Submission to the Senate Inquiry into Australia's Future Oil Supply

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Endorsed by the Committee of Torquay Landcare Inc.

This submission looks at the evidence for an imminent peak in global oil production (peak oil), from a layman's point of view and addresses implications that the predicted terminal decline in the availability of oil would hold for this country with regard to the inquiry's terms of reference

The Torquay Landcare Group is based in the hinterland of the Surfcoast Shire in Victoria, one of the fastest growing shires in the country.

Summary

The concept of Peak Oil is gaining currency and attracting increasing attention around the world. The evidence for an imminent reduction in World oil production and hence Australia's oil supply is reviewed. The implications of a severe reduction in oil supply and a significant increase in the price of oil for Australia are explored in the areas of transportation, agriculture and the economy. Strategies for mitigation of the economic and social impacts are discussed. It is the conclusion of this submission that the risks of an oil shortage induced crisis are very real, the potential consequences extremely dire and the need for decisive action is of the utmost urgency.

Outline of Submission

Background – What is Peak Oil?

- The published evidence for an imminent peak in global oil production
    - Key informants
    - Supporting evidence for peak oil from oil companies
    - Evidence that oil is a finite resource that is being depleted faster than it is being discovered.

- The projections for global oil demand
- Oil company responses to these projections
- The prospects for more oil discoveries.
    - New discoveries only just compensate for falling production.
    - Reassurance based on assertion not evidence.

- The prospects for a technological solution

- The nature of oil and its properties
    - What makes oil so special?
    - Conventional oil.
    - Unconventional oil.

- The alternatives to conventional oil
    - Biofuels.
    - Oil Shale.
    - Tar sands.
    - Natural Gas – NGL & LNG.
    - Hydrogen

- Oil dependence in historical context.

- Responses by other nations to the challenge of peak oil and decline

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The implications of a severe reduction in oil supply and a significant increase in the price of oil for Australia

- Liquid fuels for transportation
    - Road transport
    - Air travel
    - Suburbia
    - Remote communities

- Liquid fuels and fertiliser inputs for agriculture
    - Energy imbalance of modern farming
    - The Green Revolution was at the expense of a huge increase in energy consumption
    - Fertilisers from natural gas
    - Fertiliser input = Protein output
    - Can we feed the world now if the oil runs out soon?
    - Population growth in a finite world.
    - Ghost Acreage
    - Depletion of Ghost Acreage.
    - What happens when the Green Revolution comes to an end?
    - Local biological farming or Global GM

- The implications of peak oil for the economy
    - Increases in all prices
    - Risk of a share market collapse
    - Energy is growth
    - The energy curve of history
    - The silent lie
    - Conspiracy or fate

Strategies to minimise the impact of decreasing supply and increasing cost of oil.

- A list of 20 things that need to be done as a matter of urgency.

Conclusion

References

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Background – What is Peak Oil?

The published evidence for an imminent peak in global oil production

Global Peak Oil is not the same as the world running out of oil; it is the point after which further increases in oil extraction are impossible to achieve regardless of exploration, technology or economic demands. The oil supply will be at its maximum.

It means that we have used about half of the world's extractable oil and the second half will be harder to locate and extract, of lower quality and will take more energy to get out of the ground.

Once it takes a barrel of oil to pump a barrel of oil in any oil well, that oil well is finished producing as an energy source, regardless of what oil might still remain in the ground.

The body of work on peak oil is extensive and persuasive, as to whether it is right or wrong we will all find out quite soon. The experience of the lower 48 states of the USA is instructive. Peak oil production was predicted to occur there in 1970 by Dr M King Hubbert writing in 1956 (Hubbert, 1956). Applying the axiom, "You can only produce what you first discover," he exhaustively compiled the history of oil discoveries and reserve additions. He then translated the history into a production profile for the future. Hubbert showed that oil field production shows a characteristic bell-shaped curve, now called the Hubbert curve, it ramps up sharply in the early going, peaks once practical limits are reached, then declines. The curve is more or less symmetrical. He was ridiculed and his work censored at the time, it was not until about 1973 that Hubbert was proved correct. The world situation has been studied by many eminently qualified petroleum geologists who are now convinced that the peak of Hubbert's curve for global oil production is near.

Dr Colin Campbell is a retired petroleum geologist with a distinguished career behind him, as founding president of the Association for the Study of Peak Oil and Gas (ASPO) he has produced the following graphic (Figure 1). It shows a breakdown of the various oil types and sources (Campbell, 2004).

- Conventional oil production peaked in the USA in 1970
- Europe, (UK North Sea and Norway) have recently peaked
- Russia peaked in 1988
- The Other group includes non Middle East OPEC and non OPEC producers, these countries are collectively close to peak
- The Middle East is close to peak
- Unconventional oil production from polar and deep sea fields, heavy oil and oil from natural gas liquids will provide at best a 4 year buffer to global peak oil.

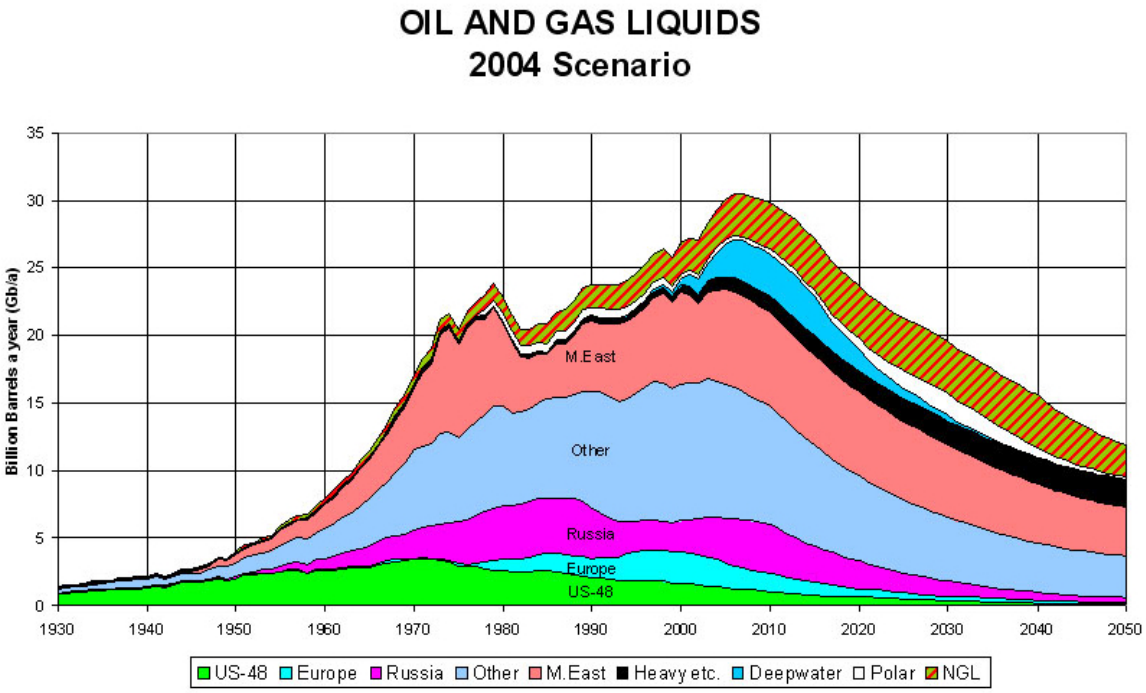

Figure 1, Oil and Gas Liquids Depletion Chart:: Annual production in billions of barrels per year (Gb/a) projected over time by region and type.
(Image taken from website http://hubbartpeak.com/campbell, 2004)

Matthew R Simmons is chairman of America's largest Energy Investment Bank, Simmons & Co. and energy consultant to The World Bank, Halliburton and US Vice President Dick Cheney. He has researched the oil resources of the Middle East in great detail and is convinced of the immediate threat of peak oil (Simmons, 2005).

The work of Simmons (2005), Campbell (2004), Deffeyes (2003), Bakhtiari (2004), Skrebowski (2004), Laherre (2003), Hirsch (2005) and others indicates that the entire oil producing world is very close to peak oil extraction, but the exact date of the peak will only be determined in hindsight. Table 1 below summarises the various predictions from these reputable sources for when we will reach peak oil.

Table 1: Projected dates of peak oil

Projected Date of Peak Oil	Source of Projection
2006-2007	Oil Executive (Iran), (Bakhtiari, 2004)
2007-2009	Investment Banker, (Simmons, 2003)
After 2007	Petroleum Journal Editor (Skrebowski, 2004)
Before 2009	Oil Company Geologist (ret.)(Deffeyes, 2003)*
Before 2010	Vice Provost, Cal Tech (Goodstein,2004)
Around 2010	World Energy Council (WEC,2003)
2012	Petroleum Executive China (Pang Xiongqi, 2005)
2010-2020	Oil Company Geologist (ret.) (Laherrere 2003)
2016	Energy Information Administration, US Department of Energy Nominal Case Analysis (DoE EIA, 2000)
After 2020	Cambridge Energy Research Associates Alert (Jackson, 2004)
Time not Specified	Atlantic Council Of The United States (Hirsh,2005)

Note: Most versions of this table (from Hirsch) include a reference from Shell Oil predicting a peak in 2025. I was not able to find the original article on which this was based and have excluded it.

*Deffeyes has recently updated his prediction and states that the peak of production passed on the 16th of December 2005. (http://www.princeton.edu/hubbert/current-events.html)

Key informants

Of all the writings on the subject those of Skrebowski and Hirsch have had a strong impact on the author of this submission.

Dr Chris Skrebowski is the editor of the respected journal Petroleum Review, a monthly magazine published by the Energy Institute in London. He previously edited Petroleum Economist and was an oil market analyst for the Saudis in London for eight years. He started his career in the oil industry as a long-term planner for BP. He came to research the subject with the intention of refuting the claims of Campbell, he tried for 9 years, but couldn't and has become an influential spokesman for the peak oil movement.

Dr Robert Hirsch was given the task of reporting on peak oil to the US Department of Energy with a view to mitigation of the possible impacts (Hirsh, 2005 (1)). He came to the view that not only was the crisis inevitable, but that effective mitigation would require at least 20 years and the commitment of huge resources: political, intellectual and practical. His report did not set a date for peaking, but left it an open question and concentrated on risk management.

The decline rate in oil production that Hirsch modelled was a conservative 2% per annum, many experts predict decline rates of 4% - 8% or even faster. The rate of decline of existing North Sea oil production was initially 7% but is now close to 14% per annum (Fraser, 2006) and US production fell by 6.6% in 2005. (http://www.gravmag.com/oil.html

In a recent interview Hirsch (2005 (2)), states that if the rate of decline is 4- 8 % then the minimum time for effective mitigation would be 30 to 50 years. In this interview he goes on to describe how he was dismayed and depressed by the future he could foresee. He took no part in the debate for several months and has only now begun to speak publicly again on peak oil. His voice is a sane and reasoned call to urgent action.

It is possible that the peak is already upon us, it is also possible that it is 5 or maybe even as long as 10 years in the future.

Supporting evidence for peak oil from oil companies

1) The US oil company Chevron has come out with a clear statement on the validity of peak oil. (http://www.willyoujoinus.com/).

2) Exxon-Mobil accepts that peak oil is a real problem. (http://www.peakoil.ie/newsletters/577).

3)Shell says its reserves fell last year because it only found enough oil to replace 15% to 25 % of what the company produced. (Guardian website, 2005).

4) BP told the US stock exchange that it replaced only 89% of its production in 2004 (Vidal, 2005)

5) The total production of the top 22 publicly listed oil companies fell by 0.65% in the first 3 quarters of 2005 compared to 2004. (Skrebowski, 2005)

Evidence that oil is a finite resource that is being depleted faster than it is being discovered.

1) Oil discovery peaked in 1965, we are currently using more than 4 barrels of oil for every 1 barrel that is discovered (Ho, 2005) as shown in figure 2 below.

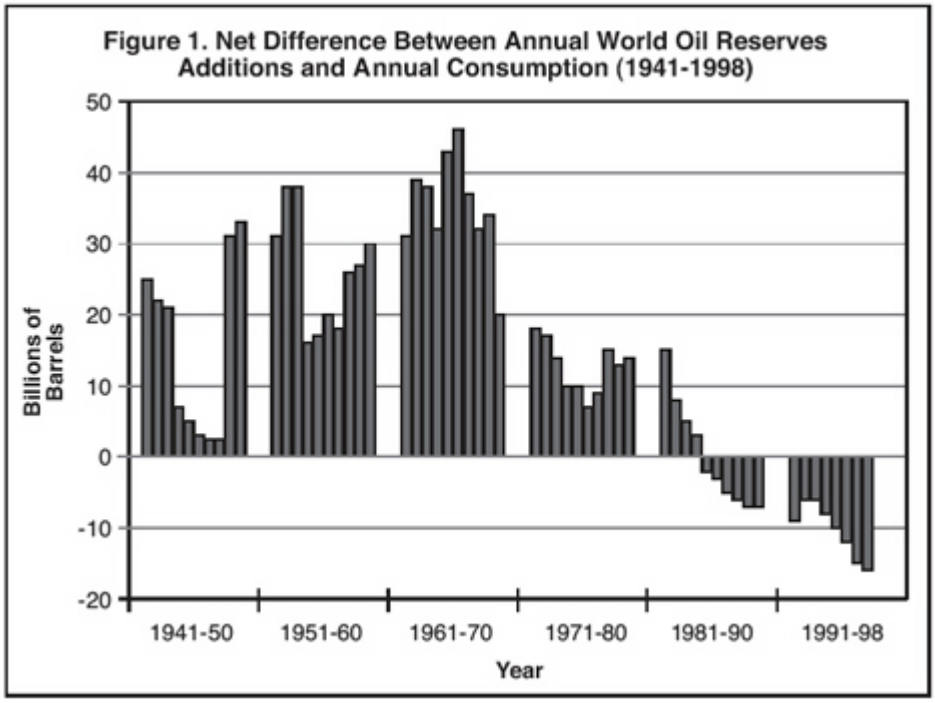

Figure 2 The critical facts to understand in the graph above are that oil discoveries peaked in 1965 and that in each year since the mid 1980's we have been consuming more oil than is being discovered.
(Image taken from : www.issues.org website).

2) It is the informed judgment of petroleum geologists is that the time lag between the discovery peak and the production peak in any given oil field is about 40 years, as was the case in the lower 48 states of the USA. Although in the case of newer oil fields such as the North Sea the latest technology reduced the time from discovery to peak down to 24 years

3) Per capita global oil production has already peaked, in 1979 (Deffeyes, 2005).

4) In 2003 $8 billion in global exploration expenditure by the international oil companies yielded $4 billion worth of new discoveries (Boxell, 2004).

5) The recent rate of discovery of "giant" oil-fields, of more than 500 million barrels, has tapered to zero. In 2000 there were 16 such discoveries, in 2001 nine, in 2002 just two, and in 2003 none. It takes six years from the discovery of an oil-field for the first oil to come to market (Leggett 2006). And even if they're called "giant", they still represent less than a week's global supply at current demand rate. The new fields that are being found are small, often remote, in the polar regions or out in the deep sea. For example Brazil's state-owned oil company, Petrobras, reports that it has discovered a huge new offshore oil field off the coast of Rio de Janeiro state. Petrobras estimates it contains at least 700 million barrels of crude - about 10% of Brazil's current reserves. The world is using about 84 million barrels of oil each day. We need a string of similar "huge" discoveries, one every 8.3 days to maintain our

current rate of consumption.
(http://www.guardian.co.uk/china/story/0,,1694346,00.html)

6) The reserves of the nationalised oil companies of the Middle East are shrouded in secrecy and political intrigue, OPEC internal politics led most member states to artificially double their stated reserves in the mid 1980s. The published figures can not be taken at face value. The Saudi position has been analysed by Simmons in his book "Twilight in the Desert, The Coming Saudi Oil Shock and the World Economy" (2005). This book suggests the Saudi oil may be close to peak production. We already know that the greater Burgan field in Kuwait, one of the largest in the world, peaked in November 2005.

7) The production of all or nearly all of the non OPEC countries has peaked or is close to peaking and is predicted by the International Energy Agency (IEA), a UN body, to increase by only 0.1% in 2006 (IEA website http://www.iea.org/, 2006).

8) The second largest oil field in the world the Cantarell field in Mexico has peaked and is set to decline, possibly at a catastrophic rate.
(http://www.energybulletin.net/4574.html. 2005)

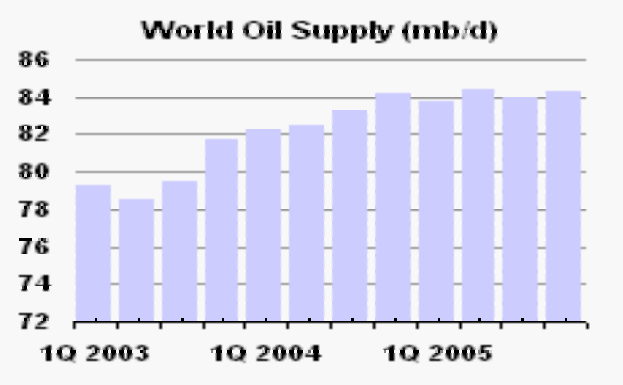

Figure 3, Quarterly World Oil Production 2003-2005: Quarterly average daily production in millions of barrels per day (mb/d).
(Image taken from Highlights of Oil Market Report, IEA website http://omrpublic.iea.org/, 2006)

This chart (Figure 3) shows that world production in 2005 was flat.

The projections for global oil demand

At the same time that supply is being challenged, demand is set to continue increasing at a greater than exponential rate. China and India are both actively competing with western nations to secure oil supplies. The 2006 "State of the World" report from the Worldwatch Institute states: "Our analysis shows that if the two countries [China and India] were to use as much oil per person as Japan does today, their demand alone would exceed current global oil demands. And if their per capita claims on the biosphere were to match those of today's Europe, we would

need another full planet Earth to sustain these two countries" (Worldwatch Institute, 2006).

US Vice President Dick Cheney, interviewed by Engelhardt (2005), is on record as predicting that the world will need an extra 50 million barrels of oil per day in 5 years time.

> "For the world as a whole, oil companies are expected to keep finding and developing enough oil to offset our seventy one million plus barrel a day of oil depletion, but also to meet new demand. By some estimates there will be an average of two per cent annual growth in global oil demand over the years ahead along with conservatively a three per cent natural decline in production from existing reserves. That means by 2010 we will need on the order of an additional fifty million barrels a day. So where is the oil going to come from?"

Global oil companies response to these projections

If the international oil companies were seriously planning for this situation it would be reasonable to expect that they would be ramping up refining capacity but this is not the case. No new refinery has been built in the USA in the last 29 years. (Mouawad, 2005)

The peak year for tanker capacity was way back in 1981. So, too, was the peak for refinery capacity. Global drilling rig counts also peaked that year. (Leggett, 2006)

Instead of frantically searching for more oil the major oil companies are mainly engaged in mergers and acquisitions as each tries to secure a bigger share of a shrinking resource base. Since 1998 there have been 14 major oil company mergers/acquisitions.

The prospects for new oil discoveries

There is an expectation based on classical economic theory that scarcity of oil will push up the price and this will spur the development of more oil fields, improved oil extraction and replacements for oil, so that we can all continue on in our endless pursuit of growth and wealth.

The assumption that a gradual increase in prices will result in an orderly gradual fall in demand (demand destruction), with price moderation, may not work in practice. (Reynolds, 2002)

Energy is money but money is not energy. A $100 note does not contain 20 times the energy of a $5 note. When it takes a barrel of oil to pump a barrel of oil from a depleted well, that well is dead and no amount of money will change that situation.

Massive investments in exploration have not been recouped, many exploratory wells have been drilled with no results. Take the example of oil production in the lower 48 states of the USA. After the oil shocks of the early 1970s, real oil prices doubled and then tripled. This price increase caused drilling to double. Nonetheless, production declined nearly 20 percent. As a result, the oil and gas sector increased its fraction of national investment without increasing its contribution to GDP – "in effect, hundreds of billions of dollars were flushed down a dry hole" (Kaufman, 2006).

In 2003 $8 billion in global exploration expenditure by the international oil companies yielded $4 billion worth of new discoveries, (Boxell, 2004).

According to industry consultants IHS Energy, around 90% of all known oil reserves are now in production — suggesting that few major discoveries remain to be made (http://energy.ihs.com,).

New discoveries only just compensate for falling production.

Jerry Rubin of the Canadian Industrial Bank of Commerce led a group which has reviewed global oil production extensively as part of the bank's involvement in the Alberta tar sands project.

Rubin et al (2006) looked at 164 upcoming oilfields in his study. He found that new oil is, in fact, being discovered and coming on stream. But more than half of the new oil simply balances declining production from existing fields in the North Sea and Kuwait's Burgan region. The CIBC does expect a net gain in oil production in coming years, but it will be small and getting smaller. They expect 3.6 million barrels of new oil to come on stream in 2006, but 2.2 million barrels will go to replace declining reserves elsewhere, leaving just 1.4 million barrels of new oil. There will be 1.5 million barrels of new oil in 2006 and 2007, but less than a million barrels a day in 2008 (Rubin et al,2006).

This year demand for oil is expected to grow by 800,000 barrels per day and by 1.6 million barrels per day in 2007. Outside of the United States, net production increases in 2006 of 100,000-200,000 bbl/d are expected. (http://www.eia.doe.gov/emeu/steo/pub/contents.html 2006)

The global supply/demand situation is very tight.

Oil is a fungible global commodity. A change in supply or demand anywhere will affect prices everywhere. In such a tight demand/supply market the removal of a small amount of oil can have dramatic effects.

A 4% global shortfall could lead to a 177% increase in the price of crude oil. (National Energy Commission USA, 2005)

Reassurance based on assertion not evidence.

In spite of these prospects for global oil production, many observers in the US and world financial markets who discount the risk of an imminent peak in oil supplies, are reassured by statements from the Energy Information Agency (EIA) of the US Department of Energy who say that oil supplies will not peak for 30 years or more and that there is plenty of oil left in the US (IEA website http://www.iea.org).

However as Richard Heinberg points out in his book "The Party's Over. Oil, War and the Fate of Industrial Societies" points out, the EIA (Energy Information Administration) in its annual statement makes the following statement: "These adjustments to the USGS (US Geological Survey) and MMS (Materials Management Service) estimates are based on non technical considerations that support domestic growth levels to meet projected demand levels" (Heinberg, 2005).

In other words supply projections are simply adjusted to meet demand projections!

The official US government position is that there is another Kuwait sized oil field hiding somewhere in the US! They just haven't found it yet but they will and nobody has to worry about the US running out of oil!

The US is currently importing nearly 65% of their oil needs. They constitute 5% of the world's population and they use 25% of the world's oil.

The International Energy Agency (IEA), a UN body, is similarly upbeat about world production with the bland assumption that the Middle East can increase production to meet any increase in demand.

The prospects for a technological solution

Technology is really only finding new ways to use energy, technology can't make energy. In fact Heubner (2005) contends that human technological innovation is in decline, having peaked in 1873, it is now at the same rate of innovations per billion of population as it was in 1600.

The latest advances in extraction technology have been applied to depleting fields such as in the North Sea. This resulted in initial excitement as production showed an upswing, however it became apparent that the use of horizontal drilling and various water and gas injection techniques etc. only hastened the end and steepened the slope of decline (Blanchard 2005). The use of advanced extraction techniques does not yield more oil from an oil field, it just gets the extractable oil out faster. Extracting oil too fast from a field can cause irreversible damage and reduce the total yield that might otherwise have been expected from the field. Simmons and others are concerned that this may be happening in the giant Ghawar oil field in Saudi Arabia. To maintain pressure and production, 7 million barrels of seawater are pumped into the oil field every day. The oxygen and bacteria that come in with the water damage the oil reservoir. The Ghawar is now producing 55% water and only 45% oil. (http://www.princeton.edu/hubbert/current-events.html,2006)

The nature of oil and its properties

What makes oil so special?

There is nothing else available or on the horizon which provides the readily available, easily transported, incredible energy density of oil.

The amount of energy in oil is huge:

- One barrel of oil can be harnessed to do the same amount of work as 12 men labouring for a full year.
- Fifteen cents worth of petrol will lift a small car 400 metres into the air.
- Ten litres of petrol will move a 1 tonne car 100 km in an hour, it would take the driver 6 weeks of 10 hour days to push the car the same distance.
- Each Australian uses 17 barrels of oil per year, in energy terms this is equivalent to every person having 200 human slaves working for them, each being paid less than 10 cents a day and not being fed, clothed or housed.

Conventional oil

This is defined as sweet light crude as well as heavier sour crude from traditional oil wells. Sweet oil has a low sulphur content and is easily refined without pollution, when it is light it has low viscosity and density thus pumping is easy and extraction low cost. This was the best and the most easily extracted oil and it was exploited first, "the low hanging fruit". Sour crude has lots of sulphur and heavy crude is thick, hard and expensive to pump. In most oil fields the light oil floats on top of the heavy oil and is pumped out first. All the other types of oil from different sources are grouped together as unconventional. Increasingly the new finds are of unconventional oil.

Unconventional oil

This is everything else: deep sea, polar, natural gases liquids, synthetic oils from oil shale, tar sands (considered below as synthetic oils)) as well as heavy bituminous oils such as those from the Orinoco belt of Venezuela or the very acidic crude of Kazakhstan. Oil from coal is considered separately.

These unconventional oils are all hard to get out of the ground, some need to be melted in situ before extraction or in the case of tar sands have to be dug up. They are difficult and polluting to refine. These operations are capital and energy intensive and can not be easily or rapidly scaled up or down to match demand. To double production of east Texas crude in the good old days, one just opened the valves, to double synthetic oil production from tar sands in Alberta today means finding a few billion dollars then hiring and training several thousand more workers who will tolerate life in a harsh and grossly degraded environment.

"Unconventional means inconvenient. It means less energy at higher financial cost, higher environmental cost, higher social cost, and higher moral cost." (Unknown).

The alternatives to conventional oil

There are some alternatives to oil but all of them are inferior to oil and for various reasons no single product or product mix will make up for the depletion of oil.

The Energy Return on Energy Invested (ERoEI) of oil is much greater than any possible alternative.

In the early days of gushing oil wells it was as high as 100:1 (ERoEI=100), that is, one barrel of oil invested in drilling etc. would yield 100 barrels of product. By the 1950's this was down to 20-30 and is much lower for many fields today, the global average EroEI is probably around 5.

Biofuels

Ethanol and Biodiesel are promoted as renewable alternatives to oil. Brian Fleay in an article regarding Australian liquid biofuels compares the energy content of ethanol derived from Australia's annual production of sugar and wheat with the energy content of annual consumption of auto gasoline, auto diesel and primary oil (Fleay, 2006). This paper demonstrates the energy content of anhydrous ethanol from sugar and wheat would be a small fraction of the energy content of annual consumption of petroleum-based fuels. While anhydrous ethanol from biomass is technically viable as a transport fuel it cannot be produced on a scale that replaces current petroleum products. It is not remotely possible to divert much of these agricultural products to fuel production at the expense of food supply.

These findings were contradicted by Pimental & Patzek who found an ERoEI of less than 1 for ethanol produced from corn.

These investigators then went on to study biodiesel produced from soybean or sunflower oil, the ERoEI of this biodiesel is less than 1. This means that more petroleum energy is used in the production of biodiesel from these feedstocks than is released by burning it (Pimental & Patzek, 2005). Other feedstocks for biodiesel eg tallow or waste vegetable oil may be slightly more favourable but these are not available in large volumes.

The production of ethanol from ligno-cellulose and cellulose such as straw, crop waste, grass or wood is a potential but as yet not functional industrial process, it may or may not have a financially viable future. However if no crop waste is returned to the soil, fertility will fall and more (natural gas derived) fertiliser will be needed.

There are prototype plants producing biodiesel and ethanol from algae grown in bio-reactors using photosynthesis and carbon dioxide from power plants, algae can also be grown on sewage effluent and theoretically harvested to yield biodiesel and the volatile liquid dimethyl ether (DME) but there is no published data on the commercial viability of these processes.

However crops grown for biofuels will compete for diminishing arable land with food crops. Global food supply is already struggling to meet the needs of the population.

Oil shale

This type of rock should be called organic marlstone, (but this would not appeal to investors), it has a lower energy density than muesli. It should be put into the same category as coal or peat. It can be cooked at high temperature to produce keragen, a hydrocarbon with the potential to be further processed with natural gas into a synthetic oil. The ERoEI of this process is about 1.3 and as such it will never replace oil. It needs huge amounts of water and is also grossly polluting, yielding massive volumes of toxic crushed rock greater than the original volume of rock. (http://www.ecocitybuilders.org/energy.html)

Tar sands

These bituminous deposits exist in vast reserves in Alberta in Canada. These are currently yielding 1 million barrels per day of synthetic oil. There are plans to increase this to 2 million barrels per day over the next 10 years. The process produces huge amounts of polluted waste water and requires a huge amount of natural gas both for heating the water to super heated steam and providing the hydrogen for the synthetic oil.

Natural gas production in North America has already peaked and is in terminal decline, Canada has 8.1 years of natural gas left (Hughes 2006). It effectively takes 2 barrels of oil equivalent to make 3 barrels of synthetic oil from tar sands. (http://www.ecocitybuilders.org/energy.html). Tar sands will always be a marginal player in the oil business.

Oil from coal

This process has been in Germany and South Africa in the past and will be used increasingly around the world. Coal can also be piped as a semi liquid fuel, as a slurry of crushed particles coated with wax and floating in water, for industrial processes.

However coal reserves are also limited, peak coal in the USA is expected around 2065, sooner if mining accelerates post peak oil (Bartlett A. 2005). Global peak coal may be a century or more away. Australia has reserves of 100 billion tonnes of coal, 55 Billion tonnes of black coal and 45 billion of brown coal. These will be very important to our future and should be conserved.

The mining of coal (and all mining in general) is very energy intensive and uses a lot of oil. The cost of coal will go up post peak oil with both increased demand and increased cost of production.

Coal is a worse producer of greenhouse gases than oil or gas and the climate change issue is now a very urgent global crisis. It won't go away just because we ignore it.

Natural Gas Liquids (NGL) and Liquefied Natural Gas (LNG)

Natural gas can be chemically modified to produce liquid transportation fuels, these distillation products are the same as conventional petrol and diesel, and are referred to as Natural Gas Liquids (NGL). This is not the same thing as Liquefied Natural Gas (LNG) which is natural gas physically compressed into a liquid at high pressure (4.64 MPa) and very low temperature (- 82 degrees centigrade). LNG must be stored in a vessel like a huge pressurised thermos flask. Up to 35% of natural gas is lost when it is converted to LNG for Shipping. LNG boils off during transport and storage, this escaping gas is used to fuel the tanker ships, which then revert to bunker oil for the empty trip home (Simmons 2006).

Australia's proven natural gas reserves were downgraded by two thirds, from 2 trillion cubic metres to 621 billion cubic metres last year (Energy Information Administration (IEA) USA Energy Outlook website, 2005).

While we are now importing gas from PNG, at the same time we are planning to soon begin the export of 32 million tonnes of LNG a year (up from 7.7 million tonnes) from off the WA coast (IEA Liquefied Natural Gas Market website, 2005).

How much natural gas do we in Australia need for our own future use?

Hydrogen

Hydrogen is an energy carrier not an energy source. There is no free hydrogen on the planet, it has to be made and making it takes more energy than is yielded from burning it.

Hydrogen is the smallest atom in the periodic table of elements, it leaks out of storage vessels at a rate of about 2% per day. Hydrogen is 20 times as explosive as petrol and burns with an invisible flame, so no parking of hydrogen cars in enclosed spaces or underground car parks. As it leaks through a metal vessel it alters the chemical structure of the metal to make it very brittle. The fuel tank of a hydrogen car would need to be 4 to 5 times the size of a petrol tank to carry useful amounts of fuel. Minor accidents between hydrogen powered cars would have a high rate of fatal explosions.

Even if all these problems could be overcome, to make a single fuel cell to use hydrogen in a single car would require 10 grams of platinum. The World's above ground reserves of platinum are virtually zero and recoverable reserves might only be enough for 10 million fuel cells in a world of 750 million cars.

Hydrogen has to be made either from natural gas or from water using electricity. Natural gas depletion is already a problem in North America and Europe. The energy

needed to make hydrogen from water would require a massive expansion of electricity generating capacity in order to produce all the hydrogen required to replace oil.

Nuclear energy has been proposed as a clean power source to produce hydrogen from water. To replace the world's current consumption of oil with hydrogen from nuclear power, it has been estimated that there would need to be built, starting now, 10 thousand of the largest reactors costing about $5 billion each.

The construction time for a nuclear reactor is at least 10 years. To run a global nuclear/hydrogen economy equivalent to our petroleum economy, we would need to build one nuclear reactor a week for 20 years, the construction of the reactors would consume a vast amount of oil and before the last one was finished the world could run out of uranium. The world may well run out of uranium (from proven reserves) within 50 years even at the present rate of use. The true size of world uranium reserves is an open question.

Uranium mining is very energy intensive, 2000 gigajoules of oil or equivalent energy are required to produce 1000 tonnes of uranium ore. The separation of the isotopes by ultra centrifugation is also incredibly energy intensive.

All of the biofuels, synthetic oils, unconventional oils, oil from coal and hydrogen production when added together will never come close to equalling the world's current production of conventional oil.

The most they can contribute will be a lessening of the steepness of the slope of the inevitable energy descent once the peak of oil production is passed.

Oil dependence in historical context.

There is a simplistic view of history which sees our ascent from the constraints of nature as a seamless series of technical triumphs which will just keep on going indefinitely.

Humanity has really only made two major energy transitions in the past. The first was from wood to coal and the second from coal to oil.

As society changed from wood to coal and from coal to oil, each new energy resource was "better" than its predecessor. It could be used more efficiently and it generated a greater surplus of energy returned on energy invested.

The depletion of forests, "peak wood" combined with overpopulation and soil depletion were the major causes of the collapse of civilizations such as the Mayans, the Easter Islanders and the Anasazi people of the south west of North America (Diamond, 2005).

The advent of the coal age allowed the escape from the constraints of renewable energy and ushered in our modern industrial economy.

The availability of coal lead to steam powered pumps and lifting equipment which dramatically increased coal production, available energy increased the available energy and from this point on to the present day our use of energy has increased exponentially.

The first half of the oil age has seen an incredible amount of growth in wealth and population, there are now more than six times as many people on earth as there were 200 years ago and some of us have a standard of living that our ancestors could not begin to comprehend.

When we hit peak oil and enter the second half of the oil age, we are not set to seamlessly leap to some newer and better source of power. There is nothing much for us to leap to.

Responses by other nations to the challenge of peak oil and decline

The Swedish government has recently accepted that peak oil is imminent and has initiated a plan to make Sweden independent of fossil fuels by 2020 (Olofsson, 2005).

The US Congress has had hearings on peak oil and Rep. Roscoe Bartlett (Republican-Md) and Rep. Tom Udall (Democrat-NM), have joined forces to confront the institutional apathy of the American government on this issue.

The response of the Australian Senate to the question of peak oil by having this inquiry is very timely and very important. The outcome of this inquiry will be widely reported around the world.

Summary

Even if one should choose to dispute the evidence for and argue the timing of peak oil, commonsense dictates that:

- Oil is a finite resource
- We are using it up faster than we are finding it
- We are at present totally dependent on it
- There is nothing on the horizon to take its place
- “If something can’t go on forever…… it won’t”

The following thought experiment was proposed by an anonymous individual on the internet:

- What if oil production does *not* peak in the next 20 years, but we all prepare for it peaking?
- What if oil production *doe*s peak in the next 20 years, but none of us prepare for it peaking?

These are both unrealistic extremes, but which outcome do you think would be better?

There are strategies which can ease the transition to lower petroleum availability. These include conservation, relocalisation of the economy, community food production, the wholesale introduction of renewable energy system etc. These are discussed in detail below. These changes will all take time and all will require energy and resources. Their early introduction would be a "no regrets" policy. For the very worst outcome would be that we were ready in advance of the problems.

The implications of a severe reduction in oil supply and a significant increase in the price of oil for Australia

For Australia the problems of the peaking of world oil production and a reduction in oil supply will be primarily in the critical areas of:

- Liquid fuels for transportation
- Liquid fuels and fertiliser inputs for agriculture
- The economic ramifications of decreased growth.

Liquid fuels for transportation

In Australia the crisis of peak oil and decreased supply will be primarily a crisis of transportation fuels. Compared to the USA, Canada and Europe we have a benign climate, and are not heavily dependant on oil and natural gas for electricity generation. Northern hemisphere nations have legitimate fears of "freezing in the dark".

There is nothing else that provides the compact, easily transported energy density of petroleum.

Road transport

Road transport depends on petroleum which supplies the energy for 97% of transportation of all goods in Australia. Almost 80% of Australia's petroleum use is in transport. 55% of road transport fuel is petrol, 39% diesel and 6% is LPG, and Australia uses about 45,000 megalitres of petroleum each year (Robinson, B. 2004). LNG can be used as transport fuel in diesel engines but it is not anywhere near as convenient as diesel oil. Australia currently imports 17% of its liquid petroleum fuels (Radio National *PM* 22/2/2006).

Australia's oil production is falling at a rate of 8%, with Bass Strait production dropping at 14% (McNamara, 2005). If the average of these depletion rates (12%) is applied nationally, then this country will have used half of its remaining reserves in less than 6 years time. At this stage we will be dependent on imports for more than half of our petroleum supplies. Import parity pricing means that we will be fully exposed to the global price impact of peak oil.

Air travel

Air Travel will become very expensive and contract massively. There is no non petroleum fuel source for aviation. To the extent that air transport is essential reserves of fuel for aviation will have to be maintained. Air freight charges will become prohibitive for all but the most precious of cargo. Air transport accounts for 8% of world GDP (http://www.atag.org/files/Soceconomic-121116A.pdf).

Suburbia

The Implications for Suburbia of big increases in petrol prices are very serious. Suburban real estate prices will possibly collapse dramatically post peak oil. The design of remote commuter dormitory suburbs is totally predicated on the car, or more often two or more cars and two incomes to service a large mortgage (from the French: "a pledge unto the death"). How will these families cope with petrol at $3, $5 or $10 per litre.

The organization and distribution of suburban shops, schools, recreation and employment are all based on the assumption that it will always be possible to drive wherever and whenever with unlimited cheap fuel. This assumption will be shown to be false.

Dodson and Sipe (2005) have produced an in depth study of the impact of peak oil on the suburbs of Brisbane, Sydney and Melbourne. They show that the greatest adverse impact of peak oil will fall disproportionately on the poorer outer suburbs of our cities. Their work is clearly expressed in the VIPER (Vulnerability Index for Petrol Expense Rises) index and maps showing the areas which will struggle the most (Dodson and Sipe 2005).

All around the far flung fringes of our all major cities we continue to displace farmers and market gardeners, to pave over the most agriculturally productive land in Australia and assume that that somehow it will all work out for the best. This is completely wrong headed and will be seen, in the near future, as a huge mistake.

"*The infrastructure of suburbia can be described as the greatest misallocation of resources in the history of the world*" - James Howard Kunstler.

Kunstler makes this statement in the American film on peak oil: "The End of Suburbia". Other noted authorities to appear in this film include Simmons, Deffeyes, and Campbell. If this dystopian prediction is true for the USA it must be an equally significant risk for Australia.

The rethinking and re-engineering of the infrastructure of suburbia post peak oil will be a huge challenge. Permaculture has much to offer in this difficult task (Holmgren, 2005).

The psychology of previous investment makes it hard to turn one's thinking around on the continued expansion of suburbia. How does one tell the new home buyers, who have recently mortgaged themselves to the hilt, that it was all a big mistake?

Who will deliver the message? It is a job no politician would want! It is much easier to just hope for the best and push on regardless. That is just what we are doing, it's wrong, it will only make things worse in the end, but it's understandable.

Regional cities and towns

Regional cities and towns will do much better than the suburban fringes of the major cities. The options of walking, cycling and public transport will be viable and the community should have enough critical mass of population and economic activity to survive.

Government support for rail services and all public transport is absolutely vital and should have the highest priority. Apart from patching holes in the bitumen all expenditure on roads should stop and all funding be allocated to our rail infrastructure. Rail moves people and goods with 5 times the fuel efficiency of road transport.

The production of food close to where people live will be essential. The cost and availability of food will only be maintained by the relocalisation of productive agriculture very close to and within every centre of population. Zoning and planning laws must adapt to this imperative (discussed in detail below).

Remote Communities

These may not survive post peak oil unless they are self sufficient and/or heavily subsidised.

Liquid fuels and fertiliser inputs for agriculture

Energy imbalance of modern farming

Australian farmers are praised as being amongst the most efficient in the world. This is based on output per man hour and is achieved by the use of prodigious quantities of petroleum.

Take wheat for example. The food energy content of wheat as it leaves the farm is approximately the same as the amount of petroleum energy which has been invested in its production. By the time this wheat has been transformed into bread on the breakfast table the ratio of petroleum energy to food value is of the order of 10 to 1.

Bartlett (2005) has described modern agriculture as the process of using land to turn petroleum into food.

The Green Revolution was at the expense of a huge increase in energy consumption

The much heralded "Green Revolution" in India and elsewhere dramatically increased agricultural production and reduced world hunger. Between 1950 and 1984 the Green Revolution transformed agriculture around the globe, world grain production increased by 250%. That is a tremendous increase in the amount of food energy available for human consumption. This additional energy did not come from an increase in incipient sunlight, nor did it result from introducing agriculture to vast new tracts of land. The energy for the Green Revolution was provided by fossil fuels in the form of fertilizers (natural gas), pesticides (oil), and hydrocarbon fuelled irrigation. The Green Revolution increased the energy flow to agriculture by an average of 50 times the energy input of traditional agriculture. In the most extreme cases, energy consumption by agriculture has increased 100 fold or more (Pfeiffer, 2004).

Fertilisers from natural gas

Australian soils are geologically old and nutrient poor and have been substantially lost to wind and water erosion, because of the destructive and depleting nature of past practices of conventional farming. Our soils have come to require significant inputs not only of both ammonia based fertilisers from natural gas but also phosphates (of which the world has less than 80 years reserves).

The Bosch-Harber process of making anhydrous ammonia combines atmospheric nitrogen with natural gas at high temperature and pressure. A large amount of

natural gas, equal to 37.8 gigajoules, is required per tonne of ammonia. The World consumed about 150 million tonnes of ammonia last year.

The global supply of natural gas is widely expected to peak at some stage, it could be as soon as 10 to 20 years after supplies of conventional oil peak. (When a natural gas field is exhausted it just stops flowing, rather like a big exhausted pressure pack can, there is no gradual tapering off.) The USA and Canada have passed peak natural gas in 2001-2002. They are frantically drilling new wells in smaller and smaller fields to maintain supply. Canada has only 8.1 years of natural gas left (Hughes 2006). These countries will increasingly be competing to import both Liquified Natural Gas (LNG) and fertilisers. China uses twice as much fertiliser as the USA. Australia's proven natural gas reserves have recently been shown to be two thirds smaller than previously thought. The world demand for LNG is rising fast as Europe and America both are running out of their own in ground supplies of natural gas. The cost of fertilisers will continue to rise.

How long will Australia's natural gas last?

Fertiliser input = Protein output

Vaclav Smil, Professor of Geography at the University of Manitoba and author of the 2001 book "Enriching the Earth" has demonstrated the global food system's startling degree of dependence on nitrogen fertilization. Smil showed that 40% of the protein in human bodies, planet-wide, would not exist without the application of synthetic nitrogen to crops during most of the 20th century.

"That means that without the use of industrially produced nitrogen fertilizer, about 2.5 billion people out of today's world population of 6.4 billion simply could never have existed" (Smil, 2004).

The current world population is 6.4 billion. It has been calculated that the carrying capacity of the earth without oil and gas could be as low as 2.5 or even 1 billion people.

The issue of global food security is a huge question mark hanging over our heads.

Population growth in a finite world

There are probably just too many people on this planet.

Dr Albert Bartlett, Professor of Physics from the University of Colorado, in a recorded lecture entitled Arithmetic, Population, and Energy gives an easily grasped explanation of the hopeless impossibility of exponential growth of a population in a closed system (Bartlett A, 2005). He contends that the greatest failing of mankind is our collective inability to grasp the significance of the exponential function.

Exponential growth is growth by a constant percentage increase over a set period of time eg 7% per annum growth is exponential.

Bartlett gives the example of an experiment in which bacteria are grown in a bottle of nutrient medium. These bacteria reproduce by each dividing into two offspring at the rate of one division every minute.

A single bacterium is placed in the bottle at 11 o'clock. The experiment has been run several times and the volume of the culture bottle has been adjusted so that it is exhausted and completely full when the bacteria have been dividing for 60 minutes. For the purpose of the lecture, and this thought experiment, the bacteria are deemed to be sentient beings who can contemplate their future. At what stage in their population growth did the bacteria become aware of their predicament? When was the bottle one quarter full of bacteria? The bottle was one quarter full of bacteria at 11.58! At this stage three heroic bacteria crawl out of the bottle and with super bacterial strength, manage to drag back to the colony three new bottles of culture media. Universal bacterial rejoicing at the perceived prospect of an almost unlimited future is short lived. The first new bottle is full at 12.01. The second & third bottles are full one minute later at 12.02.

Oil consumption has been increasing at 2-3 % per annum and this rate is predicted to increase as China and India power up.

The Earth is a closed system of limited resources, regardless of what some economists may think. The Earth is our bottle of nutrient media and oil is one of its most important ingredients. We have nearly used half the oil on Earth which means that it is almost 11.59!

"Ghost Acreage"

For at least the last 80 years and probably much longer, large areas of the world, including countries like the UK and Japan, have been unable to produce enough food locally, they have been feeding themselves by drawing on "Ghost Acreage". A term developed and expended on by Professor Emeritus Dr William R Catton Jr in his ground breaking book "Overshoot" (Catton, 1980).

On the subject of Ghost Acreage he wrote:

> *"A number of nations have seemed to get away with exceeding the human carrying capacity of their own land, but Georg Borgstrom & The Hungry Planet 1965 pointed out they had only been able to do so by drawing upon carrying capacity that was "invisible" - that is, located elsewhere on the planet. The food required by such a nation's population comes only partly from the harvest of "visible acreage" - farm and pasture land within the nation's borders. A very substantial fraction comes from net imports of food. Not all the imports come from other countries; some are obtained from the sea.*

Borgstrom therefore subdivided "ghost acreage" into two components, "trade acreage" and "fish acreage". "By each phrase he simply expressed, in terms of land area, the additional farming that would have been needed to provide from internal sources the net portion of a nation's sustenance actually derived from sources outside its boundaries and in excess of its own carrying capacity" (Catton, 1980).

''By 1965 more than half of Britain's sustenance was coming from ghost acreage. If food could not be obtained from the sea (6.5%) or from other nations (48%), more than half of Britain would have faced starvation, or all British people would have been less than half nourished. Likewise, if Japan could not have drawn upon fisheries all around the globe and upon trade with other nations, two-thirds of her people would have been starving, or every Japanese citizen would have been two-thirds undernourished (which presumably means that nearly all might have died). Yet this was the most prosperous nation in the Orient, the one whose low birth rate supposedly exemplified Asia's hope of averting overpopulation" (Catton, 1980).

He then went on to define a third form of Ghost Acreage, Fossil Acreage.

"Man's use of fossil fuels has been another instance of reliance on phantom carrying capacity. The energy we obtain from coal, petroleum, and natural gas can be expressed as "fossil acreage" - the number of additional acres of farmland that would have been needed to grow organic fuels with equivalent energy content. Mankind originally did rely on organic fuels, chiefly wood. Wood was a renewable resource, though even in the world's once vast forests it grew in limited quantity. Access to vast but non-renewable deposits of coal and petroleum came to be mistaken by peoples and nations as an opportunity for permanently transcending limits set by the finite supplies of organic fuel" (Catton, 1980).

Depletion of "Ghost Acreage"

The implications of peak oil for our essential food production from this phantom acreage are profound.

1) The Trade Acreage will diminish as production surpluses diminish when the energy from Fossil Acreage is reduced, resulting in soaring costs and diminished availability of fuel and fertiliser.

2) Also the food distribution costs between countries and within large countries like Australia will climb dramatically.

3) The Fish Acreage will diminish as the cost of fuel further reduces the viability of fishing for grossly depleted stocks of fish, which are already approaching commercial or actual extinction all over the globe.

4) If the global fishing fleet were a country, its oil consumption would place it in 18th place in the world, just behind The Netherlands.

5) The reduction in our access to cheap readily available transport energy will severely impact on our access to food. In the USA (and probably Australia too) the average distance travelled by food from place of production to dinner plate is about 3000km.

Since Borgstrom wrote the Hungry Planet in 1965, the population of the planet has increased by more than 3 billion.

What happens when the Green Revolution comes to an end?

When the fertilisers and fuel for irrigation pumps become prohibitively expensive, the situation around the world will revert to being much worse than it was before their introduction in the 1960s and 70s. Not only will there be almost twice as many mouths to feed, but the inherent fertility of the soil will be very greatly reduced by 40 years of intensive chemical application and many aquifers have been pumped down to levels inaccessible by manual pumps and wells.

Sustainable agriculture techniques can perform as well as, or better than, energy intensive agribusiness farming. In a study conducted over 10 years on farms around the world, sustainable farming practices with integrated pest management improved farm yields by an average of 79% in four years. And not just in a limited set of locations: the study covered 286 different projects in 57 developing countries. That's over 12 million farms, or 37 million hectares (Pretty et al., 2005).

However it may be that the earth's present population can not be sustained post peak oil even if there is a major shift to sustainable organic farming. It is probably already too late. These things take quite a bit of time, a lot of effort and the will to change.

Given the probable time frames of oil and gas depletion and the degraded nature of the world's soils and the lack of a united approach to the problem, it may be impossible to avert famine on a truly terrible scale.

It will take years to restore natural fertility and for the aquifers to recharge.

How global warming and climate change add into this mix is imponderable and all the more disturbing for that.

Local biological farming or Global GM

The global agribusiness propaganda would have us believe that we need all of their technology to avert famine in the third world. This is not only untrue but also soon to

become irrelevant to the debate. The petroleum feedstock for their products is not going to be affordably available for much longer.

In the near future we really won't need globalised, uniform GM seeds with terminator genes and herbicide resistance, what we really will need are thousands and thousands of carefully adapted local seed varieties to suit local conditions. The government should urgently address the establishment of seed banks and support seed saving as part of relocalisation of food production.

The implications of peak oil for the economy

In a very real way our economy is based on the energy from oil, it is both the pumping heart and circulating blood of our way of life. Oil is not just an important aspect of our economy, without it the economy and everything about it that we take for granted would contract beyond all recognition.

The global economic implications of peak oil will be severe, long lasting. If the peak happens really suddenly, as well it might, most people in our community will be caught completely off guard and unprepared, mentally, financially and physically.

Increases in almost all prices

The price and availability of virtually everything that we import, export, manufacture, construct, transport, eat, wear, buy, sell, rent, live in or use in our daily lives will be affected by peak oil.

Prices of plastics, which are derived from oil and gas, have moved from around $950 to $2025 a tonne in just over a year, this has been across the board on just about all plastics, according to Noel Edwards, managing director of Dow Chemicals. The flow on effects of these price rises will increase the cost of almost everything in modern life.

Oil is very useful as a feedstock for industry, it may be that burning it for fuel will increasingly be seen as an unacceptable waste of an irreplaceable resource. The "Imbedded Energy" in products will directly increase their cost and transport of some goods will become prohibitively expensive.

As fuel takes a bigger and bigger share of family income spending on other things will contract. One family's expenditure is another family's income. Jobs will be lost, mortgages will be in arrears, foreclosures will mount, and businesses will fail.

These are the most obvious consequences. However at a more fundamental, philosophical level the economy will collapse when it becomes apparent that without cheap oil further economic growth is impossible and that a recession/depression is inevitable.

The Risk of a Share Market Collapse

There is scarcely a single company listed on the stock exchange that does not have the assumption of readily available, cheap fuel built in to its business plan. When the truth about peak oil comes into the public consciousness, there will be a panic sell off of shares. That moment of market realization and the ensuing crash could be well in advance of the actual time of peaking. (www.odacinfo.org/PeakOilUKConferenceProceedings.htm)

Energy is Growth

It has been argued elsewhere in detail, that the increasing consumption of energy first from coal and then oil & gas was the prime mover of subsequent economic and population growth (Price, 1995).

If one were able to plot a graph of energy consumption, population growth and economic growth over the last 250 years it would appear as a set of three almost overlapping exponential curves, starting off from the almost horizontal, they would now all be on an almost vertical trajectory and heading off the top of the page.

We have come to accept as normal the ready availability of almost unlimited energy at the push of a button, this was not the case for our ancestors and it will not be the case for our descendants.

Catton (1980) states:

> *"A geological savings bank had been accumulating these deposits of fossil energy for hundreds of millions of years. The steam engine and various improved successors to it - gasoline, diesel, jet, and rocket engines - gave man the key to this geological bank. What marvels poured forth from the turning of that key!"*
>
> *"The energy expended in two decades by a vast labour force of Egyptians stacking up some 2,300,000 blocks of stone (each weighing about two and a half tons) to form the Great Pyramid of Cheops was less than the energy released in a few minutes by three stages of a Saturn V rocket propelling men toward the moon."*(Catton, 1980)

We have all been going to this Global Geological Bank of Natural Capital each day and making withdrawals, fooling ourselves that it was income when we were really just drawing down our collective capital. Now we can see that our bank balance is half gone and we will have to quite quickly modify our energy lifestyle to live within our means before it is all gone.

Simply stated we need to move as quickly as we can to use no more energy each day than can be harvested from the sun, wind, rain, tides and latent heat of the earth.

The government must act decisively, emphatically and immediately to support the widespread adoption of renewable energy systems.

Heinberg (2005) uses the metaphor that whereas fossil fuels might be considered a massive energy inheritance, and one spent perhaps unwisely, renewables are much more akin to a hard won energy wage.

Within 40 to 60 years, within the lifetimes of our children, not only nearly all the oil and gas will be gone but also a large part of the world's coal and maybe all of the uranium.

If we have not made the change by then our children will be in a new Dark Age.

The Energy Curve of History

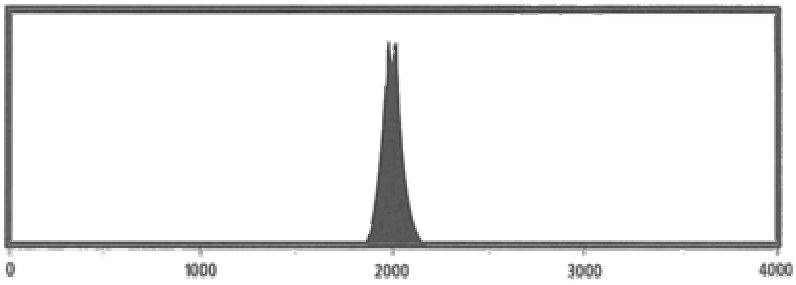

Figure 3, Graphic Impression of Energy Consumption by Mankind over 4000 years. (Image taken from Life after the Oil Crash website http://www.lifeaftertheoilcrash.net)

The Silent Lie

Bartlett (2005) writes," in not speaking out about the unsustainable nature of our dependence on rampant oil extraction we are effectively perpetuating a lie— " (Albert Bartlett website). Bartlett goes on to quote what Mark Twain has called the silent lie. Twain was writing about human slavery in the 19th century. In the 21st century each of us has our 200 petroleum slaves, these invisible workers, will slowly one by one, exit stage left until we are left on our own and in all sorts of trouble and nobody is prepared to talk about it!

This is what Mark Twain said about the silent lie:

> *'Almost all lies are acts, and speech has no part in them.....I am speaking of the lie of silent assertion; we can tell it without saying a word....."*
>
> *"For instance: It would not be possible for a humane and intelligent person to invent a rational excuse for slavery; yet you will remember that in the early days of emancipation agitation in the North, the agitators got but small help or countenance from any one"'*
>
> *"Argue and plead and pray as they might, they could not break the universal stillness that reigned, from pulpit and press all the way down to the bottom of society—the clammy stillness created and maintained by the lie of silent assertion—the silent assertion that there wasn't anything going on in which humane and intelligent people were interested"'*
>
> *"The universal conspiracy of the silent assertion lie is hard at work always and everywhere, and always in the interest of a stupidity or a sham, never in the interest of a thing fine or respectable. It is the most timid and shabby of all lies."*
>
> *". . the silent assertion that nothing is going on which fair and intelligent men [and women] are aware of and are engaged by their duty to try to stop."*
> (Twain website)

We need to stop silently lying and stop making excuses and collectively face reality.

Conspiracy or fate?

It is easy to invent conspiracy theories around the issue of peak oil, theories of how "Big Oil" and "The Military-Industrial Complex" are conspiring with corrupt politicians and overbearing governments.

The Internet is awash with such ideas. The truth is probably much more mundane.

As C Wright Mills the noted sociologist wrote sometime in the 60s:

> "*Only sometimes and in some places do men make history; in other times and places, the minutiae of everyday life can add up to mere "fate".*

He gave us an unusually clear definition of this important word. Infinitesimal actions, if they are numerous and cumulative, can become enormously consequential. Fate, he explained,

> *".....is shaping history when what happens to us was intended by no one and was the summary outcome of innumerable small decisions about other matters by innumerable people……'*

> *"Using the ecological paradigm to think about human history, we can see that the end of the age of exuberance was the summary result of all our separate and innocent decisions to have a baby, to trade a horse for a tractor, to avoid illness by getting vaccinated, to move from a farm to a city, to live in a heated home, to buy a family automobile and not depend on public transit, to specialize, exchange, and thereby prosper."* (**C Wright Mills, website**).

If the everyday decisions of everyday people have got us to where we are, entering the second half of the oil age, a period of contraction, forced adjustment, stress and difficulty, then it may well be that the same everyday decisions of everyday people will be the only path to a sustainable future that is worth living. If they are informed people can take a degree of control of their own futures, acting decisively to reduce consumption, to recycle, repair, relocalise and redefine the concept of a meaningful life.

The future after peak oil may be on a smaller scale but still be better, brighter and more fulfilling. Many would find that a simpler life, of growing their own food and making things, could be the source of more happiness than "spending money they don't have, buying things they don't want, to impress people they don't like".

But people need to know what is going on!

Strategies to minimise the impact of decreasing supply and increasing cost of oil.

Action is needed from the all levels of government.

Most of the important responses and solutions will happen at a local level. Increased transport costs and reduced incomes will mean that life is going to become much more locally centred than it is now.

However the federal government, in addition to trying to steer the nation safely through the potential minefield of regional and global resource competition and conflict, has an important leadership role to play.

Federal, state and local government must act together.

1) The issue of peak oil needs to be raised in the public mind and discussed openly and widely.

2) We should follow the Swedish example and plot a national course towards a future that is worth living, without oil, together.

3) Internationally we should endorse the Oil Depletion Protocol developed by Dr Colin Campbell of Association for the Study of Peak Oil and Gas (ASPO, 2005). This protocol calls on all nations to voluntarily reduce their oil imports by an annual percentage equal to the global rate of decline in production. This is our best chance to avoid getting involved in further resource wars. The first oil war is already underway.

4) As a nation we must move beyond oil and we must do it soon, we can not hope to find another source of energy like oil, there isn't one. Even if there were other source of unlimited power we will soon be confronted with other, equally or even more terrifying, limits to our exponential growth delusion.

5) The people need information, guidance, advice, reassurance: they need to know that their government is governing on this issue, planning for the future and not just pretending that we can continue on as we have done.

6) We need flexible, creative modelling and scenario planning. General Eisenhower, in a quote which is painted on the wall of every US army staff training college, said: "*It's not the plan, it's the planning".* A responsible government would begin to plan by examining a range of plausible scenarios, optimistic and catastrophic, immediate and long term. This has been done elsewhere and we should be examining these plausible pathways and assessing them in the Australian context. (http://www.oilscenarios.info/). Linear analogue thinking, "we have always done it this way", has gotten us into this mess. The thinking that solves the problem will not be the same thinking that caused the problem. Without a total rethink we are simply driving into the future with our gaze fixed firmly on the rear-view mirror.

7) There must be an honest education program. When people realise what is in store for their energy future they will be angry, frightened, uncertain and confused. The news is bad, it is scary, it is confronting, but it is much better that we all face it together now than being caught totally off guard, bewildered, angry and unprepared somewhere in the very near future. The risk of gross political instability and a lurch to the extreme right or left, as occurred in the chaos that followed World War One, is a real concern of many observers on the many websites that discuss peak oil issues.

8) Steps can be taken to minimise the impact of peak oil but they need to happen before the crisis, while the economy is still strong enough and the necessary resources for turbines, photovoltaic arrays etc are still available.

9) We need to conserve what we have and make it last while we make the necessary changes to renewable energy sources. We need to use our diminishing resources to make lifeboats and not fuel to the boilers of business as usual. We can change the paradigm from one of increasing consumption to one of decreasing consumption and then on to one of a steady state reliant only on renewable power.

The following European countries used less oil in 2004 than they did in 1994. None of them are what we would call economic disasters.

Table 2: European Decrease in Oil Consumption 1994 - 2004

Country	Oil Consumption 1994 (1000s of barrels per day)	Oil Consumption 2004 (1000s of barrels per day)
Denmark	209	189
Germany	2880	2665
Italy	1920	1871
Norway	212	209
Sweden	354	319
Switzerland	272	258
United Kingdom	1777	1756

(BP Statistical Review of World Energy 2005)

10) We need to get our rail infrastructure up to the level where it can replace road transport of essential goods. Further major road development is folly, we should just aim to patch holes in the bitumen. The rail system needs billions of dollars.

11) We need to promote public transport, develop cycle paths and create safe paths for pedestrians around our cities.

12) All public transport timetables should be coordinated.

13) Bus registration and taxes should be slashed and those on inefficient cars increased. We must conserve fuel.

14) We need to support and promote renewable energy and develop innovative ideas in energy conservation. All energy sources not just oil and gas must be conserved. When the oil is gone we will rue the profligate wastage of our coal and natural gas reserves, we will need these to buy us some time as we power down into the future.

15) Local community networks will need support and guidance to set up locally sustainable systems to provide power, water and waste management.

16) The old and fading skills of using hand tools and non mechanised agricultural equipment must be regained. We should institute a national program of information and skills transfer from our past to our future, from our fit and active older citizens to those who must survive the coming challenge. There is, soon to be lost forever, contained in the memories of our senior citizens, a vast store of essential wisdom and remembered competence in all sorts of tasks: how to repair things that can't be thrown away, how to prepare and preserve food, knitting and making clothes etc, the list is huge and time is short.

A huge section of our community whose jobs currently depend on esoteric services in the areas of our society divorced from real productivity may well soon be permanently

unemployed. These people need to get a skill that will feed them and their families and contribute to our collective survival.

The trimmed down, low energy spaceship Earth will have no room for passengers, only working crew, everyone must have a useful skill. Education of the entire community must be given a very high priority. Those without a useful skill might go hungry, the ability to use a scythe or darn a sock will, one day soon, mean a lot more than a knowledge of the intricacies of derivatives trading.

17) We need to urgently plan for our food security and promote local food production, local industry and a vibrant local economy. When travel is too expensive, when incomes fall or vanish, when food trucks no longer arrive every day from far away; people will only be eating what they, their neighbours and their communities grow close to home.

18) We need to embrace Permaculture, a system of sustainable living developed by Australians Bill Mollison and David Holmgren. It is defined as:

"Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for local needs."

The term permaculture is a contraction of permanent agriculture, it aims to minimise energy and labour inputs while recycling nutrients and naturally enriching the soil, the environment and the lives of those who live within its integrated system. The flows of all energy inputs: solar, photosynthetic, wind, water, human, and other are tracked within this integrated system so that maximum productive yield is achieved with the lowest possible inputs of energy from all sources. David Holmgren has done extensive work on retrofitting suburbia for sustainable living and in his recent book, "Permaculture: Principles and Pathways Beyond Sustainability", he specifically addresses the issues of energy descent (Holmgren, 2004).

This system has spread around the world and is a proven viable method for living a sustainable, rich and fulfilling life starting from where we are now. Permaculture can be applied on any scale from small gardens to farms. It is one of our best hopes for the future. It can be applied successfully, many places around the world are working hard at developing models of sustainability based on permaculture principles. One of the best developed is the Kinsale Energy Descent Plan, developed to lead the town of Kinsale in Cork on the west coast of Ireland into a sustainable future (Kinsale Energy Descent Action Plan, 2005). Another is the Willits Economic Localization Project in northern California (www.willitseconomiclocalization.org).

19) The way we in Australia, currently envisage our urban/suburban/exurban/rural communities and economic zones must change. The narrow focus by municipal and regional authorities on planning and zoning laws that are aimed at keeping everything nice and neat and in its place, primarily to defend property values and the status quo will soon be an unaffordable luxury and a positive obstacle to survival. An

understanding of the pressing need to relocalise our food production must be brought into the mainstream of urban and town planning. Rather than more endless, useless sprawl we will need the planned ruralisation of non productive city and suburban areas along the lines of the development proposal from Folke (2001) of the Nordic Association of Agricultural Scientists.

20) Everything that is required of us: relocalisation, conservation and the development of renewable systems can be done in a controlled gradual "Powering Down". After the initial traumatic consequences of market realization of peak oil and its aftershocks have settled, it should be possible to urgently moderate oil consumption and still have some sort of reasonable economy. The economy would then need to be directed towards making rapid preparations for the coming day when all the bounteous energy from oil is no longer available, it can be done, but it will take all of us, working together, to do it. The market won't do it this time, it will only steer us back on to a path of running up the down escalator.

We will need government action.

To paraphrase Richard Heinberg (2005).

If this nation is to survive peak oil and if our children are to have a life worth living, we will need not only inspired leadership, we will need a solid, sustained and earnest commitment, from everyone, at all levels of society, the likes of which we have not seen since the Second World War.

Conclusion

The evidence for an imminent peak in global oil production is overwhelming. Australia will be in no way immune to, or protected from, this process. The most urgent uncertainty is whether the subsequent oil extraction decline is a bumpy plateau, allowing a gradual powering down or a catastrophic steep crash and global calamity. Either way Australia urgently needs to make adjustments and develop a coherent plan to respond to the inevitable decline in the supply of oil and gas.

It is interesting to compare and contrast the different responses all levels of Australian government to the separate challenges of terrorism and peak oil. A huge effort and much capital have been expended in an effort to minimise the risks of a terrorist attack, which may or not occur. Whereas virtually nothing has been done to mitigate the consequences of peak oil, which will definitely be upon us soon. The potential disaster of a post peak oil collapse of our society is arguably as bad as the worst imaginable terrorist attack.

Peak oil is the most pressing of many resource depletion issues confronting us but we are also depleting unsustainably our topsoil, water, forests and fisheries as well as phosphate and metal ore reserves.

Global warming and climate change are approaching the point of no return and the waste stream from our disposable society is running out of dumping space.

The global population has overshot the earth's carrying capacity. Australia's carrying capacity post peak oil is uncertain and must be assessed as a matter of urgency.

Even if a new magical power source was to appear we would not have long to continue with the insane delusion that infinite growth is possible on a limited planet.

We need leadership to acknowledge the truth about peak oil in this country.

We need leadership to promote sustainable alternatives.

We need our leadership to embrace the International Oil Depletion Protocol to reduce the risk of war.

There will be a deep and long lasting economic depression starting from the moment of market realisation that peak oil means the end of growth.

Sustainability and Capitalism, as currently practised, are incompatible. After the crisis hits and when the initial chaos has subsided, we can not go back to what we do now. There is no perpetual growth on a limited, finite and fragile planet. We are animals not unlike all the other species on this planet, we live within nature, we have nowhere else to go, we have missed our chance to reach the stars and we must learn to live within our means on this old, dry and infertile continent.

If world oil extraction were to peak this year, then assuming a average rate annual decline, by somewhere around 2050 the oil will be will be virtually all gone, oil production will be at about a quarter of current levels and falling fast. The end of coal, natural gas production and possibly uranium will be in sight and the industrial age, as we have known it, will be coming to its end, it will have lasted about 150 years and represent about 0.15% of the history of our species.

The petroleum interval has been a brief frenetic period of growth totally out of the ordinary for us and our planet. We have been fooled into thinking that we can rewrite the rules of science and mathematics, but we can't.

We will not be returning to the past, we will have our knowledge, our skills and some sustainable technologies, but our future will much more closely resemble our past than our present. We will need the wisdom and knowledge of elders to help us move to this new future.

We need leadership to really lead. We will need to return to the virtues of thrift, patience, delayed gratification, hard work and adaptability. These were the virtues of our forebears and they will be needed by those who are to survive.

Our future will be in smaller towns and sustainable community villages, based on the principles of permaculture. Many of these towns and villages will develop within and around what were previously the boundaries of big cities. Each will need to have its own power, water and waste systems. They will be linked by cycle paths, walkways and public transport. Food will be produced locally, small scale industry will develop and these villages and towns will together constitute integrated self sufficient communities.

We will need leadership to help us develop this new paradigm of a steady state, low energy, locally based, decentralised, resource conserving society.

There is no alternative.

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General material for this submission has been drawn in large part from the following websites amongst others:

The Oil Drum	http://www.theoildrum.com/
The Energy Bulletin	http://www.energybulletin.net/
Life after the Oil Crash	http://www.lifeaftertheoilcrash.net/BreakingNews.html
Peak Oil News Weblog	http://peakoil.blogspot.com/
From the Wilderness	http://www.fromthewilderness.com/
ASPO	http://www.peakoil.net/
Peak Energy	http://peakenergy.blogspot.com/
Resource Insights	http://resourceinsights.blogspot.com/
Ruralisation	http://www.holon.se/folke/lectures/Ruralisation-filer/v3_document.htm
The Community Solution	http://www.communitysolution.org/

Many of these sites explicitly encourage dissemination of information on peak oil and related subjects. Most of what I have learned about the issues in this submission has come from these and other sites and their many links and references.

This submission has also drawn in part on the writings and recordings of Richard Heinberg, Kenneth Deffeyes, Albert Bartlett, Matthew Simmons, Robert Hirsh, Colin Campbell, Ali Samsam Bakhitiari, Chris Skrebowski, James Howard Kunstler and others. To the extent that anyone's work has been used without attribution I apologise. Most authorities in this field share a sense of urgency about the need to

prepare for the consequences of peak oil and promote a wide ranging discussion of the issues.

The work of permaculture pioneers Bill Mollison and David Holmgren is an inspiration, their teachings should be on the curriculum of every Australian school.

Dr James Barson 23/2/2006