July 7 2006

The nuclear debate: Two energy options for Australia[♣]

John Mathews

The Prime Minister launched a debate on nuclear energy in June, stating that he thought nuclear energy "inevitable".[1] A government inquiry has been established, chaired by Dr Ziggy Switkowski, with terms of reference that cover many topics but leave out, interestingly enough, any discussion of possible sites for nuclear reactors and disposal of nuclear waste.[2] That gives a fair idea of why the inquiry has been established.

The PM has gone on the record to state that "I want all of the (energy) options on the table".[3] Taking the PM at his word, let us discuss two future energy scenarios for Australia, both costed at $10 billion over the next ten years, and both calling for major private sector investment.

The first is a nuclear option. Let us pose a ten-year program in which three 1000 MW reactors are built and produce electric power. Taking world capital costs as a guide, let us assume that their costs will be of the order of $3.3 billion each, or $10 billion over 10 years.[4] Like the government's own inquiry, we leave to one side the issue of where they might be sited, and how the wastes will be disposed of.

If $10 billion is in play, then let us propose an alternative investment scenario, one devoted to building a biofuels industry in Australia. Let us propose that 10 bioreactors are built each year, with an annual capacity of 100 ML each (100 megalitres, or 100 million litres). That's 1000 ML of biofuel (ethanol) being added each year, so that by the end of 10 years the annual output will be 10,000 ML of biofuel – or one third of the current petrol consumption of 35,000 ML.

♣ I would like to acknowledge helpful comments from Robert Marks (AGSM) and John Hodgson (Mackay Sugar Cooperative).

1 'Nuclear power inevitable, says PM' The Age, May 19 2006. Accessible at: http://www.theage.com.au/news/national/nuclear-power-inevitable-says-pm/2006/05/19/1147545501002.html

2 'Nuclear task force won't make recommendations' ABC Radio National 4 july 2007. Accessible at: http://www.abc.net.au/news/newsitems/200607/s1678773.htm. The official terms of reference of the inquiry can be found here: http://www.pm.gov.au/News/media_releases/media_Release1965.html

3 'PM calls for nuclear debate' ABC Radio National, AM, Sat 20 May 2006. Accessible at: http://www.abc.net.au/am/content/2006/s1642908.htm

4 'Climate alert spurs nuclear debate', Sydney Morning Herald, 24 May 2006. Accessible at: http://www.smh.com.au/news/national/climate-alert-spurs-nuclear-debate/2006/05/23/1148150254688.html?page=2

Now let us compare the two investment pathways and what we as a nation could expect from each of them. First, each pathway is feasible, utilizing proven technologies. Although no nuclear reactors have been built in Australia, the technologies available are well known and understood. Likewise for bioreactors, several already operate (example Australian Ethanol is proceeding with a $60 million grain-fed plant at Swan Hill in Victoria, while the CSR Ethanol Biodistillery at Sarina has an annual capacity of 60 ML) and the technologies available are widely recognized and understood, and provided by recognized engineering consultants such as Praj or Delta-T.

Assuming each investment pathway is costed at $10 billion, the nuclear option will call for subsidies to attract private investment. These can only be guessed at, but a reasonable assumption would be $2 billion for the first reactor, and $1 billion for each of the next two – or $4 billion overall. The biofuels option would not call for subsidies at all; it would be a matter for private calculation by largely rural investors and farmers.

The impact on the balance of payments will be nil for the nuclear option (or negative if we take into account the costs of importing nuclear components), but it will be dramatic for the biofuel option. As shown in Chart 1, the import cost of oil has blown out to $6.5 billion per year, projected to rise to $10 billion by 2006. By cumulatively substituting for one third of our oil requirements, the biofuels program would reduce imports by $10 billion – which is the capital cost of the entire program.

The power output of the nuclear option in the tenth year can be calculated from the assumption that each reactor will be rated at 1000 MW. Assuming that they operate on average for 10 hours per day, and produce for up to 350 days per year (very favourable assumptions), this gives the nuclear option an energy output of 10,500 GW-hr – which is around one fifth of current Australian electrical energy production.[5]

Interestingly enough, the 100 bioreactors would be expected to produce a comparable amount of power purely as a by-product. Assuming that the power plants associated with the bioreactors are able to generate power at 45 MW and that 50 of the 100 bioreactors run on grains and therefore produce power year-round, and 50 of them operate for a third of the year on sugarcane and use bagasse to produce power, then the energy generated by the first group would be around 7,875 GW-hr and for the second group around 2,625 GEW-hr, or again 10,500 GW-hr in total. This is approximately the amount of energy currently generated in Australia by power stations fired by black coal.[6] What stands in the way of the bioreactors selling their power to the electricity companies is the current low price of coal-generated power; government-mandated ‘green energy’ uptake requirements are needed to kick-start the market for independent power production.

Is land the problem? The nuclear reactors could be expected to take up land of approximately 10 hectares. It is not the land use that is the problem, but the siting –

---

[5] See Australian Bureau of Agriculture and Resources Economics, Energy Update 2005; available at: http://abareonlineshop.com/PdfFiles/PC13166.pdf

[6] According to ABARE, *ibid*, black coal fired power stations produce between 7000 and 8000 PJ each year.

which is no doubt why the present government inquiry is ignoring the issue. For the bioreactors, it is generally assumed that a 100 ML bioreactor needs sugar cane grown on 15 to 20 hectares to operate – so 100 such reactors would call for 1500 to 2000 hectares of extra land, or 15 to 20 square kilometers – a tiny part of Queensland.

The by-products of the nuclear option are again a problem, which is again no doubt why the government inquiry is ignoring the issue. They include spent fuel rods and radioactive wastes including plutonium, which will need secure surveillance for upwards of 100,000 years. The costs of providing such secure operation are not being calculated for this exercise. The costs of maintaining adequate security at the bioreactors do not exceed those of any industrial facility, since no toxic materials are involved.

By contrast, the by-products of the biofuel option are themselves economically significant products. From sugarcane there is crushed cane residue, or bagasse, which is used to fire power generators making the bioreactors energy self-sufficient (and generating an excess that can be fed to the grid, if prices can be regulated). From grains there is the by-product of distillers' grains, which are an excellent cattle-feed (especially if fed hot and wet to cattle at nearby feed lots), and then the final residue can be biodigested to produce methane gas to be used for power generation or on-sold. There are also other by-products including liquid carbon dioxide.

On greenhouse gas emission, the nuclear option – while promoted as "green" – is in fact a net contributor to GHG emissions when considering the impact of uranium mining and transport, and waste disposal, as well as operation of the nuclear reactors themselves. By contrast, the biofuels option is GHG neutral: every carbon atom burnt in a vehicle is a product of photosynthesis, where the same carbon atom has been drawn from the air. Of course, cane growing utilizes some energy, but much of this can in fact be recycled from the bioreactor, and the proximity of bioreactor to fuel crops such as cane fields reduces energy costs of transport to a minimum.

The comparison between the two options is summarized in the Table.

Table. A ten-year $10 billion energy program: Two options

	Nuclear	Biofuels
Number of reactors	3 @ 1000 MW	100
Construction costs	$10 billion	$10 billion
Construction subsidies	~ $4 billion	nil
Electric power generated	10,500 GW-hours	10,500 GW-hours
Liquid fuel produced	nil	100,000 mL
Land needed	10 hectares	1500-2000 hectares (15 to 20 square kilometers)
Operating subsidies	~ $1 billion per year	nil
By-products	Radioactive spent fuel and plutonium	Distillers' grains (cattle feed) and biodigested methane gas
Security issues	High costs to secure	nil
Balance of payments reduction	nil	$10 billion
Greenhouse gases impact	Mildly negative	Neutral

Nothing stands in the way of the biofuels option for Australia other than the provision of a market. Petrol distribution and retailing in Australia is heavily concentrated in the hands of four international oil majors – Caltex, Shell, BP and Mobil. Together they control over 80 percent of the Australian motor fuel market. Countries where ethanol and biofuels generally have made headway – such as Brazil, the United States, India and China – have government-mandated minimum ethanol-blend fuel requirements for their domestic markets. Australia does not have such a mandate – and in its absence the international oil majors continue to obstruct the development of biofuels industry in Australia.[7]

While the situation remains uncertain in Australia, and investments are held back by the climate of uncertainty generated by stop-go government policies, the rest of the world is embarking on a truly epic historical transformation of the industrial world's energy foundations. As shown in Chart 2, oil and gas can be expected to decline in the 21st century, while nuclear remains at its present level, and the huge gap between rising demand and diminishing supply will be met by renewables – by biofuels and by solar and wind. Do we want Australia to miss out on the greatest industrial transformation of the past 200 years?

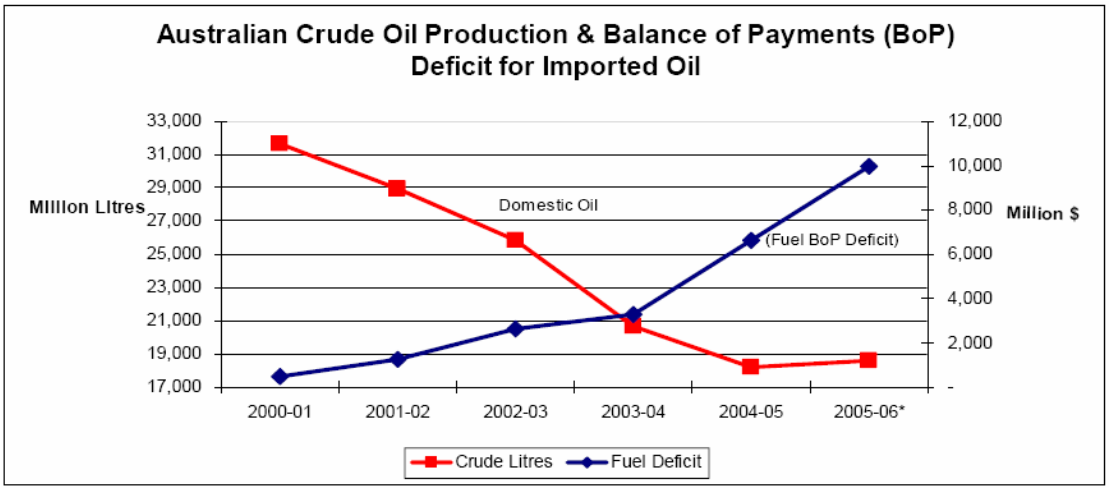
The options are clear. If you were the leader of a political party, and you knew that petrol prices were going to continue rising due to the peaking of global oil supplies, and that ethanol could be produced at a lower cost than oil-based petrol, which energy option would you be taking to the people?

Professor John A. Mathews is professor of strategic management at the Macquarie Graduate School of Management, Sydney.

[7] See comments by Renewable Fuels Australia, available at: http://www.aph.gov.au/senate/committee/economics_ctte/fuel_1/submissions/sub25.pdf

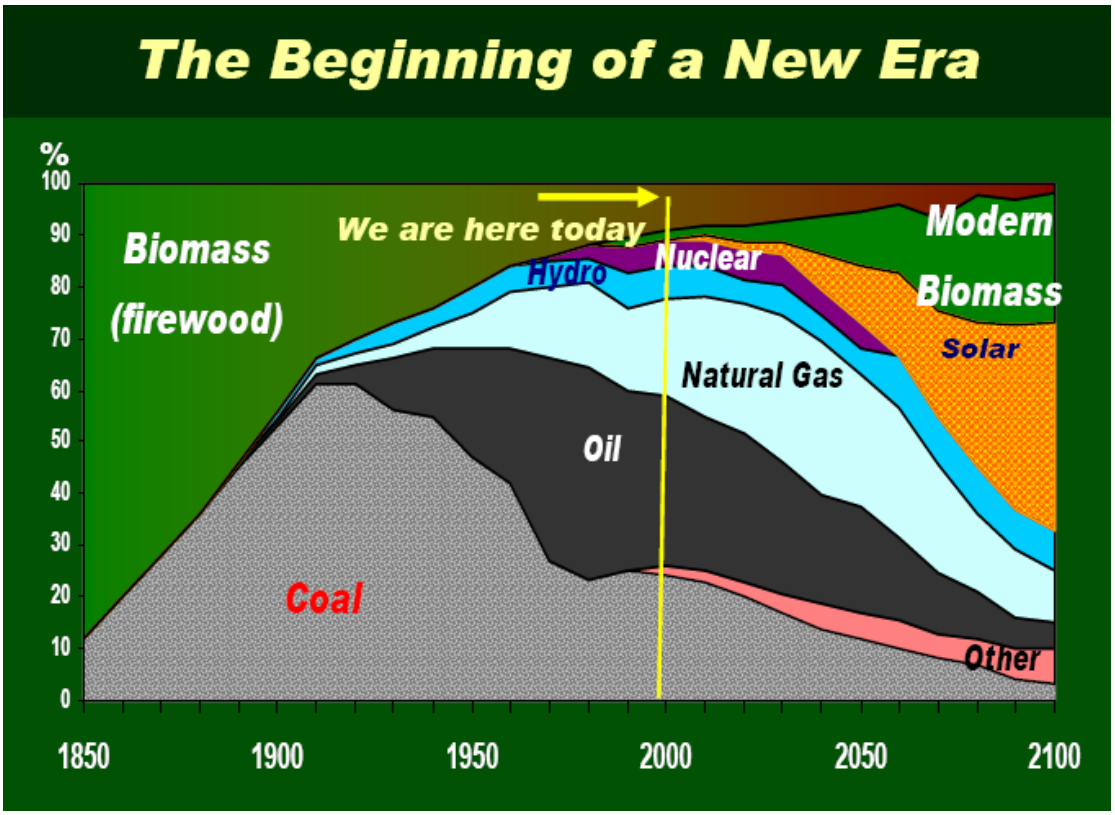
Chart 1. The rising cost of imported oil to Australian tax payers

Crude oil & petroleum products represent 60% of current BoP deficit



Source: Renewable Fuels Association

Chart 2 Sources of energy, 1850-2100



Source: N. Nakícenovic, A. Grübler and A. McDonald (eds), *Global Energy Perspectives*, Cambridge University Press, 1998