubles and road trains. The best hope for Australia is to use the large reserves of natural gas as the transition fuel for Australian vehicles. To do that effectively will require that LPG, CNG and LNG be used by government car fleets, providing financial incentives for vehicle conversions or the purchase of dedicated gas vehicles and financial support for the provision of fuel storage or distribution infrastructure. (STC 2004).

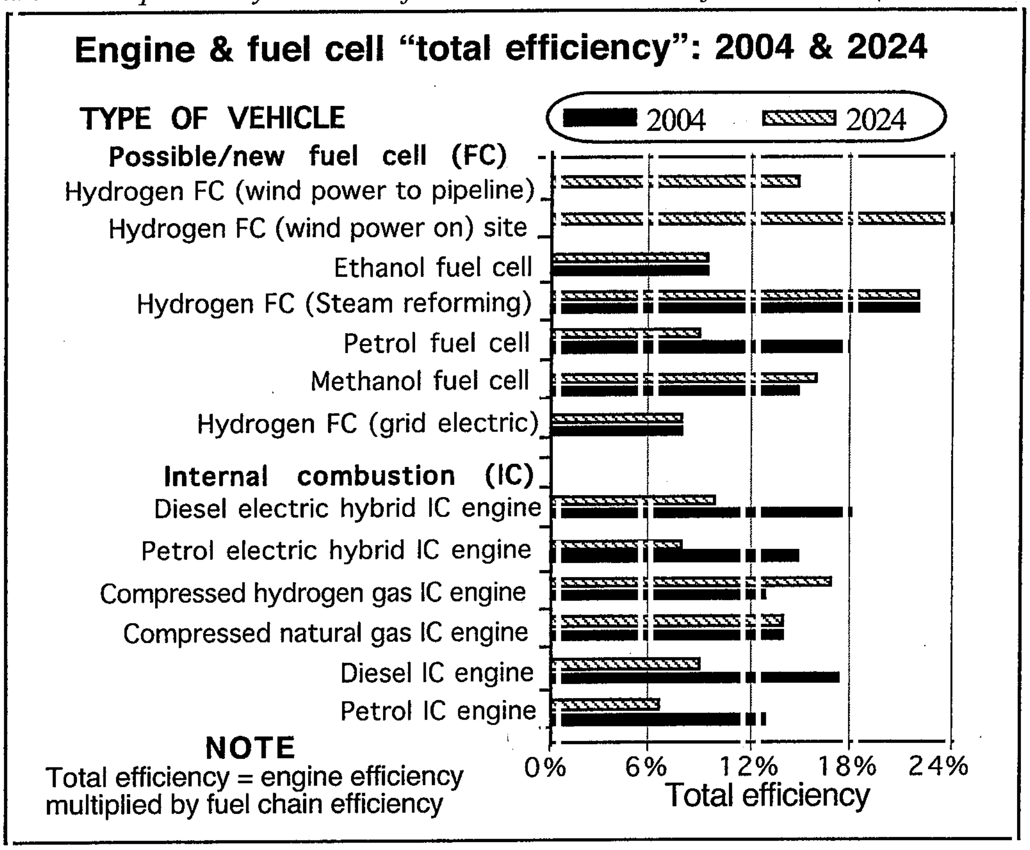
Passenger rail could become one of the few energy efficient uses of electricity if it is generated from gas or a nuclear reactor. The provision of high speed diesel/electric inter city passenger and freight trains could greatly assist in reducing liquid fuel use by substituting for road freight and air passenger travel. There is a need to build up the rail infrastructure, which is in a shocking state. The short term goal should be to stop that freighting which is in the category of 'taking coals to Newcastle', which has been done overseas, and to steadily increase the price of diesel so as to deter unnecessary freight movement. There is a the need to conserve diesel use and build up a strategic reserve of diesel to keep the truckie's going for at least one year. (Parker 2004 C)

Hydrogen produced by electrolysis from nuclear or wind energy

Australia has sufficient wind resources to extract clean hydrogen from by electrolysis for a large number of fuel cell vehicles between 2014 and 2024. in rural areas. (MacGill and Outhred,2004) To produce enough clean hydrogen for urban car fleet's would require a large nuclear reactor in each state except Tasmania. Japan, the Netherlands and many other nations that have not wasted their energy resources as Australia has, but have limited wind resources are not so fortunate. Using electricity from a nuclear reactor is only option .that does not significantly increase CO2 emissions.

Figure 7 demonstrates that by 2024 that 'fuel cell' powered vehicles **using hydrogen made from fossil fuels** are not energy efficient due to the decrease in fuel chain efficiency of oil. The use of hydrogen produced by wind farms in rural areas can serve both the local needs of farmers and some mining ventures. Hydrogen can be efficiently used to fuel trucks with hydrogen/diesel engines passing through rural areas and bush and long distance inter city trains for transport of freight and passengers could use compressed hydrogen. The total fuel chain emissions and vehicle emissions are not so different for internal combustion engines and fuel cells. Unless the hydrogen is made from a renewable energy resource.

Figure 7 IC Engine and fuel cell total efficiency for the years 2004 and 2024..
Source: Extrapolated by the author from charts in the Scientific American. (Wald M 2004)



The ethanol fuel cell 'fuel chain emission' data looks good but, as Wald the author notes many people argue that fuel used at all stages in growing corn to make ethanol needs to be taken into account. (Wald 2004) However, ethanol petrol blends can significantly reduces pollutant emissions. However, in Asia they will not be using food crops to make ethanol. World energy trends reveal that the use of renewable energy to produce electricity has declined from 11% in 1971 to 7% in 2001. . (Hogan and Cohen 2004)

More nuclear electricity will restrain the world market price of oil and gas.

Considering uranium resources in isolation from other finite resources such as conventional oil is a futile exercise. Australia's has 45% of the world high grade uranium reserves so it is inevitable and equitable that those reserves be used for electricity production abroad even if no nuclear power stations are built in Australia. The introduction of an additional large-scale energy source, like nuclear power, into the global energy supply mix helps to provide price stability and reduce shortages in three ways.

1. use of nuclear power reduces demand for fuels it displaces, and reduces future prices. This benefits all users of the other fuels, even though they themselves may not have adopted the new source. Thus, the adoption of nuclear power by the industrial countries will have helped to restrain the world market price of oil and coal, to the benefit of all.

2. nuclear power, and renewable power infrastructure, after construction has very low operational fuel costs compared with the fossil-fuelled options. Taking into account increasing cost of oil, when the officials projections are proven wrong, will have nasty economic consequences that are mostly avoided with nuclear power or renewables.

3 the adoption of a significant amount of a non-fossil energy source can reduce significantly the economic impact of disruptions in the supply of imported fossil fuels.

Nuclear power will initially have a minor role is overcoming oil shortages because there is not enough time to build enough nuclear reactors by 2010 but if there is major reactor building program it has the potential to play a crucial role in holding the world economy together by 2012. If nuclear power production increased threefold from 16 % of the worlds total power output in 2003 to 48% by 2030 when the world primary energy demand has increased by 50% then at least 2000 more nuclear reactors will required. of which more than 1000 would be required in our region.

Japan, China, Indonesia and India in a few years, will have no indigenous oil resources and will be totally dependent on the most political unstable parts of world, the Middle East and The Stans for their oil supplies without which they cannot grow their economies or feed themselves. The strategic importance of uranium for Japan China, Indonesia and India is to be able to generate electricity for industry and for building renewable energy infrastructure. China, India combined only generate 3% of their electricity with nuclear power and they will have to learn from Japan which has 25% nuclear electricity.

From a global and Australian regional perspective, the most energy efficient, equitable and strategic use of the remaining reserves of both oil and uranium, is to provide for essential transport and 'power assist' labour intensive agriculture of our neighbours. And to ensure that the complex hydrocarbons in oil are used to manufacture the essential petrochemical products required by farms, hospitals and essential services. both oil and nuclear electricity are needed to provide the infrastructure for the development of renewable energy resources. (Abernethy 2004) (Pimental & Wilson 2004) (New Scientist Supplement 2001)

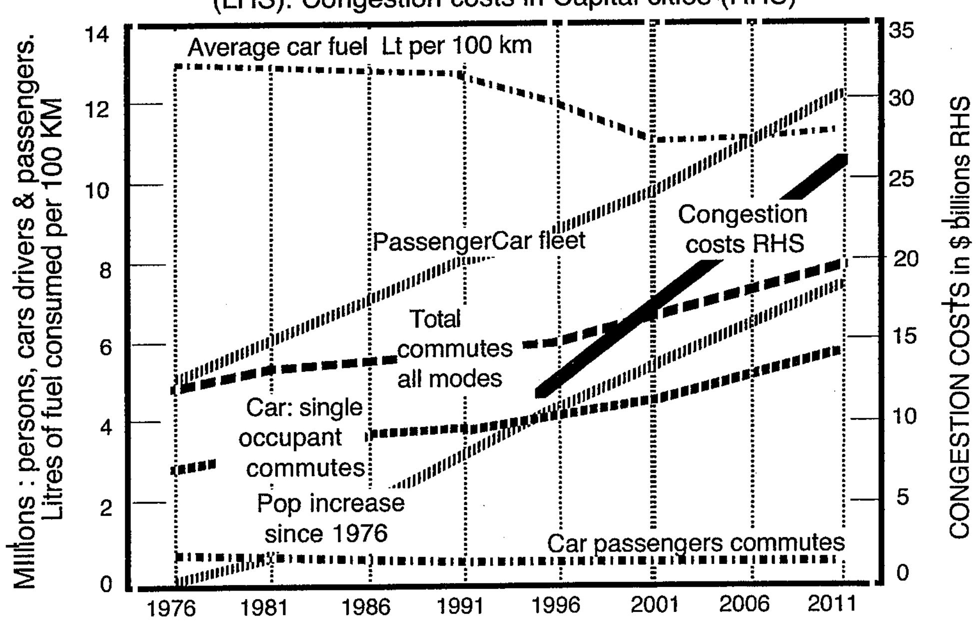
National economies are at risk of collapse if transport is over dependent on oil.

The countries with the highest levels of car ownership per 1000 population are locked in to transport systems that are over dependent on imported oil from the most politically insecure parts of the world oil. Car ownership is 780/1000 in the (US), 620/1000 in Australia and around 450/1000 plus or minus a 100 or so in europe (See table 1). The US is the most vulnerable and European countries with high levels of commuting by public transport use, walking and cycling for journey to work are the least vulnerable. For example Sweden , Denmark, the Netherlands and Germany. Australia urban economies are less vulnerable than the USA but as Australia production of crude oil has peaked and is now declining so it would be prudent to assume that the Australian economy is at risk and very vulnerable .

The peak hour congestion in Australian cities is caused by a car fleet which is badly utilised because commuter cars have only 1.1 passengers and nearly all of them are fuelled by oil products. In the early 1980s, it was caused by the growth in the population, which spread into sprawling outer suburbs, where the employed have to commute long distances and have no alternative to the car. As a consequence, the car population doubled between 1976 and 2001, an increase of 5 million cars that parallels the 5.4 million increase in the resident population. Figure 8 uses the Census Data to show the almost parallel growth of human and car populations since 1976.

Figure 8 Unsustainable Australian commutes 1976 to 2011

Census Day commutes: by all modes and as single occupant drivers or car passengers. Fuel consumption and total population increase since 1976 (LHS). Congestion costs in Capital cities (RHS)



The costs of congestion in Australian cities, particularly Sydney, Brisbane and Melbourne, are increasing. The projected growth rate of congestion costs from 1995 to 2011 is higher than the actual and projected growth in the car and human population and is even higher than the number of commutes by all modes. The increase in commutes by all modes would be far less costly if the number of single occupant car commutes could be cut back.

Figure 8 includes CSIRO estimates of car fleet fuel efficiency which is projected to get worse from 2001 to 2011 due to the growing proportion of large cars and four wheel drives (Foran & Poldy 2002). In 2003 85,500 4WDs were sold, 13.8% more than in 2002, and existing policies will continue this trend. (Parker 2004 B)

The benefits of improved fuel consumption in new small and medium sized cars will be lost making the car fleet less fuel efficient per passenger km. As the average car has a life of 9.5 years half the fuel wasteful cars on the roads will still be on the roads in 2014 and there are no tax incentives to buy small fuel efficient cars.

Figure 8 shows that the cost of congestion in Australian capital cities is primarily caused by commuters who use a vehicle designed to carry three, four or five people to drive alone to work. Single occupant car use has been encouraged by the introduction of the GST in 2000 which reduced the cost of cars. The absence of import duty on 4WDs is another concession for buying and driving these larger vehicles. The introduction of reduced tariffs in January 2005 will reduce the price of imported small cars by around $800 and the cost of large luxury cars by around $3,000, thereby encouraging more fuel wasteful driving.

Table 5 Sectoral use of Australian petroleum products in 2002

Sector of the economy	% Share	Main products used	Type of use
Agriculture	3.7 %	Petrol & diesel	Farm equipment & electricity generators
Mining	4 %	Diesel & fuel oil	Mining Equipment & power for mining
Chemicals	3.1 %	Industrial diesel	Boilers and chemical products
Metal products	2.7 %	Industrial diesel	Boilers and process equipment
Other manufacturing	3.7 %	Industrial diesel	Heavy industrial machines & boilers
ALL TRANSPORT	76 %		
Road transport - cars	32.5 %	Petrol	Mostly cars and 4WDs: some LCVs
Road transport - trucks	23. %	Diesel	Mostly Trucks, B-doubles &buses
Road transport - LPG	3.5 %	LPG	Mostly taxis and fleet cars
Rail transport	1.6 %	Diesel	Intercity passenger and freight trains
Air transport	12.4 %	Aviation fuel	Domestic and international flights
Sea transport	2.8 %	Diesel & fuel oil	Fishing, coastal & international shipping
Commerce & services	1 %	Heating oil & LPG	Hospital boilers, resturaunts etc
Residential	0.9 %	Heating oil & LPG	Cooking and heating
Lubricants	3.1 %	Lubricants	Heavy equipment
Electricity generation	1.8 %	Diesel & fuel oil	Regional generator & coal fired stations

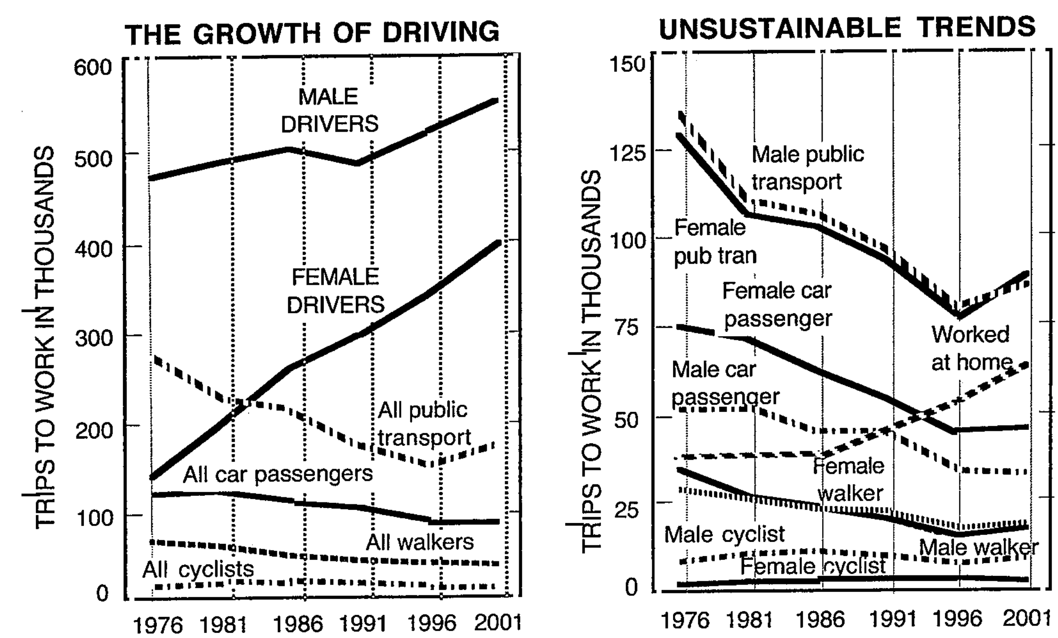
Source ABARE

The practice of subsidising car use as part of salary packaging has grown to such an extent that it significantly discourages public transport use and encourages the purchase of vehicles that are larger than they would be if not part of a salary package. New cars in 2003 will have fuel efficiency labels for buyers but there are no fiscal incentives to buy fuel efficient cars and around 25% of all cars sold will be 4WDs in 2004. More roads are being built to encourage more driving. Freeway construction which is underway will only reduce congestion in the short term, but after a few years will generate more road congestion and further discourage the use of public transport, walking and cycling. Existing Commonwealth policies will ensure that car fleet oil consumption will increase by around 2.7% per year and high levels of petroleum product use (shown in Table 5. will increase.

The growing vulnerably in typical oil dependent Australian city : Melbourne

Melbourne is a good example of growing Australian oil dependence; the robust trends (shown on Figure 9) also apply generally to other capital cities. All the capital cities have an overall modal split that is similar to that of Melbourne, with the growth of female car commutes from 1976 to 2001 being the most dominant trend. (Parker 2004). Other sources show that car commutes have also become longer than most other weekday journeys; in 2001 they accounted for 32% of the total distance travelled by car. Car commutes are concentrated in the congested rush hours, and are subject to stop-start driving conditions and 'cold starts'. Commutes are responsible for around 40% of peak hour emissions, fuel consumption and road congestion

Figure 9. Melbourne journey to work ABS Census 1976 to 2001



SOURCE: ABS Census, Basic Community Profiles for Melbourne (SD).

NOTES: Motorcycle, truck and taxi modes are omitted to clearly show trends.

Similar trends for all the other capital cities predict increased congestion costs and vehicle fuel consumption to the year 2011. (VicRoads 2003)

The Census data for the journey to work and car ownership are very reliable data for making intercity comparisons right down to local government level, being based on a 97% population sample. Unsustainable commutes are graphed from 1976 to 2001 on Figure 9. In metropolitan Melbourne 80% commutes were made by car. Walking and cycling combined only accounted for 3.9% of all journeys to work in 2001. Cycling has stayed around 1% in the last 25 years. Most commuter destinations are now beyond walking distance so walking declined from 6.3% in 1976 to 2.9% in 2001. The only sustainable trend is the five percent of those who worked at home on Census day. This was similar in all five Australian cities and has increased since 1986 which suggests that a further increase will occur by 2006. (Parker 2004 B).

Commutes by all modes are plotted against household density per square kilometres for the 16 statistical regions in Melbourne in 2001 (See Figure 10)

This shows the dominance of single occupant car commutes and high car ownership levels in outer suburbia. The percentage of walking, cycling and public transport commutes all decline with decreasing household density.

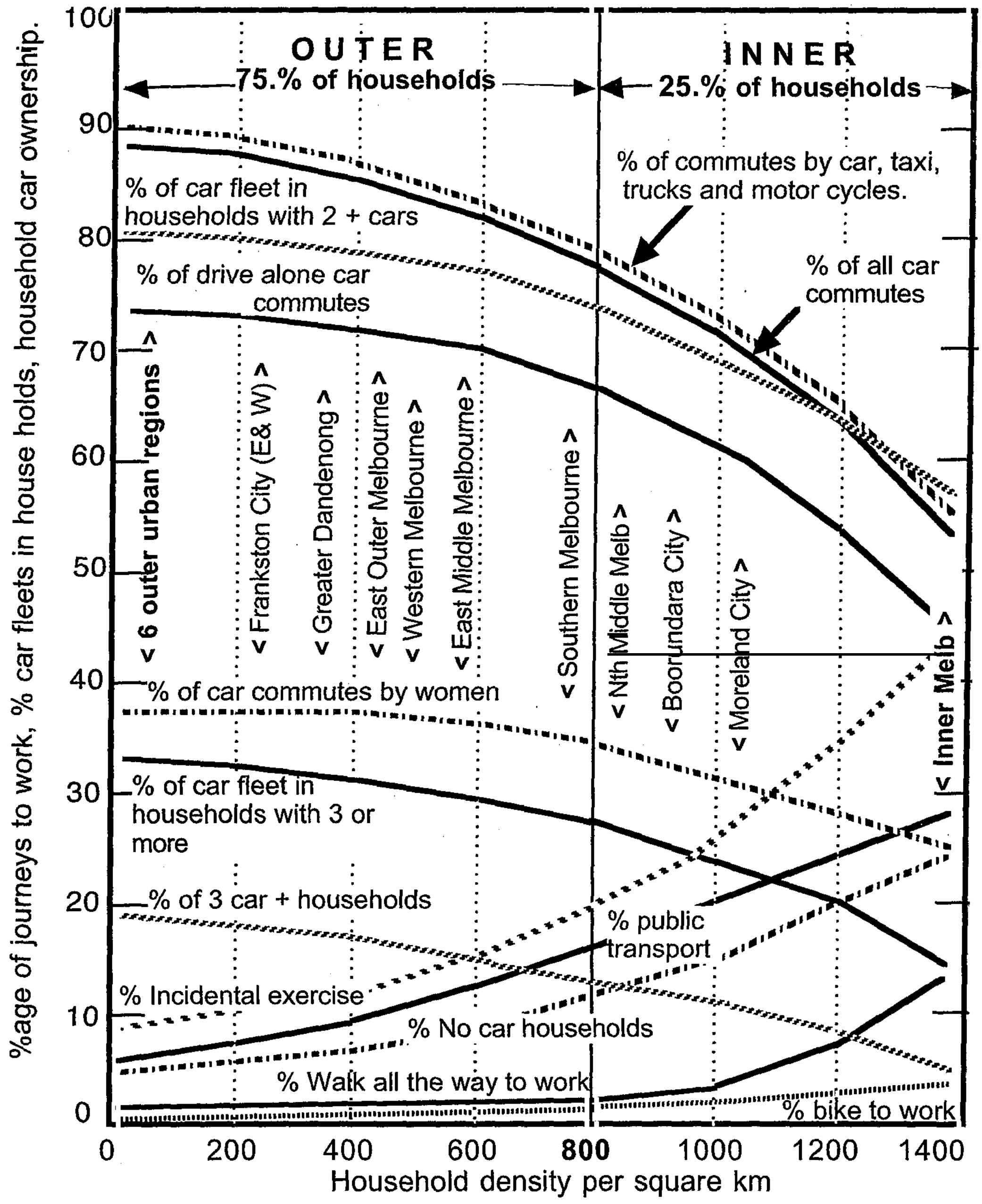
Most of the unsustainable commutes are located in the sprawling outer suburbs which have between 20 and 800 households per square kilometre and where 75% of the population now reside. In these areas, 80% of households own 2 or more cars; around 85% of those who are employed commute by car and they are responsible for 85% of the distance travelled by all commuters and for 70% of the drive alone commutes in the metropolis. Furthermore, 78% of the car fleet resides in households with 2 or more cars. Walking, cycling and public transport account for only 13% of all commutes. Many city dwellers are likely to suffer considerable hardship because 90% of their journeys to work are by car, truck or motorcycle and there is no easy way of continuing to do that without cheap oil. (VicRoads 2003)

There is a significant difference between the Inner Melbourne Region, and the six outermost regions. The Inner Melbourne Region has a density of 1,300 households per square km, commuting is far less car dependent and 43% of commuters benefit from "incidental exercise" incurred in walking, riding a bike or in walking to and from public transport.

When the petrol becomes expensive, most households in this region will be able to dispense with their cars and survive without petrol, as people did from the beginning of World War 2 to around 1950, when Melbourne was a more compact city.

With current government policies the growth of the oil dependent transport system will inevitably retard the urban economic growth not only in the outer suburbs of the capital cities, but also in provincial cities which have the same level of car dependence. Data for 8 Victorian provincial cities show this to be the case. (Parker 2004).

FIGURE 10 MelbourneCommutes by 16 urban regions and Household density
Source: Census data for the 16 regions of Metropolitan Melbourne



Notes. The %age of incidental exercise = The total % age of all public transport, cycling and walking journeys. The %age of drive alone car commutes = car driver commutes minus car pass commutes. Curves in outer regions have been statistically smoothed.

REDUCING OIL DEPENDENCE BEFORE IT PUTS NATIONAL SECURITY AT RISK

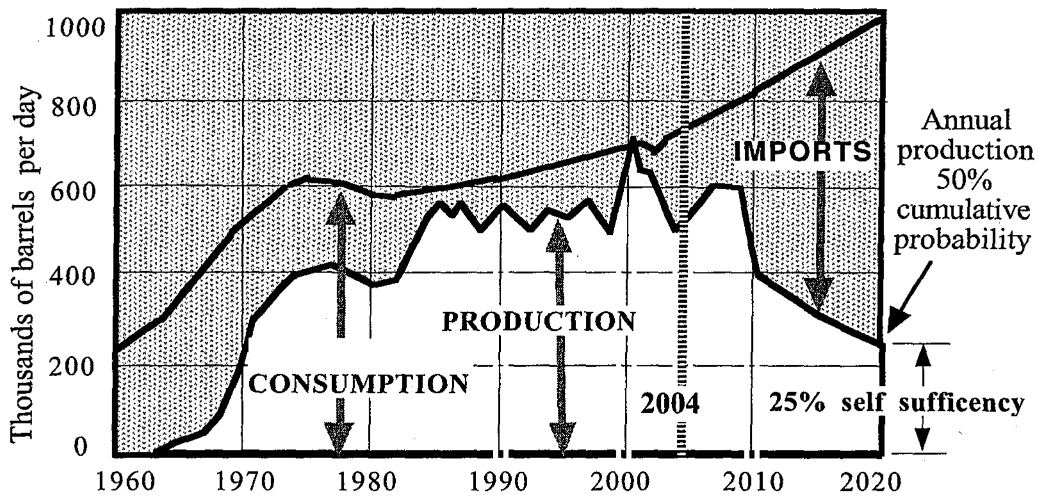
Over the last forty years Australia has become addicted to cheap oil, especially for transport which uses almost 80% of Australia's petroleum; 55% of road transport fuel is petrol, 39%

diesel and 6% is LPG. Transport predictions to the year 2010 for single occupant car commuting, car travel generally, air passenger travel, inter city road freight and intra-city commercial vehicle traffic all show unsustainable growth of oil dependency.

The oil dependent transport sector is responsible for 76% of oil consumption and that cannot be seriously reduced unless the car industry is restructured so that hybrid petrol electric cars are produced. Large car production sales to be cut by the application of fuel efficiency standards. To minimise disruption of existing manufacture of small cars they should be fitted out with engines designed to efficiently run on gas, phased out when the more efficient small hybrids vehicles are mass produced. The light commercial vehicle import business needs to be regulated so that LCV's satisfy mandatory fuel efficiency standards.

Figure 11 Australian crude & condensate: imports, production, consumption and self sufficiency from 1960 to 2020

DATA SOURCE. Fifth report of the Royal Commission on Petroleum 1976.
"Oil and Gas Resources of Australia 2002" Geoscience Australia, March 2002.



The Commonwealth does not recognise this growing threat to national security. The assumption is that there is enough cheap oil in the world barrel for another 30 years. The decline of Australia's oil production has been documented (Geoscience 2004) and is shown in Figure 11. The disparity between, the growth in oil consumption, oil imports and the decline in indigenous oil production predicts a serious loss of self sufficiency between 2006 and 2020.

High levels of car and oil dependence are potentially very serious threats to Australian national security and the Commonwealth's current policies are based on science that has been corrupted by ideological considerations. (Flannery 2004 B) Even the US took energy security planning seriously in the 1970s and produced a sound definition of national security:-

National security requires a stable economy with assured supplies of materials for industry. In this sense frugality and conservation of materials are essential to our national security. Security means more than safety from a hostile attack; it includes the preservation of a system of civilisation. (Huddle 1976)

The Commonwealth does not recognise this growing threat to national security. The assumption is that there is enough cheap oil in the world barrel for another 30 years. The decline of Australia's oil production has been documented (Geoscience 2004) and is shown in Figure 11. The disparity between, the growth in oil consumption and oil imports and the decline in indigenous oil production predicts a serious loss of self sufficiency between 2006 and 2020. The following four issues need to be addressed:-

1. According to the Australian Petroleum Production & Exploration Association, by 2010 Australian oil production will cover only half of the country's needs and will cost between $3 billion and $12 billion at today's prices. It is more likely to be at or near the $12 billion mark if significantly more oil is not found in deep water. (Trounson 2004).

2. In the unlikely event that major oil fields are found in deep water, providing enough oil for self-sufficiency for the next 30 years with some left over to export, there would still be a serious threat to Australian national security. The risk of the world depression is very high and that would bring the Australian economy down with it.

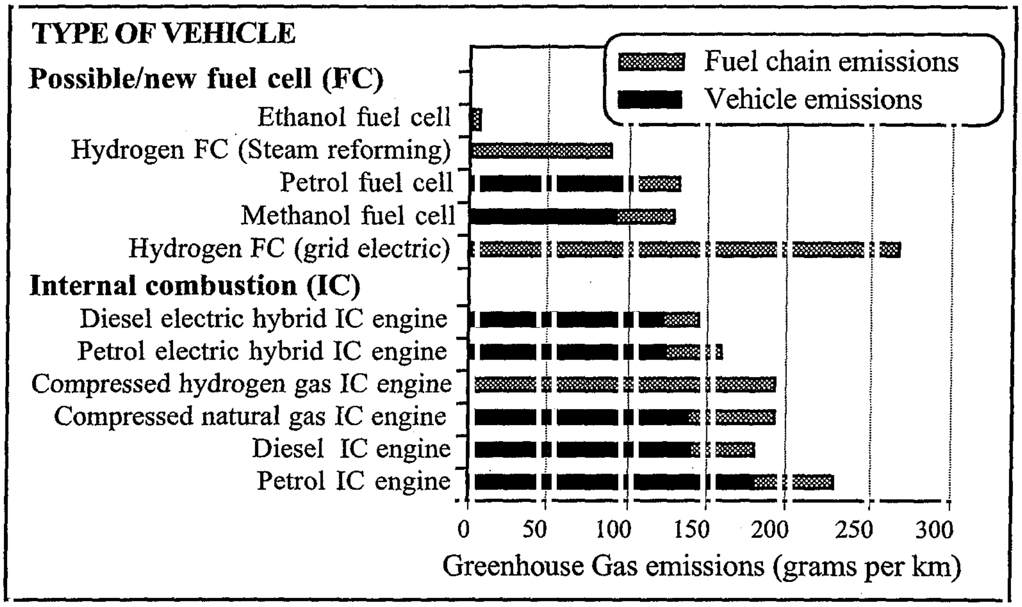
3. A 1930s type depression in rich, sparsely populated countries like Australia seems likely. Australia, unlike the U.S. the E.U. China and Japan, is well endowed with natural gas, which could be used as a transitional fuel to replace petrol and diesel. However, Australia has no national energy security plan in place to do that. Nor is there any evidence of political intent to use gas in this way. For Australia, there is little time left to take effective action to insulate itself from oil shortages which will initially collapse aviation and agriculture due to high prices of jet fuel and nitrogen fertilisers made from gas and oil. A little later road and rail passenger and freight transport, tourism, the petrochemical industry and the car industry will be working part time and will finally also collapse. (Fleay 1998)

4. The white paper, *Saving Australia's Energy Future,* released on the 15th June 2004, assumes that centuries-old dirty fossil fuels such as oil and coal, should not, and will not give way anytime soon to solar, wind or tidal power or nuclear power. The white paper assumes that there will be no problems with global or indigenous oil supplies for the next 30 years and totally ignores the evidence that there will be major problems within a decade and more wars control oil , or to secure pipeline access across Afghanistan. (Renner 2002) (SESSWG 2004).

4. There is no practical alternative to oil in the next few years and we have to adjust to a growing oil scarcity. The timetable laid out by the Bush Administration in its $1.2 billion "hydrogen economy" policy statements is not credible. The hydrogen economy is not the quick fix to oil depletion. On the contrary, a 2004 report from the US National Academies of Science concluded that, "under the best case scenario the hydrogen transition will do little to cut oil imports or greenhouse gas emissions during the next 25 years." (Bossel & Eliasson 2003).(Wald 2004)

Figure 12 shows that hydrogen (made with fossil fuels) in fuel cell powered vehicles will not significantly reduce greenhouse gas emissions: nor will making hydrogen with nuclear power

Figure 12 Total Greenhouse emissions of vehicles with IC engines and fuel cells 2004
Source: US Department of Energy and Wald 2004



However, the efficient production of clean hydrogen by electrolysis from the surplus power capacity of wind farms is possible but unlikely to happen. Australia has the wind resources (Magil and Outred 2004) and the capacity to develop the technology to make enough clean hydrogen for many transport purposes but not for mass motoring in the capital cities.

National energy security plan needed for Australian and the Asian region

It would be prudent for the Commonwealth to have an energy security policy as they have had in Japan since the since the 1974 oil crisis, which closed down industries vital to the national economy and demonstrated the vulnerability of the Japanese economy to reduced oil supplies. (Hook 1994) Furthermore, China, India, Indonesia need to learn from Japan's 28 year old energy security policy, which over writes narrow economic concerns in order to produce more energy efficient passenger trains and intermodal networks, hybrid petrol electric vehicles of all kinds, electric scooters and electric bicycles and modal substitution: including secure bicycle parking for million bike/train commuters.

The Japanese ruling bureaucracy realised in 1974 that national security is about enabling Japan to survive oil shortages; that oil conservation is just as important as having a military capacity and that oil dependence was a serious threat to their way of life. Japan's energy security policy has reduced oil dependence in the transport sector by creating the finest rail system in the world, for urban commuting and intercity transportation, which is sustainable because it is reliant mainly on hydro electric sources (Hook, W. 1994). Intermodal passenger transport is highly developed with 6 million bicycles being used to access rail stations; very efficient modal interchanges linking buses and trains and providing secure bicycle parking.

Japan has introduced legislation requiring the sale of new cars, after four years of use to other countries so that new energy efficient cars, particularly small petrol electric hybrids, will, in a few years, renew their car fleet and make it the most fuel efficient in the world. Petrol is A$1.75 per litre, a price high enough to encourage the sale of smaller cars. Electricity generation is heavily dependent on oil and is the reason for Japan planning to generate 40% of its electricity from nuclear power. This electricity can be also used for more high-speed trains and to power electric bicycles which are becoming popular in Japan (Parker 2004 A). Japan has almost zero population growth, has no indigenous oil resources and has been sensibly planning to survive since the 1970s when Japan's elite bureaucracy MITI made important decisions.

The EU more recently accepted that conserving oil resources and investing in the energy efficient use of oil and renewable energy is the only sensible option. Ever since the neo-cons in the US buried former President JimmyCarter's energy conservation policy the US has been the model of world worst practice. Australia has a lot to learn about energy security planning from Sweden whose first plan goes back to the 1949.(Link 1977). By the late 1970's Swedish view of the national security had matured a great deal it even dealt with the problem of combating terrorism. The Journal 'Sweden Now", stated what their basic assumptions were:-

> *"Our war arsenals are like gigantic dinosaurs fostered and fed on an environment that no longer exists. Instead infiltration, sabotage and terrorism are better adapted to today. So watch guarding, stockpiling and preparedness by means of economic rather than military defence is becoming ever more realistic.....Sweden is one jump ahead in what they call 'economic defence' Designed as a plan to cope in case of war...it proved during the 1973 oil crisis to serve an important purpose in this type of emergency, which is expected to happen again" .(Link 1977)*

If Sweden's approach to energy security planning anticipated the 9/11 terrorist attack 24 year before the US woke up to the real world. Promoting energy efficiency, energy conservation and the use of renewable energy, the peaceful use of nuclear are more important means of ensuring national security than military might. 12% of Sweden's primary energy is hydro-electric power and 50% is nuclear power. Should all else fail it can survive without oil.

Neutral Sweden has not been in a war for 160 years because its national security policy has always been sophisticated. Since 1949 the need for land use planning around rail lines and the support of industries which make energy efficient trains, buses and light rail vehicles was recognised. These were developed because they could use the plentiful supply of hydro-electric power at the end of world war 2 and building nuclear power station in the last 50 years. The high level of bicycle, moped and public transport use, coupled with, successful road safety measures and the provision of bicycle infrastructure, is part of a transport and land use planning process. Since 1949 this has been a component part of a national security policy designed to enable Sweden to survive and preserve the integrity of their way of life.

Another thing that has to be learnt from this is that there are long lead times in making significant energy efficiency changes, Sweden took 40 years and Japan took 30 years. The Dutch took 14 years to increase public transport use, increase bicycle use to 25% of all trips and make the Dutch car fleet more fuel efficient with 40% less fuel consumption per vehicle than in Australia (Parker 2001). The Dutch Bicycle Master Plan and the Greening of their tax system were very successful.

Of course economists who dominate government decision making in Australia. understand little about the geo-physical realities of finite resources. They grizzle about our small domestic market and letting the markets decide. What Swedish experience shows is what matters, it is not population size but being having an educated elite, where intellectuals of all kinds, scientists, military leaders and politicians are constructively involved in a dialogue, and where the intelligence service tell the truth to their ministers even when they know that is not what the minister wants to hear. This is what enables a government to anticipate future events and respond with practical policies.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that strategic role of Australia's 45% share of the worlds uranium and thorium resources should not be considered in isolation from long term energy security and national security planning. Australia is no long self sufficient in oil and there are serious doubts about future oil discoveries in Australian territory be able to meet a small fraction of oil demand Oil continues to provide most of the fuels for transportation and the feed stock for the the petrochemical industry but there are emerging concerns about the worlds long-term reserves and volatile pricing. of oil imports.

According to the international Energy Agency energy companies are also under investing in new oil and gas production capacity by up to 20 percent. As a consequence of Muslim nationalism in key OPEC countries foreign investment in the oil industry is prohibited and there is no evidence of major technological breakthroughs in exploration, production and refining of conventional oil. The publicly listed oil companies are twiddling their thumbs and returning vast sums to their shareholders and concentrating on their near term financial performance.(Velins, E 2005)

Nor should the strategic role of uranium ignore environment policy because the only evidence of major technological breakthroughs in exploration, production and refining is for non-conventional sources of oil. By 2006 governments will take fright and they will gang up and the oil industry will get it marching orders. From 2007 to 2010 shale oil, tar sands and heavy oil will be increasing rapidly producing a huge increase in $CO2$ emissions, and other pollutants. Its possible that some giant new oil fields will be discovered in deep water, that methane hydrates will become a viable resource at this time and that biological techniques for using bacterial to make heavy oil less viscous in decommissioned wells will also be available. Australia will decide to use more brown coal. However, all these sources of oil and gas will produce far more greenhouse gas emissions the production of conventional oil from wells before the peak.

From an environmental perspective the only good news is the rapid embrace of hybridisation by car makers and consumers. Car maker intend to provide for overnight charging in future hybrid petrol electric models because so many consumers want that option. It is concluded that this makes the base load power stations, which need more night-time, off-peak demand to increase their efficiency.There needs to be a detailed study of the potential of nuclear energy to be used in this way in Asia so that imported oil can be used more essential purposes.

There is nothing new in using electricity for transportation. Electric urban passenger trains and cable trams have been around for 100 years. Electric trolley buses and electric delivery vehicles have been around since the 1940s and diesel electric freight trains are commonplace. In Japan and Europe high speed intercity expresses with speeds up to 230 km per hour have been working safely for decades. In the 1990s. Japan created the electric power assisted bicycle to substitute for short car trips and in 2005 factories in China will produce 6 million electric bicycles. By 2007 there will be commercially available hybrid electric cars getting most of their energy from over night battery recharging to balance out peak demands. The electricity produced by Australia's uranium in Asian nuclear reactors will in time be able to keep their transport systems going. Hopefully, before oil shortage begin to wreck there plans to industrialise. and reduce widespread poverty in the rural areas.

Australia and the Asian region are both vulnerable because of their growing dependence on oil imported from, politically unstable countries with finite oil reserves, whose ability to expand production to meet predicted demand is in serious doubt after 2008. Imported oil will greatly increase in price which at first Australia will able to pay for. The problem is that Australia's trading partners particularly China, India and Indonesia not being able to buy enough for essential purposes and food production and will sink into a severe recession and famine. They will have no choice but to cut back their commodity imports from Australia which will then sink into a recession as consequence and from there on it gets bleaker and leads to a full blown economic depression.

It is concluded that frugality and conservation of strategic domestic reserves of oil are essential to our national security and just as important as our military capacity. Far more energy efficient transport fleets are needed with a planned incremental transition over to nuclear electricity in Asia as the primary energy source. For Australia electricity from fossil fuels (with carbon sequestration), wind power and natural gas will allow a transition to oil/electric hybrid vehicles and electric vehicle s.

Australia has no control over what OPEC or the NOON-OPEC oil producers do, nor can Australia reduce the growing demand that is emptying the worlds oil fields so it must become more reliant on it own actions to conserve it oil. The Commonwealth must recognise that the uncontrolled growth in petrol and diesel consumption by government, companies and the people of Australia, is putting the nation and everybody in it at risk. Oil dependence is like being addicted to chemical substance that everyone knows is potentially fatal. There is only one solution and that is to kick the habit and get a more sustainable form of mobility that is more efficient and powered by electricity or muscle power. The technology means to kick the habit is on its way, courtesy of Japan's car industry research laboratories but it will sensible planning and government intervention to use that technology in Australia. .

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It would be prudent for this Inquiry to recognise that in the absence of an effective international energy security plan their is need for Australia to have energy security plan of its own. More efficient electric hybrid vehicles most charged overnight with electricity will be commercially available in a few years. Wind farms are advanced in their development with highly efficient 2 to 3 megawatt wind turbines and more efficient coal fired power stations could be rapidly developed.

Perhaps Australia could suggest the need for an Asian Regional Energy Security Plan in which Australia makes a commitment to guarantee uranium supplies for a large nuclear energy program The nations in most need of Australian uranium are China, Japan India, Bangladesh and Indonesia all of which have low levels of CO2 emissions and low levels of self sufficiency in oil. The potential to use renewable energy resources is not very good in these countries either as they are far more densely populated than Australia. The best and most globally equitable use of Australian uranium is assist our Asian Neighbours to survive the peaking of world oil supplies. The report of this HOR Uranium Inquiry should state clearly and unambiguously that The Inquiry should recognise, recommend or advocate the following:-

1. The world is changing in a way that threatens national security so there is a need to act independently and provide the Commonwealth with the powers to introduce this crash program that will the reduce oil consumption each year and allow of indigenous sources of oil to be conserved as a strategic reserve. To survive the end of the age of cheap oil Australia has to start adapting now.

2. Recognise that Australia is well endowed with renewable energy resources and has no need to build nuclear power stations but should in the remote regions of Australia provide a secure supply of uranium and a secure means of storing nuclear waste for the mutual aid of China, Japan India, and Indonesia all of whom have a real need for more safe nuclear power.

3. Recognise that the energy used to extract and deliver oil to its end use will exceed the energy contained within that oil by around 2036 and that oil will cease to be competitive with other fuels well before then. It should recommend the systematic de-coupling of oil consumption from economic growth.

4. Recognise that Australian is well endowed with natural gas and that a strategic reserve be kept to be used as a transition fuel for existing petrol powered vehicles.

5. That an energy efficient hybrid electric cars, LCV's and trucks should be made in Australia.. and that these vehicles and other vehicles already being manufctured in Australia be subject to fuel efficiencey standards.That electric bicycles complying with EU regulations be promoted in Australia and that there needs to be a strategic reserve

of one years supply of petrol and diesel oil.

6. That Australia can and should adapt fast enough to build the infrastructure and develop the technology that will exploit energy from our abundant clean and renewable resources. In particular the use of abundant wind power to produce hydrogen by electrolysis needs a major study and significant investment.

7. An energy security policy is needed that will reduce oil dependence in the transport sector. It should produce a major shift from road to rail for urban commuting and intercity transportation, and for private air and road travel to rail travel. It should ensure the growth of intermodal passenger transport, with bicycles being used to access rail stations and trunk bus routes; and modal interchanges linking buses and trains with secure parking for bicycles and electric bicycles.

8. It should advocate that the financial barriers to changing travel behaviour can be removed by "Greening" the Commonwealth tax system to provide incentives for more sustainable transport behaviour; constrain unsustainable car use and make the use of energy efficient cars a mandatory requirement for all government car fleets; and encourage the car industry to manufacture petrol electric hybrids. and cars specifically designed to efficiently use natural gas.

9. Petrol prices need to go up to A$1.75 per litre, a price high enough to encourage the sale of smaller cars and provide the funding for the needed bicycle and public transport infrastructure. The sale of large fuel wasteful cars should be discouraged via taxation.

10. It should advocate that State Governments change their Transport Acts to redefine main road departments roles in reducing the demand for more roads. The International Energy Agency (IEA) recommendations for practical oil demand management measures for all developed nations be used to constrain motoring (IEA 2005). The IEA argues that these motoring constraints will greatly encourage walking, cycling and public transport; and enabling bicycles to substitute for short drive alone car trips and complement the provision better public transport, walking and cycling infrastructure

11. Encourage State governments to work with local government to make the urban fabric more permeable for walkers and cyclists, so as to provide safer and more convenient access to nearby destinations and enhance access to the public transport system. This should be combined with urban consolidation measures.

Endnote: Australia survived with minimum oil supplies for several years, when the Japanese imperial navy with battleships, and swarms of carrier based torpedo bombers cut off oil supplies. Will the Uranium Inquiry report "tell the truth to power" and acknowledge that Australia's current level of oil dependence is the greatest potential threat to national security since Federation.?

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