CRUDE OIL – FACING THE END OF THE OIL AGE

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1. INTRODUCTION

“Don't worry about oil running out; it won't for very many years," said Colin Campbell*. "The issue is the long downward slope that opens on the other side of peak production. Oil and gas dominate our lives, and their decline will change the world in radical and unpredictable ways." (Source: article in the Guardian, Thursday April 21, 2005 by John Vidal).

*Campbell and other experts anticipate global peak production of conventional oil - the kind associated with gushing oil wells - is approaching fast, perhaps even next year. Their calculations are based on historical and present production data, published reserves and discoveries of companies and governments, estimates of reserves lodged with the US Securities and Exchange Commission, speeches by oil chiefs and a deep knowledge of how the industry works. However there are also experts reporting much more optimistic official figures:

- The US Geological Survey (USGS) states that reserves in 2000 (its latest figures) of recoverable oil were about three trillion barrels and that peak production will not come for about 30 years.
- The International Energy Agency (IEA) believes that oil production will peak between ‘2013 and 2037’ and Saudi Arabia, Kuwait, Iraq and Iran, four countries with much of the world's known reserves, report little if any depletion of reserves.
- Meanwhile, the oil companies - which do not make public estimates of their own ‘peak oil’ - say there is no shortage of oil and gas for the long term. "The world holds enough proved reserves for 40 years of supply and at least 60 years of gas supply at current consumption rates," said BP in April 2006.

In summary, we won’t run out of oil for very many years, however we could reach peak production within the next 3 to 30 years and production will decline steadily at about 2-3 per cent a year. Meanwhile, the demand for crude oil is increasing.

The decline in oil production combined with a sharp increase in the crude oil demand and a lack of refining facilities are the main factors contributing to high prices in crude oil and its derived products. This situation is not likely to change in the near future.

* * Colin Campbell, an Oxford PhD, helped to found the London-based Oil Depletion Analysis Centre because he is an industry man through and through, has no financial agenda and has spent most of a lifetime on the front line of oil exploration on three continents. He was chief geologist for Amoco, a vice-president of Fina, and has worked for BP, Texaco, Shell, ChevronTexaco and Exxon in a dozen different countries.

2. WORLD OIL PRODUCTION

2.1 OPEC countries

The Organization of Petroleum Exporting Countries (OPEC) was founded in Baghdad, Iraq, in September 1960, to unify and coordinate members' petroleum policies. OPEC members' national oil ministers meet regularly to discuss prices and, since 1982, to set crude oil production quotas. Original OPEC members include Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. Between 1960 and 1975, the organization expanded to include Qatar (1961), Indonesia (1962), Libya (1962), the United Arab Emirates (1967), Algeria (1969), and Nigeria (1971). Although Iraq remains a member of OPEC, Iraqi production has not been a part of any OPEC quota agreements since March 1998. The Energy Information Administration (EIA), a division of the US Department of Energy, estimates that the current eleven OPEC members account for about 40 per cent of world oil production, and about 2/3 of the world's proven oil reserves.

2.2 Non-OPEC countries

Of the 14 countries that produced more than 2 million barrels per day (bbl/day) of total liquids in 2004, seven were not OPEC members, and included: the United States (US) (the world's third-largest total oil producer for the year); Russia; Mexico; China; Canada; and North Sea countries Norway and the United Kingdom. Non-OPEC countries produced 60 percent of the world's oil (total liquids) in 2004, down from 62 per cent in 2003.

2.3 Producers and exporters

Table 1 lists the top world oil producers and exporters. The Middle East, North America and Eastern Europe (including former USSR) have been and still are the regions producing most of the world crude oil (Table 1 and Figure 1). Of the worlds top net oil exporters, OPEC countries are strongly represented. Ten of the 14 countries exporting more than one million barrels per day of total oil (net) in 2004 were OPEC members. Russia, Norway, Mexico, and Kazakhstan are the world's largest non-OPEC net oil exporters.

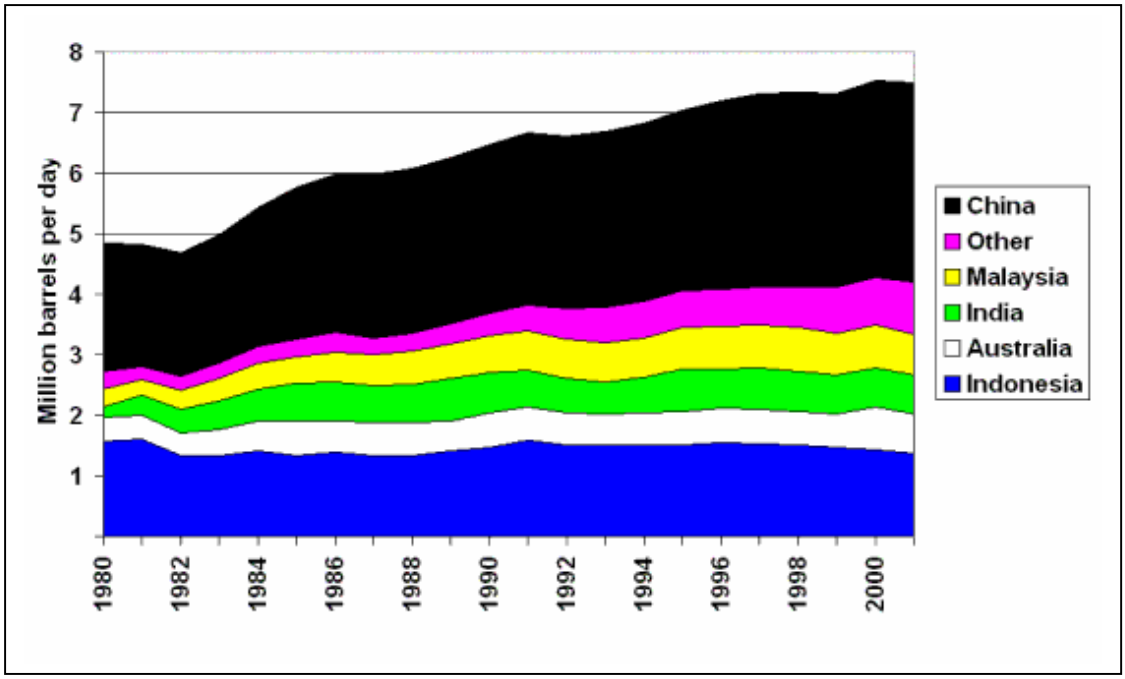
Australia belongs to the Far East and Oceania region and is a small producer (Figure 2). It also consumes a large proportion of both the oil and refined products it produces. In 2003-2004, Australia was estimated at 78 per cent self-sufficiency in these products.

In 2004, Western Australia produced 76.8 million barrels of crude oil. About half of Western Australia’s crude oil is exported, with Japan the largest overseas market for the State’s crude oil. Other major export destinations include the US, Singapore, South Korea, Indonesia, China and Thailand.

Table 1. Top World Oil Producers and Oil Net Exporters

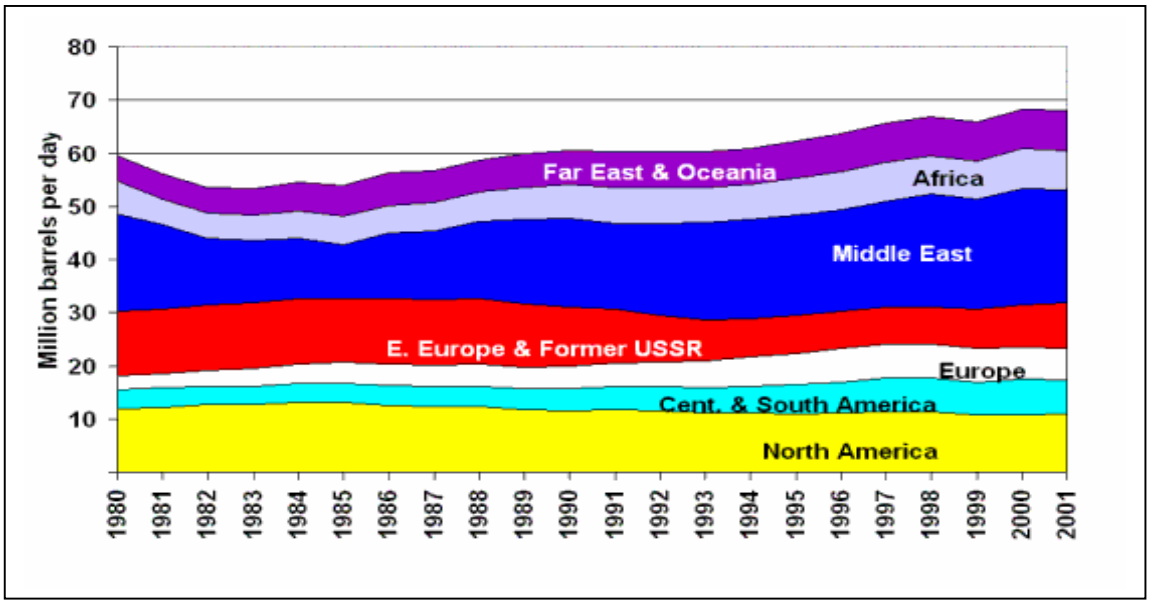
Top World Oil Producers, 2004[1]			Top World Oil Net Exporters, 2004[2]		
(OPEC members in italics)			*(OPEC members in italics)*		
	Country	Total Oil Production[3] (million barrels per day)		Country	Net Oil Exports (million barrels per day)
1)	*Saudi Arabia*	10.37	1)	*Saudi Arabia*	8.73
2)	Russia	9.27	2)	Russia	6.67
3)	United States	8.69	3)	Norway	2.91
4)	*Iran*	4.09	4)	*Iran*	2.55
5)	Mexico	3.83	5)	*Venezuela*	2.36
6)	China	3.62	6)	*United Arab Emirates*	2.33
7)	Norway	3.18	7)	*Kuwait*	2.2
8)	Canada	3.14	8)	*Nigeria*	2.19
9)	*Venezuela*	2.86	9)	Mexico	1.8
10)	*United Arab Emirates*	2.76	10)	*Algeria*	1.68
11)	*Kuwait*	2.51	11)	*Iraq*	1.48
12)	*Nigeria*	2.51	12)	*Libya*	1.34
13)	*United Kingdom*	2.08	13)	*Kazakhstan*	1.06
13)	*Iraq*	2.03	14)	*Qatar*	1.02
[1] *Table includes all countries with total oil production exceeding 2 million barrels per day in 2004.*			[2] *Table includes all countries with net exports exceeding 1 million barrels per day in 2004.*		
[3] *Total Oil Production includes crude oil, natural gas liquids, condensate, refinery gain, and other liquids.*					

Source: EIA, 2006.



Source: International Energy Annual 2006.

Figure 1. World Crude Oil Production, 1980-2001 (Million barrels per day).



(Source: International Energy Annual 2006).

Figure 2. Far East and Oceania Crude Oil Production.

3. WORLD AND AUSTRALIAN OIL CONSUMPTION

Table 2 lists today's top world oil consumers and oil net importers. North America. Western Europe and the Far East and Oceania have been and still are the regions consuming most of the world crude oil (Table 2 and Figure 3).

Of the estimated preliminary 82.5 million bbl/d of oil the world consumed in 2004, OPEC countries together consumed about 7 million bbl/d, or 8.5 percent of total consumption. Most of the world's largest oil consumers are also net oil importers. Of the world's top ten oil consumers in 2004, only Russia and Canada were net oil exporters. The remaining top consumers also are listed as the world's largest oil importers, with the exception Brazil, which was the 18th largest net oil importer in 2004.

Australia belongs to the Far East and Oceania region and is a relatively small consumer (Figure 4). As previously stated, it also produces a large proportion of both the oil and refined products it consumes. Self-sufficiency in these products was estimated at 78 per cent in 2003-2004.

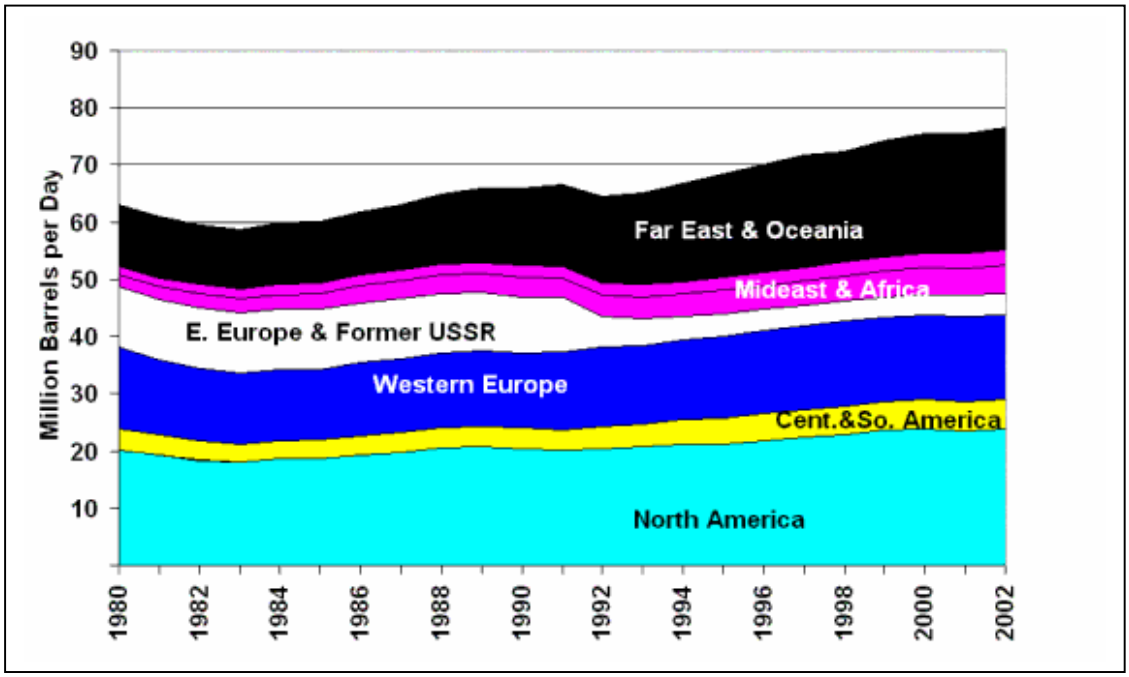
Table 2. Top World Oil Consumers and Oil Net Importers

Top World Oil Consumers, 2004[1]			**Top World Oil Net Importers, 2004[2]**		
	Country	**Total Oil Consumption (million barrels per day)**		**Country**	**Net Oil Imports (million barrels per day)**
1)	United States	20.7	1)	United States	12.1
2)	China	6.5	2)	Japan	5.3
3)	Japan	5.4	3)	China	2.9
4)	Germany	2.6	4)	Germany	2.4
5)	Russia	2.6	5)	South Korea	2.2
6)	India	2.3	6)	France	1.9
7)	Canada	2.3	7)	Italy	1.7
8)	Brazil	2.2	8)	Spain	1.6
9)	South Korea	2.1	9)	India	1.5
10)	France	2	10)	Taiwan	1
11)	Mexico	2			

[1] *Table includes all countries that consumed more than 2 million bbl/d in 2004.*

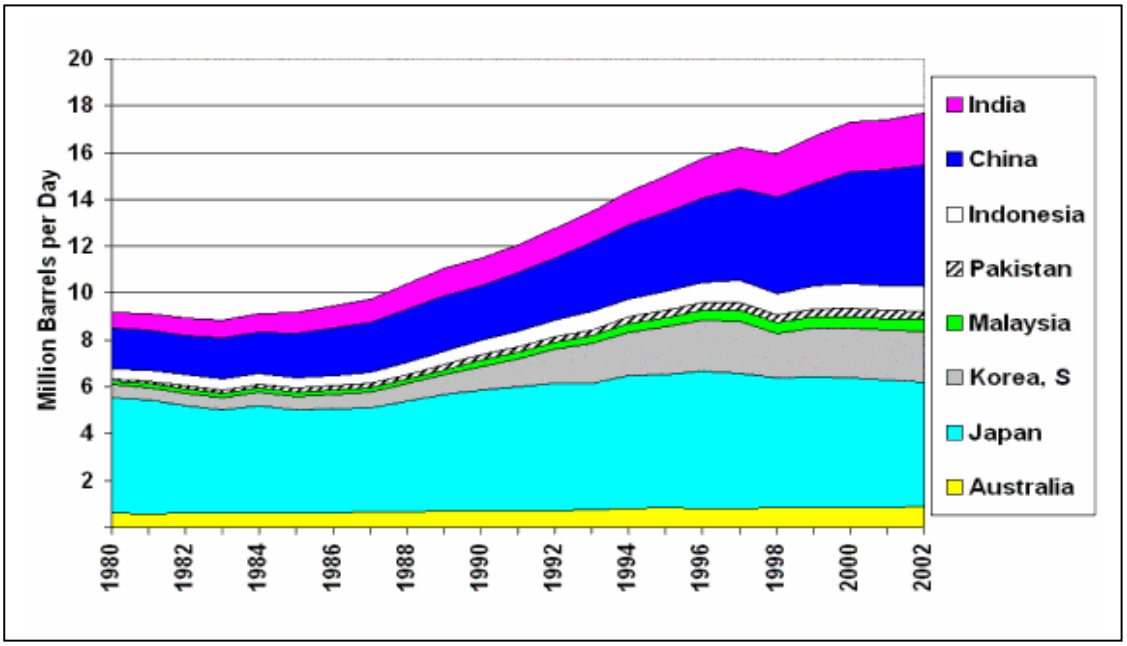
[2] *Table includes all countries that imported more than 1 million bbl/d net in 2004.*

Source: EIA, 2006.



Source: International Energy Annual, 2006.

Figure 3. World Crude Oil Consumption, 1980-2002 (Million barrels per day).



Source: International Energy Annual, 2006.

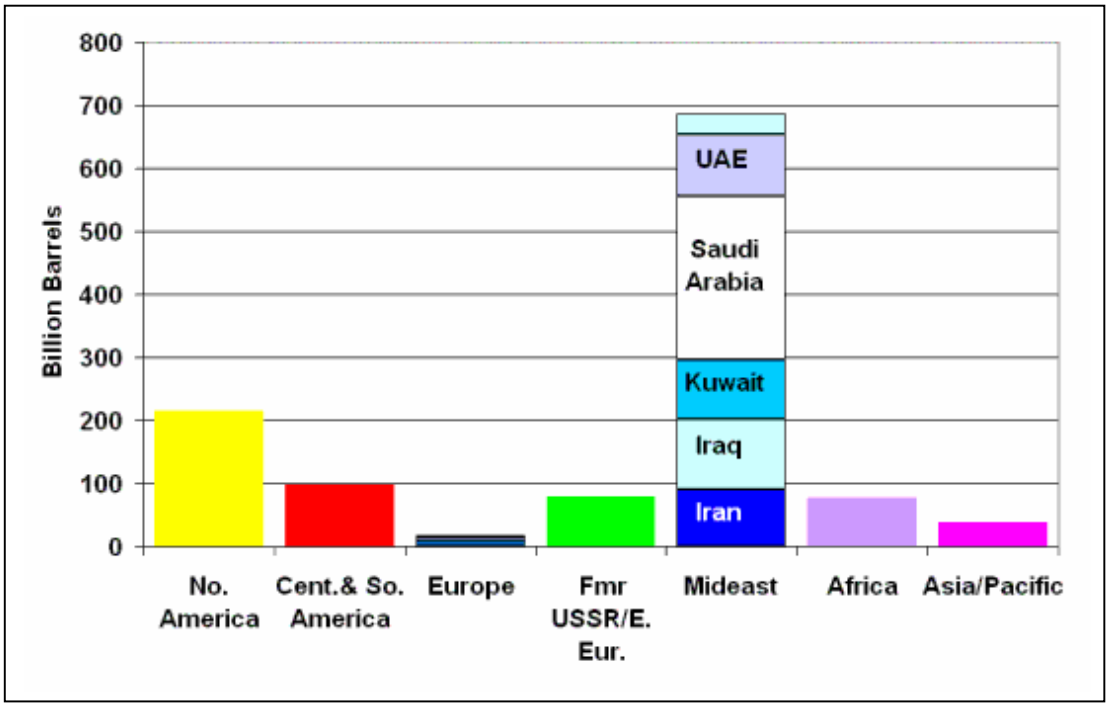
Figure 4. Far East and Oceania Crude Oil Consumption, 1980-2002 (million barrels per day).

4. PROVEN CRUDE OIL RESERVES

Almost every year for 150 years, the oil industry has produced more than it did the year before, and predictions of oil running out or peaking have always been proved wrong.

The business of estimating oil reserves is contentious and political. According to Campbell, companies seldom report their true findings for commercial reasons, and Governments - which own 90 per cent of the reserves - often lie. Most official figures, he says, are grossly unreliable: 'Estimating reserves is a scientific business. There is a range of uncertainty but it is not impossible to get a good idea of what a field contains. Reporting [reserves], however, is a political act'. (Source: article in the Guardian, Thursday 21 April 2005 by John Vidal.)

According to oil industry sources, including Campbell, the two most widely used estimates of world oil reserves, drawn up by the Oil and Gas Journal (Figure 5) and the BP Statistical Review (Table 3), both rely on reserve estimates provided to them by Governments and industry and do not question their accuracy.



Source: Oil & Gas Journal, 23/12/2002.

Figure 5. Oil Reserves, 2003 (billion barrels).

According to Campbell, companies under-report their new discoveries to comply with strict US stock exchange rules, but then revise them upwards over time, partly to boost their share prices with 'good news' results. As companies are competing for funds with other subsidiaries around the world, they have to exaggerate. Campbell's views are supported by other oil depletion analysts and petroleum geologists, most of who have been in the industry for years. They accuse the US of using questionable statistical probability models to calculate global reserves and OPEC countries of drastically revising upwards their reserves in the 1980s. They claim the estimates for the OPEC countries were systematically exaggerated in the late 1980s to win a greater slice of the allocation cake. Middle East official reserves jumped 43 per cent in just three years despite no new major finds.

Data on proven oil reserves sometimes includes non-conventional reserves such as:

Heavy oils

These can be pumped just like conventional petroleum except that they are much thicker, more polluting, and require more extensive refining. They are found in more than 30 countries, but about 90 per cent of estimated reserves are in the Orinoco 'heavy oil belt' of Venezuela, which has an estimated 1.2 trillion barrels. About one third of the oil is potentially recoverable using current technology.

Tar sands

These are found in sedimentary rocks and must be dug out and crushed in giant opencast mines. But it takes five to 10 times the energy, area and water to mine, process and upgrade the tars that it does to process conventional oil. The Athabasca deposits in Alberta, Canada are the world's largest resource, with estimated reserves of 1.8 trillion barrels (more than all of the world oil reserves combined), of which about 280-300 billion barrels may be recoverable. Production now accounts for about 20 per cent of Canada's oil supply.

Oil shales

These are seen as the US Government's energy stopgap. They exist in large quantities in ecologically sensitive parts of Colorado, Wyoming and Utah at varying depths, but the industrial process needed to extract the oil demands hot water, making it much more expensive and less energy-efficient than conventional oil production. The mining operation is extremely damaging to the environment. Shell, Exxon, Chevron Texaco and other oil companies are investing billions of dollars in this expensive oil production method.

According to one independent estimate (Oil and Gas Journal), of the world's 1.28 trillion barrels of proven reserves, 885 billion barrels (69%) are held by OPEC, as of January 2005. The non-OPEC reserves include Canadian non-conventional reserves. Not including Canada, according to this estimate the world's proven oil reserves are about 1.1 trillion barrels, of which OPEC holds 84 per cent. In the future, the inclusion of non-conventional oil reserves for other countries may also significantly impact OPEC member Venezuela, as well as non-OPEC countries such as Australia

Non-conventional reserves are generally more expensive to exploit than conventional crude oil reserves and may require special facilities and technologies. Because non-OPEC countries' smaller reserves are being depleted more rapidly than OPEC reserves, their overall reserves-to-production ratio -- an indicator of how long proven reserves would last at current production rates -- is much lower (about 26 years for non-OPEC and 83 years for OPEC, based on 2004 crude oil production rates). This implies increased OPEC production as a proportion of world production over the long term.

Table 3. World Proved1 Reserves of Oil and Natural Gas, Most Recent Estimates

(Unit: billion bbl [barrels].)

Country/Region	*BP Statistical Review*[2]	*Oil & Gas Journal*[3]	*World Oil*[4]
Country/Region	**Year-End 2004**	**January 1, 2006**	**Year-End 2004**
Canada (See Footnotes 2-4.)	16.802	178.792	4.700
Mexico	14.803	12.882	14.803
United States (See Footnotes 2-5)	29.299	21.371	21.371
North America	**60.904**	**213.046**	**40.874**
Argentina	2.675	2.320	2.321
Bolivia		0.441	0.465
Brazil	11.243	11.243	11.243
Chile		0.150	0.010
Colombia	1.542	1.542	1.495
Cuba		0.750	0.585
Ecuador	5.060	4.630	5.500
Guatemala		0.526	
Peru	0.930	0.930	0.961
Suriname		0.111	
Trinidad and Tobago	0.990	0.990	0.776
Venezuela	77.226	79.729	52.400
Other-Country Not Specified	1.500		0.218
Central and South America	**101.165**	**103.364**	**75.973**
Austria		0.062	0.081
Croatia		0.069	0.069
Denmark	1.327	1.328	1.328
France		0.158	0.160
Germany		0.367	0.225
Italy	0.739	0.622	0.729
Netherlands		0.106	0.212
Norway	9.673	7.705	9.863
Serbia and Montenegro (Yugoslavia)		0.078	
Spain		0.158	
Turkey		0.300	0.279
United Kingdom	4.487	4.029	3.908
Other-Country Not Specified	1.146		0.010
Western Europe	**17.372**	**14.989**	**16.864**
Albania		0.198	0.197
Azerbaijan	7.000	7.000	
Belarus		0.198	
Czech Republic		0.015	0.023
Georgia		0.035	
Hungary		0.102	0.161
Kazakhstan	39.620	9.000	
Kyrgyzstan		0.040	
Lithuania		0.012	
Poland		0.096	0.309
Romania	0.471	0.956	0.468
Russia	72.277	60.000	67.138
Slovakia		0.009	
Tajikistan		0.012	
Turkmenistan	0.546	0.546	
Ukraine		0.395	
Uzbekistan	0.594	0.594	
Other Former USSR	0.749		22.760
Country/Region	*BP Statistical Review*[2]	*Oil & Gas Journal*[3]	*World Oil*[4]
Country/Region	**Year-End 2004**	**January 1, 2006**	**Year-End 2004**
Other-Country Not Specified	0.614		0.102
Eastern Europe and Former USSR	**121.871**	**79.224**	**91.160**
Bahrain		0.125	
Iran	132.460	132.460	130.800

Iraq	115.000	115.000	115.000
Kuwait[6]	99.000	104.000	99.675
Oman	5.572	5.506	4.803
Qatar	15.207	15.207	20.000
Saudi Arabia[6]	262.730	266.810	262.075
Syria	3.159	2.500	2.285
United Arab Emirates	97.800	97.800	69.910
Yemen	2.850	4.000	3.000
Other-Country Not Specified	0.081		0.740
Middle East	**733.859**	**743.411**	**708.289**
Algeria	11.800	11.350	15.303
Angola	8.801	5.412	9.035
Benin		0.008	
Cameroon		0.400	
Congo (Brazzaville)	1.784	1.506	1.784
Congo (Kinshasa)		0.187	
Cote d'Ivoire (IvoryCoast)		0.100	
Egypt	3.565	3.700	3.565
Equatorial Guinea	1.280	0.012	1.765
Gabon	2.285	2.499	2.205
Ghana		0.017	
Libya	39.126	39.126	33.550
Nigeria	35.255	35.876	36.630
South Africa		0.016	
Sudan	6.313	0.563	6.405
Tunisia	0.640	0.308	0.681
Other-Country Not Specified	0.483		1.488
Africa	**112.233**	**102.580**	**112.410**
Australia	4.046	1.437	3.556
Bangladesh		0.028	
Brunei	1.050	1.350	1.120
Burma		0.050	0.191
China	17.070	18.250	15.443
Hawaiian Trade Zone			
India	5.565	5.848	4.936
Indonesia	4.722	4.301	5.295
Japan		0.059	
Malaysia	4.300	3.000	3.034
New Zealand		0.053	0.068
Pakistan		0.289	0.307
Papua New Guinea		0.240	0.194
Philippines		0.139	0.103
Thailand	0.500	0.291	0.527
Vietnam	2.960	0.600	1.350
Other-Country Not Specified	0.888		0.120
Asia and Oceania	**41.100**	**35.936**	**36.244**
World Total	**1,188.505**	**1,292.550**	**1,081.813**

1. Proved reserves are estimated quantities that analysis of geologic and engineering data demonstrates with reasonable certainty are recoverable under existing economic and operating conditions.

2. BP plc, BP Statistical Review of World Energy June 2005, except United States. Oil includes crude oil, gas condensate, and natural gas liquids. United States oil data, including both crude oil and natural gas liquids, and United States natural gas data are from the Energy Information Administration, US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 2004 Annual Report, DOE/EIA-0216(2004) (November 2005). BP notes that: "the figure for Canadian oil reserves includes an official estimate of Canadian oil sands" under active development". BP says of its data sources for oil reserves that "the estimates in this table have been compiled using a combination of primary official sources, third-party data from the OPEC Secretariat, World Oil, Oil and Gas Journal and an independent estimate of Russian reserves based on information in the public domain. Likewise for natural gas reserves, BP states that "the estimates in this table have been compiled using a combination of primary official sources, third-party data from Cedigaz, the OPEC Secretariat and Oil and Gas Journal. BP also notes that: "the reserves figures shown do not necessarily meet the United States Securities and Exchange Commission definitions and guidelines for determining proved reserves nor necessarily represent BP's view of proved reserves by country."

3. PennWell Corporation, Oil and Gas Journal, Vol. 103, No. 47 (19 December2005). Oil includes crude oil and condensate. Data for the United States are from the Energy Information Administration, US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 2004 Annual Report, DOE/EIA-0216(2004) (November 2005). Oil and Gas Journal's oil reserve estimate for Canada includes 4.7 billion barrels of conventional crude oil and condensate reserves and 174.1 billion barrels of oil sands reserves.

4. Gulf Publishing Co., World Oil, Vol. 226, No.9 (September 2005), except United States. Oil includes crude oil and condensate but excludes natural gas liquids. Data for the United States are from the Energy Information Administration, US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 2004 Annual Report, DOE/EIA-0216 (2004) (November 2005). World Oil's Canadian oil reserve estimate 'does not include 174 billion bbl [barrels] of oil sands reserves.'

5. THE SHORT-TERM OUTLOOK

Table 4 provides a short-term energy outlook until 2007. Non-OPEC oil production is expected to rise during the next two years, though not enough to keep pace with growth in total world oil demand.

Table 3. Energy Information Administration\Short-Term Energy Outlook (million barrels per day) – April 2006

	2005	2006	2007
DEMAND[a]			
OECD Demand			
US (50 States)	**20.7**	***20.9***	***21.4***
US Territories	**0.4**	***0.4***	***0.4***
Canada	**2.3**	***2.3***	***2.3***
Europe	**15.6**	***15.7***	***15.7***
Japan	**5.4**	***5.5***	***5.5***
Other OECD	**5.3**	***5.4***	***5.4***
Total OECD	**49.6**	***50***	***50.7***
Non-OECD Demand			
Former Soviet Union	**4.3**	***4.4***	***4.4***
Europe	**0.7**	***0.7***	***0.7***
China	**6.9**	***7.4***	***7.9***
Other Asia	**8.4**	***8.4***	***8.6***
Other Non-OECD	**13.8**	***14.2***	***14.6***
Total Non-OECD	**34.1**	***35.1***	***36.2***
Total World Demand	**83.6**	***85.2***	***87***
SUPPLY[b]			
OECD* Supply			
US (50 States)	**8.2**	***8.5***	***8.9***
Canada	**3.1**	***3.3***	***3.5***
Mexico	**3.8**	***3.8***	***3.7***
North Sea[c]	**5.2**	***4.8***	***4.6***
Other OECD	**1.5**	***1.6***	***1.7***
Total OECD	**21.8**	***22***	***22.5***
Non-OECD			
OPEC	**33.9**	***34.3***	***34.5***
OPEC Crude Oil Portion	**30**	***30***	***30***
Former Soviet Union**	**11.7**	***12***	***12.5***
China	**3.7**	***3.7***	***3.7***
Other Non-OECD	**12.9**	***13.2***	***13.9***
Total Non-OECD	**62.3**	***63.3***	***64.6***
Total World Supply	**84.1**	***85.3***	***87***

Sources: EIA: latest data available from EIA databases supporting the International Petroleum Monthly; International Energy Agency, Monthly Oil Data Service, Latest monthly release.

[a] Demand for petroleum by the OECD countries is synonymous with "petroleum product supplied," which is defined in the glossary of the EIA Petroleum Supply Monthly, DOE/EIA-0109. Demand for petroleum by the non-OECD countries is "apparent consumption," which includes internal consumption, refinery fuel and loss, and bunkering.

[b] Includes production of crude oil (including lease condensates), natural gas plant liquids, other hydrogen and hydrocarbons for refinery feedstocks, refinery gains, alcohol, and liquids produced from coal and other sources.

[c] Includes offshore supply from Denmark, Germany, the Netherlands, Norway, and the United Kingdom.

[*] ECD: Organization for Economic Cooperation and Development: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

[**] Former Soviet Union (FSU): Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

The greatest increases in production are expected in the former Soviet Union (FSU), including Russia (though less growth from Russia than in the previous two years) and the states bordering the Caspian Sea, and in other non-OECD producers, particularly Angola and Brazil. Brazil is expected to become a net exporter sometime in the next two years.

The short-term outlook is that demand will remain in balance with the supply.

6. The LONG-TERM OUTLOOK and Crude Oil Prices

The case for a high oil price remains compelling if you consider the long term demand/supply equation.

6.1 The demand

The world continues to have an insatiable hunger for oil, with consumption at around 82.5 million barrels per day, and growing. Current predictions are the world's oil demand, supported by the robust world economy, will increase by 1.7 million barrels per day in 2005 to reach 84 million barrels per day and by another 2 million barrels per day in 2006. The US has the largest appetite at around 20 millions barrels every day. China and India are also becoming prominent as both countries move rapidly down the path of industrialisation.

The International Energy Agency (IEA), which collates national figures and predicts demand, says developing countries could push demand up 47 per cent to 121 million barrels per day by 2030, and that oil companies and oil-producing nations must spend about $100 billion per year to develop new supplies to keep pace. That investment is not taking place.

According to the IEA, demand rose faster in 2004 than in any year since 1976. China's oil consumption, which accounted for a third of extra global demand in 2004, grew 17 per cent and is expected to double over the next 15 years to more than 10 million barrels per day - half the US's present demand.

India's consumption is expected to rise by nearly 30 per cent in the next five years. If world demand continues to grow at 2 per cent a year, then almost 160 million barrels per day will need to be extracted in 2035, twice as much as today.

Most geologists say that rate of extraction is almost inconceivable. According to industry consultants IHS Energy, 90 per cent of all known reserves are now in production, suggesting that few major discoveries remain to be made. Shell says its reserves fell last year because it only found enough oil to replace 15-25 per cent of what the company produced. BP told the US stock exchange that it replaced only 89 per cent of its production in 2004.

6.2 The supply

While demand is growing, supply continues to be stretched. Global oil production is currently around 84 millions barrels per day and, according to various sources, it will be difficult to increase this rate of production. While new reserves are proving elusive, many producing countries have passed peak production (Table 5) and are now in decline.

The IEA has predicted that by 2015, production at Saudi Arabia's Ghawar field, the world's largest onshore oil field, will have peaked.

Today 80 per cent of the region's oil comes from large fields. By 2030 that proportion is expected to have halved, making new investment crucial. Using current projections, Saudi Arabia will need to almost double today's output of 10 million barrels per day to meet the expectations of demand in 2030. However, experts in the US doubt that Saudi Arabia, at current and prospective recovery rates, could ever be able to produce 12 million barrels per day. Investment by Iran and Iraq will be vital.

Table 4. Peak production of major producers

Country	Peak Production
Libya	1970
United States	1972
Iran	1974
Romania	1976
Brunei	1979
Peru	1982
Cameroon	1985
Indonesia	1997
Trinidad	1999
North Sea	1997

Complicating matters somewhat is whether oil producing countries, such as Iran and Iraq, have the political will to make the investment needed. From an economic perspective, Governments may be reluctant to invest heavily in new oil supplies for fear of depressing prices and depleting fields too quickly. The last five years have seen a worsening exploration and production environment for major international oil companies (IOCs) and a resultant decline in production capacities.

Because of under-investment in Venezuela since late 2002, some of the country's major oilfields have been seriously damaged. Venezuela's president, Hugo Chávez, has replaced the nation's skilled oil industry managers with political appointees, causing a loss of 500,000 barrels per day of production of premium crude oil with low sulfur content.

Indonesia's oil production capacity is declining to less than 1 million barrels per day.

Mexico, Syria, Oman and several other non-OPEC countries have seen their oil production capacities decline steadily despite expensive Enhanced Oil Recovery systems installed.

Most Latin American states and national oil companies (NOCs), including Pemex of Mexico, have made their exploration and production regimes increasingly unattractive to the international oil companies.

Iran's mullahs have stifled the foreign investment that Iran's oil industry so desperately needs.

The possibility of further conflicts and tensions in many oil producing countries increases the possibility of supply disruption.

In the wake of the Iraq war, the rapid economic rise of China, global warming and recent record oil prices, the debate has shifted from 'if' there is a global peak to 'when?':

According to a report on oil shales and unconventional oil supplies prepared by the US office of petroleum reserves in 2005, 'world oil reserves are being depleted three times as fast as they are being discovered. Oil is being produced from past discoveries, but the reserves are not being fully replaced …'. It continues: 'Although there is no agreement about the date that world oil production will peak, forecasts presented by Les Magoon (geologist at the US Geology Survey), the Oil and Gas Journal, and others expect the peak will occur between 2003 and 2020. What is notable ... is that none extend beyond the year 2020, suggesting that the world may be facing shortfalls much sooner than expected.'

The study of 'peak oil' - the point at which half the total oil known to have existed in a field or a country has been consumed, beyond which extraction goes into irreversible decline - used to be back-of-the envelope guesswork. It was not taken seriously by business or governments, mainly because oil has always been cheap and plentiful.

The first person to warn of a peak in global oil production was an American called M. King Hubbert*. In 1956, he predicted that US oil production would peak in about 1970. He was castigated for suggesting anything so outrageous, but by 1973 it had become apparent that he was correct. In the late 1960s, Hubbert went further and predicted that global oil production would peak in about 2000. He may have been about five years too early. Roger Bentley of the University of Reading found that in the 1970s – during the last outbreak of peak-oil fever – other analysts from 'reputable organizations' (including Esso, Shell, the UK Department of Energy, and the UN, as well as Hubbert himself) were nearly unanimous in predicting a world oil peak somewhere around the year 2000.

*M. King Hubbert was a Shell geologist who in 1956 showed mathematically that exploitation of any oilfield follows a predictable 'bell curve' trend, which is slow to take off, rises steeply, flattens and then descends again steeply

Over the past half century, country after country has seen its oil production hit a peak and start dropping. Yet for decades, economists, petroleum executives and government officials refused to follow Hubbert's analysis to its logical conclusion – that in the easily foreseeable future, humanity will pass over a global peak of oil production.

- Colin Campbell of the Association for the Study of Peak Oil and Gas (ASPO) predicts that production will begin its decline between now and 2010.
- British Petroleum exploration consultant Francis Harper believes it will happen between 2010 and 2020.
- The consulting firm PFC Energy puts it at around 2010 to 2015.
- The publication Petroleum Review predicts that demand will outstrip supply in 2007.
- Richard Heinberg, author of the 2003 book, The Party's Over: Oil, War, and the Fate of Industrial Societies, expects a peak in 2007 or 2008.
- Deutsche Bank analysts report that global oil production will peak in 2014.
- According to Chris Skrebowski, editor of Petroleum Review, a monthly magazine published by the Energy Institute in London, conventional oil reserves are now declining about 4-6 per cent a year worldwide and predict global oil production will peak in 2008,
- Retired Princeton professor Kenneth Deffeyes, author of the just-published, Beyond Oil: The View from Hubbert's Peak is more pessimistic, and more specific, about when the peak will happen: Thanksgiving Day, 2005.

There are some more optimistic forecasts:

- Energy consultant Michael Lynch maintains that there's no peak in sight for 'the next 20 or 30 years.'
- Peter Odell of Erasmus University in the Netherlands has tacked a full 30 years onto Deffeyes' grim prediction, setting a date of Thanksgiving 2035.
- And the USA Department of Energy has the cheeriest forecast of all: a peak in 2037.

In designing an energy policy that can be sustained far into the post-petroleum future, the precise timing of the peak is of about as much practical importance as the date of the next total eclipse of the sun.

Oil supply is increasingly limited to a few giant fields, with 10 per cent of all production coming from just four fields and 80 per cent from fields discovered before 1970. Even finding a field the size of Ghawar in Saudi Arabia, (by far the world's largest and said to have another 125 billion barrels), would only meet world demand for about 10 years.

"All the major discoveries were in the 1960s, since when they have been declining gradually over time, give or take the occasional spike and trough," says Campbell. "The whole world has now been seismically searched and picked over. Geological knowledge has improved enormously in the past 30 years and it is almost inconceivable now that major fields remain to be found."

Experts accept there may be a big field or two left in Russia, and more in Africa, but these would have little bearing on world supplies. Unconventional deposits like tar sands and shale may only slow the production decline.

"The first half of the oil age now closes," says Campbell. "It lasted 150 years and saw the rapid expansion of industry, transport, trade, agriculture and financial capital, allowing the population to expand six-fold. The second half now dawns, and will be marked by the decline of oil and all that depends on it, including financial capital."

A convincing event proving peak oil is upon us happened on Wednesday 16 March 2006 when OPEC announced it was to raise production by 500,000 barrels per day. At any other time in recent history, this would have sent oil prices down, but not this time - they went up even further.

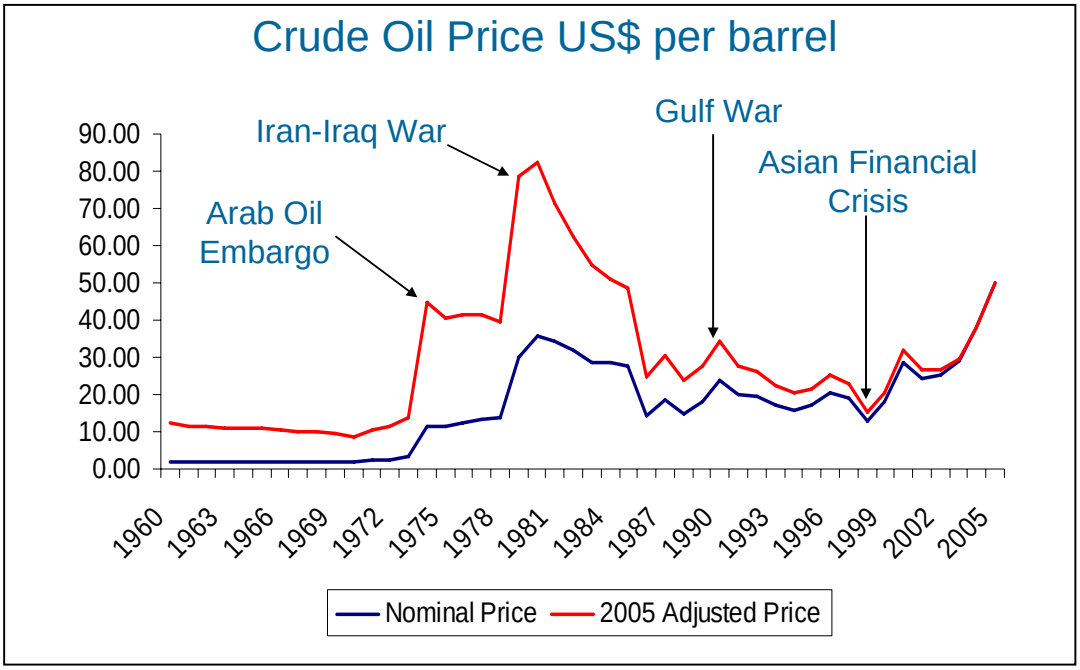
With Australian domestic consumption of both oil and refined petroleum products projected to outpace domestic production in the long term, Australia's self-sufficiency in petroleum products is projected to fall from its current level of 78 per cent to around 50 per cent by 2029-2030 (Akmal and Riwoe 2005).

6.3 The future price of crude oil price

Since 2004, world oil prices have been rising. However, the recent rise in world oil prices needs to be kept in perspective, as current trade weighted average oil prices are still lower in real terms than during either of the previous world oil crises in the early to mid-1970s and the late 1970s to early 1980s (Figure 6).

There is much discussion as to the causes of the current relatively high prices and future price trend. These are clearly complex and controversial. There tend to be two schools of thought. One argues high prices are cyclical and arise from physical shortages as a result of booming demand and problems in Iraq and other producers combining with a bull run in the share market.

The other school argues that we are witnessing a fundamental structural change in the oil market reflecting insufficient investment over the last 10 years or so. The difference between the two schools is crucial. If current prices are cyclical in origin they will eventually go down, if structural they will stay high.



Source: BP Statistical Overview, 2005, Energy Information Agency.

Figure 6. Crude Oil Price (US$/bbl).

One key issue is investment by oil companies in exploration and production.

The high prices enjoyed over the last two years mean that oil companies are experiencing record years in financial terms. In the past, high oil prices would have encouraged ever greater investments in exploration and production, thereby creating a self-adjusting mechanism. High prices increase investments which increase quantity supplied which reduces price. However, in recent years this has failed to materialise and indeed in this decade, according to Deutsche Bank, the major companies have cut their exploration budgets by 27 per cent.

The explanation for the potential lack of investment lies in the dominance of value-based management theories as the driving force of financial strategy in the major oil companies. This view of corporate finance began to gain credence in the 1990s. Its basis is simple: if the company cannot provide a rate of return at least equal to the general stock market and to its appropriate sector, it should return funds to the shareholders rather than investing them itself. This is achieved either through higher dividends or share buy-backs pushing up the share price. This problem of funds leaching out of the industry is compounded because returning funds to shareholders is becoming a key source of competition between the major oil companies to keep their shareholders happy. The danger is that the very short term benefits to share price will be at the expense of future investment in maintaining and developing crude capacity. The lead times for new capacity can be between five-to-eight years. Thus the crude shortages resulting from the current outflow of potential investment funds could be around for quite some time, together with their resultant high oil prices.

It is also in the interest of oil companies to maintain their production in balance with the relevant refinery capacity. Expansion of refining capacity has been made more difficult because of extremely tight environmental restrictions, not-in-my-back-yard community opposition, and the high cost of new construction. The oil companies could loose control over the crude oil price and, from being price makers, to become price takers if there was more oil produced than what the refiners could process. It is therefore in the interest of their shareholders that oil companies maintain control on their production expansion while pushing the concept of 'oil shortage'. To an economist, commodities are scarce and abundant at the same time. The difference between scarcity and abundance is price. You can get crude oil, in any amount, if you are willing to pay any price.

In the reviewed Report "Appropriateness of a 350 Million Litre Biofuels Target" (August 2005), ACIL Tasman comments on the new assumed input values suggested by ABARE for a re-run of the analysis are as follows:

… for crude oil prices at US$30/barrel (at 2005 prices), this assumption is toward the lower end of ACIL Tasman's suggested range for scenarios of between US$25-45/barrel (at 2005 prices) with exchange rates of A$0.71 and A$0.73, respectively. ACIL Tasman's range is slightly higher than that of the US Department of Energy and straddles the recently reported view of BP. BP expects prices to settle back to US$40/barrel in nominal terms (about US$35/barrel in real terms) by 2010. ACIL Tasman's single scenario projection from the Oxford Economic Forecasting model is US$32/barrel with an exchange rate of A$0.725.

In view of the evidence of a growing demand, a worsening of the exploration and production environment, and a global supply soon reaching its peak, crude oil prices are set to remain above 2005 prices in the short term and likely to increase in the longer term. The Reserve Bank of Australia (RBA) assumes that oil prices will remain at about US$62 per barrel while the futures markets are predicting that oil will stay above $US70 a barrel through until 2009.

7. ALTERNATIVE FUEL SOURCES

Oil is only one source of energy. If it gets truly expensive, the future will still be awash with energy because so many new sources are waiting for oil to get more expensive. New energy sources are all around us.

Aside from the continued development of offshore resources, gas-to-liquids technology may offer another avenue of producing liquid fuels in Australia. Australia's main 'alternative fuel', currently supplying around 6 per cent of transport fuel requirements by volume, is LPG, with other alternative fuels such as compressed natural gas and biofuels contributing less than 1 per cent to transport fuel supplies in total. The Government has provided a policy framework under which these alternative fuels may develop, but ultimately, they will need to compete in the market on their commercial merits.

Technologies also exist for producing liquid fuels from coal, and some countries, have either begun construction of coal-to-liquids plants or are committing resources to study the viability for commercialisation of such technologies. Australia has substantial coal reserves.

Research undertaken by ABARE and other organisations, including the Department of Agriculture and Food Western Australia, indicates that the production of biofuels such as ethanol and biodiesel should be commercially viable at present, but oil prices below US$75 per barrel and reductions in to domestic fuel taxation concessions scheduled to take place from 2006 to 2015, could progressively reduce the commercial viability of biofuels production over this period.

7.1 Ethanol

Assuming that ethanol producers* are able to sell all they can produce at prevailing market prices-that is, there are no problems with market barriers or consumer confidence, and at an estimated ethanol cash cost of production ranging between 30-36 cents per litre, after crediting back the distillers grain and carbon offsets (and before financing the facility) and an exchange rate varying between US$0.65 and US$0.75, the production of ethanol from grain is a commercially viable operation (Flowchart 1):

- **Under the current tax rate:** When the crude oil price is US$30 per barrel or higher.
- **After 2015:** When the crude oil is above US$55 per barrel.

* A month after the approval of the Dalby Bio-Refinery, Caltex announced (5/12/2005) the acquisition of Petro Fuels and Lubricants which has 11 sites selling an ethanol 10 per cent unleaded blend, including service stations in Toowoomba, Queensland. Petro Fuels and Lubricants were an independent fuel reseller based in Toowoomba and one of the two proponents of the Dalby Bio-Refinery.

7.2 Biodiesel

Assuming that biodiesel producers are able to sell all they can produce at prevailing market prices-that is, there are no problems with market barriers or consumer confidence, and assuming a total production cost (using tallow or palm oil as feedstock) ranging between 67-82 cents per litre including capital cost and associated financial costs, and an exchange rate varying between US$0.65 and US$0.75, the production of biodiesel is a commercially viable operation (Flowchart 2 and 3):

- **Under the current tax rate:** When the crude oil price is US$40 per barrel or higher for biodiesel produced from tallow or palm oil. If the biodiesel is made from canola oil, the crude oil price must be around US$85 per barrel to ensure economically viable production.
- **After 2015:** When the crude oil price is above US$70 per barrel for biodiesel produced from tallow or palm oil. If the biodiesel is made from canola oil, the crude oil price must be around US$100 per barrel to ensure economically viable production.

8. CONCLUSION

There is the possibility of facing the prospect of crude oil potentially reaching AU$100 per barrel. A shrewd guess is that with new technologies, it will stabilise supply and demand and petrol could be priced at about AU$3 per litre. That is twice today's price, but if the new hybrid motor cars deliver twice as many kilometres per litre, we will be no worse off.

The more expensive fuel oil will be directed to aircraft and to motor vehicles where it delivers the most benefits. Electricity generators could switch to nuclear fuel, coal and useful renewables such as solar power, geothermal energy and biomass.

Oil prices between U$75 and U$100 per barrel are unlikely to be a serious negative for the world or for Australia. Allowing oil prices to rise and better pricing of other resources that are not well priced at present (like road use and congestion) will economise on our use of oil, facilitate greater investment in oil exploration and production, and the development of alternative sources of energy. All these things will allow Australia to take advantage of the undoubted opportunities that high oil prices have for our economy.

The Oil Age will certainly end before we run out of oil. Just as the Stone Age ended long before we ran out of rocks.

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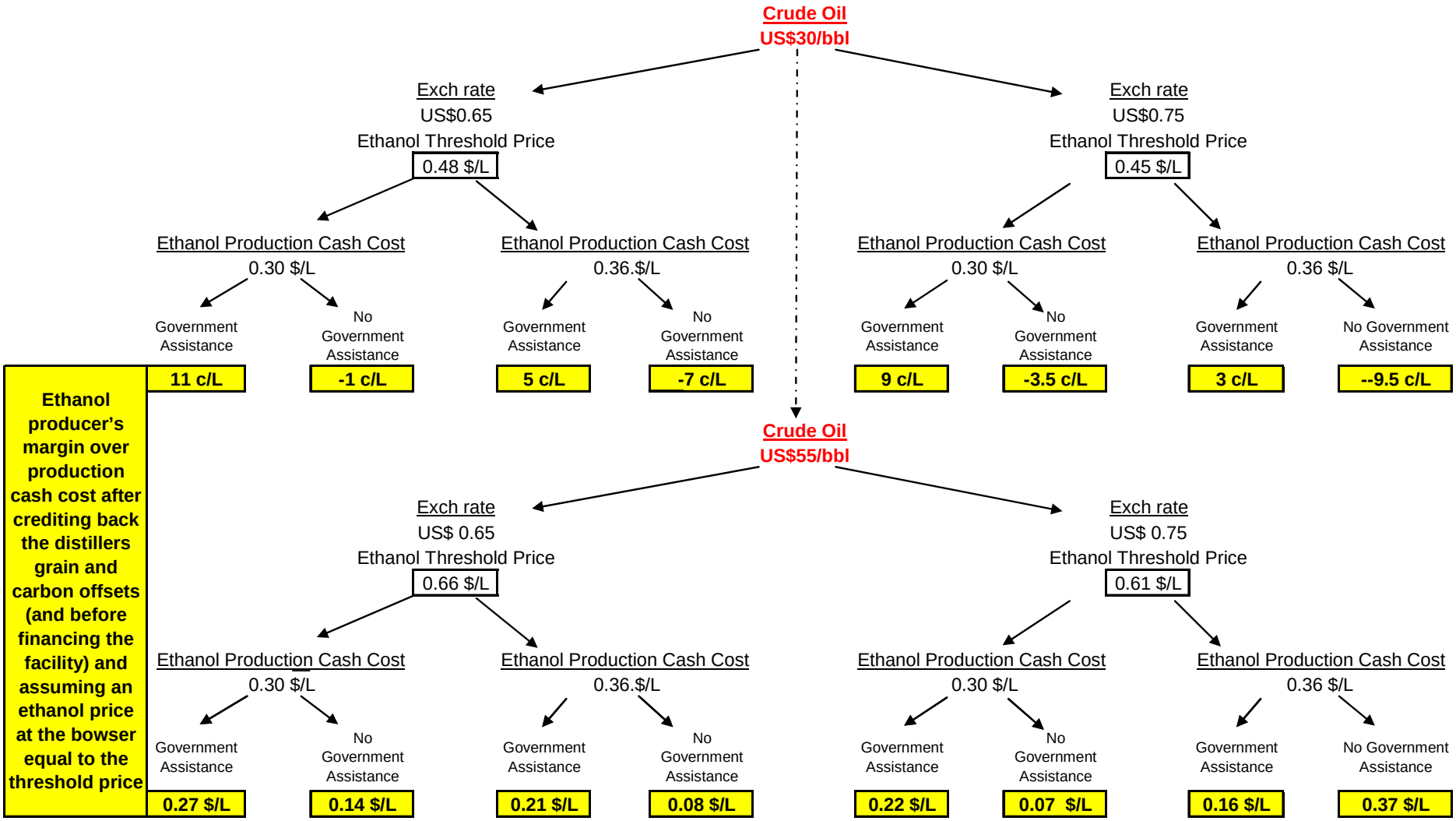
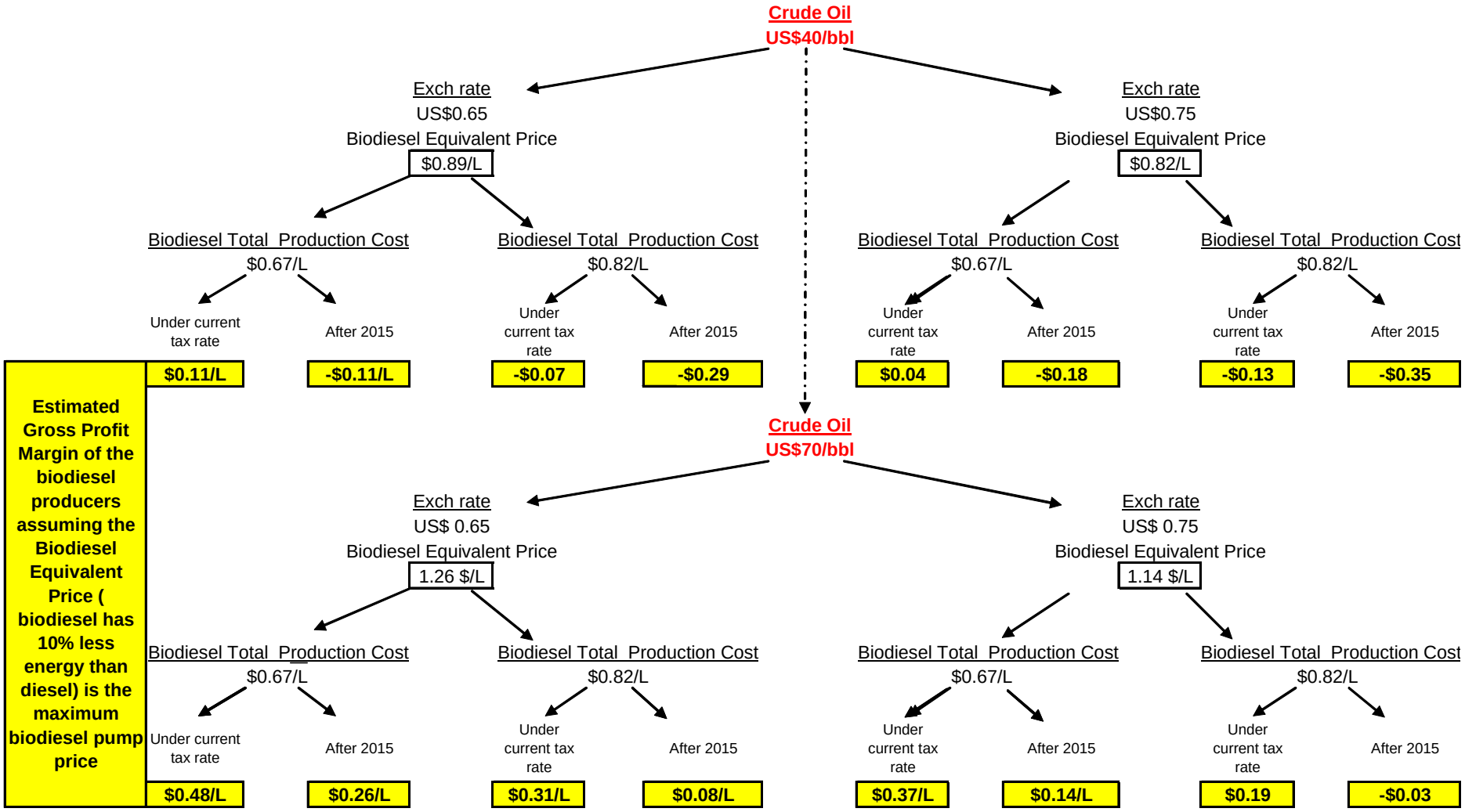
Flowchart 1. **Sensitivity of ethanol threshold price and producer's profit margin to changes in crude oil price, exchange rate and cost of production.**



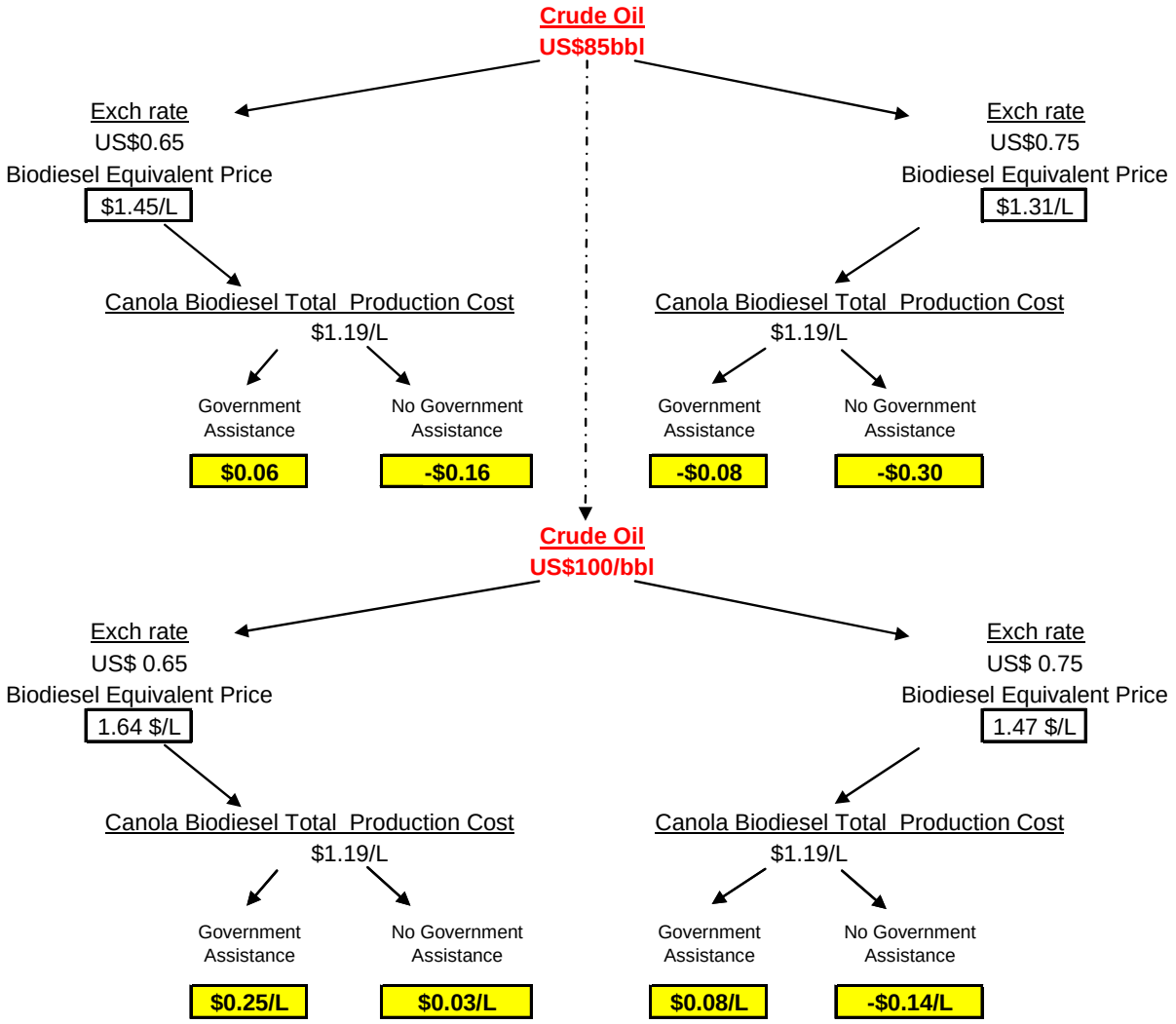
Source: J. Bonnardeaux, Department of Agriculture Western Australia, 2006.

Flowchart 2. Sensitivity of Biodiesel Equivalent Price and producer's gross profit margin to changes in crude oil price, exchange rate and cost of production.



Source: J Bonnardeaux, Department of Agriculture WA, 2006

Flowchart 3. Sensitivity of Biodiesel Equivalent Price and canola biodiesel producer's profit margin to changes in crude oil price, exchange rate



Estimated Gross Profit Margin of the canola biodiesel producers assuming the Biodiesel Equivalent Price (biodiesel has 10% less energy than diesel) is the maximum biodiesel pump price

Source: J Bonnardeaux, Department of Agriculture and Food WA, 2006