Oil Price Assumptions for *Energy Outlook*

Discussion Paper

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Ralph D. Samuelson

Energy Information & Modelling
Resources & Networks Branch
Ministry of Economic Development
PO Box 1473, Wellington
New Zealand

Michael S. Taylor

EME Consulting
Auckland
New Zealand

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The opinions expressed in this document are those of the authors alone, and should not be construed as New Zealand government policy.

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1 Introduction

This paper looks at how the Ministry of Economic Development (MED) should formulate assumptions about the future price of crude oil over the next 25 years for use in the next edition of the *New Zealand Energy Outlook*, and what these assumptions should be. Crude oil price assumptions are a required input to the Supply and Demand Equilibrium Model (SADEM) used by MED to project New Zealand energy supply, demand, prices, and greenhouse gas emissions.

Crude oil prices are actually among the less important inputs to MED's models. Their most important impact in SADEM is their effect on the price of imported liquefied natural gas (LNG), which is assumed to be priced in relation to oil. However, this relationship may merit some re-examination, as there is evidence that the link between oil prices and LNG prices is weakening.[1] Oil prices also have an impact, through an assumed consumer price response, on transport fuel demand, although this impact is small, at least in the short-term[2]. Finally, crude oil prices have an impact on the oil product share of energy consumption in the "Residential" and "Other Industrial and Commercial" sectors. Oil's share in these sectors is, however, quite small in any event.

Although the crude oil price is not a very important input to the MED's models, it is an assumption with high visibility. Oil prices drive oil product prices—petrol and diesel fuel in particular. Even though petrol and diesel prices do not have much impact on consumer transport demand, they certainly have a significant impact on the welfare of many consumers. Furthermore, higher petrol and diesel prices can harm the wider economy by reducing the ability of consumers to purchase other goods, although this impact is not modelled in SADEM. Finally, the oil price assumptions used in SADEM will tend to be interpreted to some degree as an 'official' government projection of long-term oil prices, which may be cited in debates over various energy-related policies.

This paper has three major sections. Section 2 discusses the methods one might use to obtain an oil price forecast and proposes a hierarchy of three such methods. Section 3 looks at what future oil prices each of the methods in the hierarchy proposed in Section 2 is currently suggesting. Section 4 proposes two alternative future oil price assumptions—a "base", and a "high" price case—based on an assimilation of the results in Section 3.

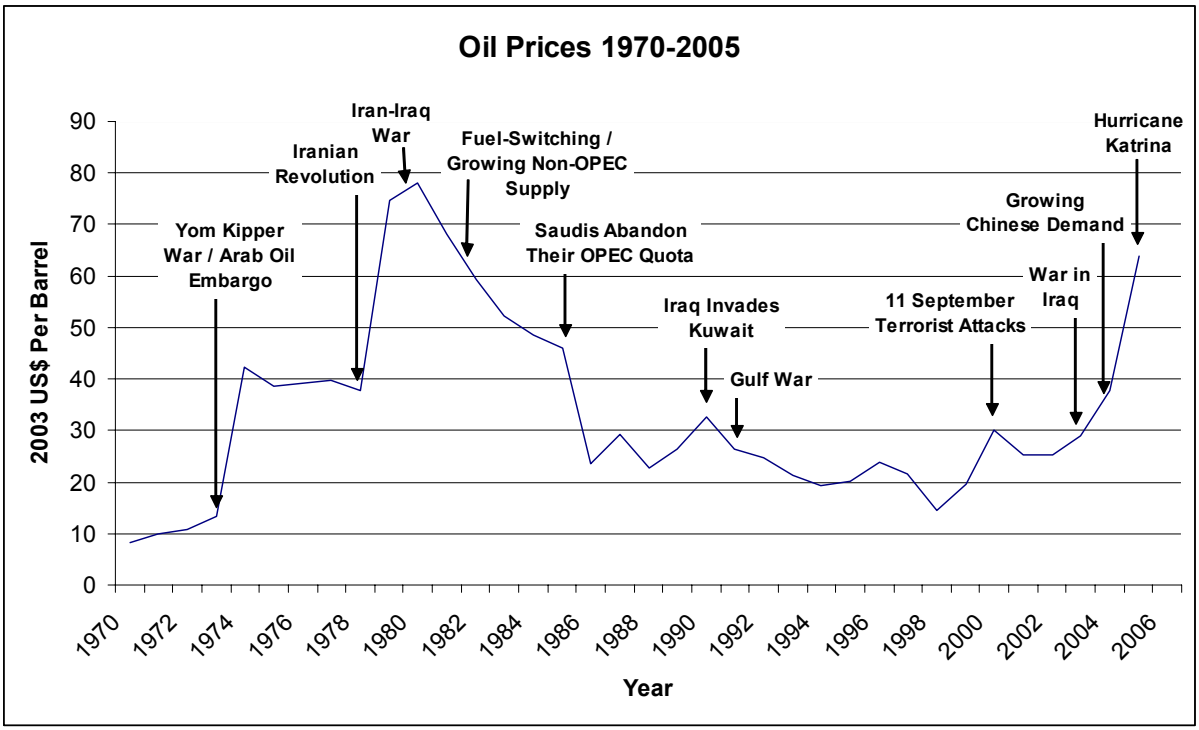
[1] See "Contact's LNG Import Plan Remains Intact", 2 September 2005, http://www.stuff.co.nz/stuff/0,2106,3397697a13,00.html.

[2] See Phil Goodwin, Joyce Dargay and Mark Hanly, "Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review", *Transport Reviews*, Vol. 24, No. 3, 275–292, May 2004, http://www.cts.ucl.ac.uk/tsu/papers/transprev243.pdf or "Transportation Elasticities; How Prices and Other Factors Affect Travel Behavior", *TDM Encyclopedia*, Victoria Transport Policy Institute, http://www.vtpi.org/tdm/tdm11.htm.

2 How to Make an Oil Price Forecast

Before starting any discussion of future oil prices, it is perhaps appropriate to point out that we approach this subject with a great deal of humility. First, we must recognize that the key variable, aside from demand, that will determine long-term future oil prices is the amount of oil remaining to be 'discovered'. We put 'discovered' in quotes here because we are referring not only to conventional oil discovered through exploratory drilling, but also oil 'discovered' through the application of new technology, which may include enhanced recovery from existing fields, non-conventional oil, or even synthetic fuels. Both the extent of the resources in the ground to be discovered and the extent of the new technologies we can discover to extract them remain highly uncertain.

Figure 1[3]



Second, oil prices have been highly volatile over the last 35 years, and seem likely to stay that way. This is illustrated in Figure 1, which shows the historical path of oil prices and some of the key events that have impacted them. Most of these events were unpredicted and, were by their nature, inherently unpredictable. Although we cannot predict what events the future will bring, the oil market as it is structured today seems inherently prone to further disruption. This vulnerability is driven by a combination of heavy dependence on a politically unstable Middle East, long and fragile supply chains, the lags involved in bringing new capacity on-stream once it becomes economic, and insufficient international cooperation to promote planning and investment.[4]

Third, over the longer term, the oil industry appears to be a highly cyclical one, with periods of tight supply, high prices, and high investment followed by periods of glut, low prices, and low investment. In attempting to project oil prices we are reminded of J.P. Morgan's response when a reporter asked him what he thought would happen to the stock market: "It will fluctuate."

[3] Data through the year 1999 in 1999 US dollars taken from data supplied by BP shown on the U.S. Energy Information Administration website at http://www.eia.doe.gov/pub/international/iealf/BPCrudeOilPrices.xls . 1970 to 1985 prices are for Arabian Light posted at Ras Tanura, 1986-1999 prices are Brent Spot Prices. Data for 1999 to 2004 were calculated from average monthly Brent Spot prices shown on the Newfoundland & Labrador Statistics Agency website at http://www.stats.gov.nl.ca/statistics/Industry/Oil_Crude_Prices.asp . Adjustments to 2003 US dollars were made using the GDP Deflator inflation calculator on the National Aeronautics and Space Administration website at http://www1.jsc.nasa.gov/bu2/inflateGDP.html . The 2005 price is the current NYMEX near month futures price as of this writing (17 October 2005).

[4] For a discussion of the investment and planning challenges facing the oil market, see International Energy Agency, *World Energy Outlook 2005*.

2.1 Futures Markets as Efficient Predictors

That said, we suggest that the best future projections of oil prices may be found in the oil market itself, rather than in any one model or analysis of the market. Due to the constant fluctuations of oil prices, both consumers and producers of oil have a need to be able to lock-in a future price of oil. In response to this need, markets have developed for oil to be delivered in the future at a price agreed upon today. The most well-known of these are the New York Mercantile Exchange (NYMEX) "Light Sweet Crude Oil" futures contract and the London-based ICE Futures Market (formerly International Petroleum Exchange or IPE) "Brent Crude" futures contract. Both of these contracts markets currently trade crude for delivery out as far as December 2012. Beyond these dates and these particular crudes, there are forward markets for oil and oil products operated by banks and other financial institutions.

The oil futures markets provide price quotes that are not just projections, they are real prices at which anyone can buy and sell oil. We would argue that futures and forward market prices, by their nature, should be the best predictions one can get of future oil market prices. Let's look at why this is so.

It seems reasonable to assume that participants in these markets as a group are sharp people, who are well-informed about what is happening in the market. They also have a strong incentive to use their knowledge and intelligence to its full advantage, since they are putting their money and wealth (or at least their career) on the line.

It also seems reasonable to assume that, in making their decisions, futures market participants make intelligent use of everything that is currently known about the future of the market. That includes the key insights that have come from all the model results and papers that have been published about the world oil market, and all the debates that are constantly raging in the media, at industry events, and in informal conversations, over the future of the oil market. Significantly, the information they take into account also includes all the commercially confidential information that participants may have about their own company's operations and those of their affiliates. The futures market is therefore in some respect a clearing house for all the questions that we would like to know the answers to, but that can't be answered due to a lack of data in the public domain.

This does not, of course, mean that futures market price quotes always turn out to be the correct price projections—far from it. Unexpected events are always happening in the oil market that will influence the price. Even the best forecast can be (and usually will be) wrong to some degree. What it does mean, however, is that the futures market reflects all known information and should not therefore be *systematically* wrong.

For example, if futures prices always tended on average to be too low, sharp market participants would notice this fact, and would start to take positions in the market that allowed them to profit from this systematic discrepancy. As the discrepancy became more widely known, more and more participants would take such positions, and the action of supply and demand would eliminate the discrepancy. We would, therefore, expect the futures market to be an unbiased predictor of oil prices. This ability of markets to capture all known information is known to economists as the "Efficient Markets Hypothesis".

Interestingly, the Efficient Markets Hypothesis also implies that no modeller should be able to routinely be better at forecasting oil prices than the futures market. After all, if there were a

modeller who could forecast future oil prices better than the futures market, sharp market participants would take positions where they could profit from the modeller's forecasting abilities. Supply and demand would soon eliminate the discrepancy between futures market prices and the model results.

The assertion that futures markets are efficient predictors is borne out empirically as well as theoretically.[5] We should, however, add an important caveat: although futures markets may be the best predictors of future oil prices that we have, the empirical evidence is that they are not very good predictors. This probably says more about the inherently unpredictable nature of oil markets than it does about the quality of the predictions.

2.2 A Preference Hierarchy for Projections

We would, therefore, propose the following preference hierarchy for projecting the future price of oil:

1. *What the futures markets are saying directly.* Although futures market prices are clearly the preferred method of projecting the price of oil, they have one serious limitation: they only provide price quotes out a few years, and do not provide data adequate for longer-term price forecasts. In principle, quotes from the forward markets for oil operated by banks and other financial institutions could fill this need. Unfortunately, price quotes in these markets are generally only available to clients of these institutions, and are not made public.
2. *What well-known industry analysts are saying.* These people and organizations make their projections known from time to time and we can use them. The public sector work of the International Energy Agency and the U.S. Energy Information Administration are probably the most respected of these. There are many private-sector analysts as well, generally with close ties to the industry. Normally, we in government should view what an analyst closely tied to an industry is saying with a healthy scepticism, based on suspicions of self-serving conclusions for his/her clients. In this case, however, close ties to the industry may be a good thing. This is because, for oil prices, the most self-serving conclusion is to get the forecast right—that is how your industry clients will make the most money. Admittedly, these analysts may be under some pressure to temper their results to agree with prevailing

[5] Manmohan S. Kumar, "The Forecasting Accuracy of Crude Oil Futures Prices", *IMF Staff Papers*, Vol. 39 (June, 1992), p. 432-461 showed that using end-of-month data for 1983 to 1990 forecasts using futures prices for delivery out to 10 months ahead not only invariably provide better predictions than a simple random walk model, but that they also generally outperformed certain much more sophisticated econometric and time series models. William J. Crowder and Anas Hamed, "A Cointegration Test for Oil Futures Market Unbiasedness", *Journal of the Futures Market*, v. 13, no. 8 (December, 1993), p. 933-941 tested the efficiency of the oil futures market from March 1983 to September 1990 and concluded that there was evidence supporting the hypothesis that futures prices were efficient predictors. Benjamin Miranda Tabak, "On the Information Content of Oil Future Prices", Working Paper Series n. 65 (February, 2003), Banco Central do Brasil looked at whether Brent futures prices out to three months were efficient and unbiased predictors of future spot prices. He concludes that futures prices are unbiased predictors of future spot prices, but that they have relatively low explanatory power, with the adjusted R2 not exceeding 0.2. Menzie D. Chinn, Michael LeBlanc and Oliver Coibion, "The Predictive Content of Energy Futures: An Update on Petroleum, Natural Gas, Heating Oil and Gasoline", NBER Working Paper 11033 (January, 2005), National Bureau of Economic Research could not reject the hypothesis that futures prices were an unbiased estimate of the future spot price and that futures prices are an unbiased predictor of observed spot prices, although futures prices explain only 5-10% of the variation in the spot price.

industry wisdom, but that, too, may actually be good. The prevailing industry wisdom is probably what the forward markets would be saying if there were publicly quoted markets. So the private-sector analysts, to some degree, provide an indirect view of what the market is saying.

3. *Our own understanding of the fundamentals of the market.* Oil is perhaps the most thoroughly studied market in the world. Virtually every aspect of the oil market is being constantly examined by some of the world's most well-regarded and well-funded organizations, both public and private. Rather than trying to compete by formulating our own detailed analysis, we will make best use of their results. It is, however, good to give our overall conclusions a reality check based on what we know about the market.

3 A Proposed Set of Price Assumptions

So let's look at these three sources of information and what they are telling us today.

3.1 Futures Markets

As noted in Section 2.1, there are two crude oil futures markets—NYMEX "light sweet" and IPE "Brent". NYMEX "light sweet" crude is deliverable at Cushing, Oklahoma, a major Midwestern U.S. oil pipeline hub. Several grades of crude may be delivered to satisfy the contract, including one known as "West Texas Intermediate" or "WTI".[6] Despite its name, West Texas Intermediate is considered a "light" crude. "Light" crudes are the easiest to refine into petrol and other high-value products, and therefore generally command the highest price. There is also an informal "spot" (or cash) market for WTI, whose price is quoted in the *Wall Street Journal* and in various industry reporting services. The published WTI spot price usually tracks within a few cents of the first month NYMEX "light sweet" crude price.[7] Because West Texas Intermediate is so closely tied to the NYMEX "light sweet" futures contract, the names are often used interchangeably in casual conversation.

Brent is a North Sea European crude that is also considered to be a "light" crude, but not as light as WTI. It has historically traded for about US$1 less per barrel than WTI.[8] Settlement rules for Brent futures are more complicated than for NYMEX, and not relevant to this paper.[9]

[6] See the NYMEX website http://www.nymex.com/CL_spec.aspx.

[7] See "Pricing Differences Among Various Types of Crude Oil" on the U.S. Energy Information Administration website at http://tonto.eia.doe.gov/ask/crude_types1.html.

[8] See "Pricing Differences Among Various Types of Crude Oil" on the U.S. Energy Information Administration website at http://tonto.eia.doe.gov/ask/crude_types1.html.

[9] See the IPE's website http://www.theipe.com/oil/brent_futures.asp.

We focus our attention here on the NYMEX "light sweet" futures market, rather than the Brent futures market, for three reasons:

1) The WTI spot price or the first month NYMEX contract price is "the price of oil" typically quoted in the news media, so it accords well with what most people think of as the oil price.

2) The NYMEX futures prices are publicly available on the NYMEX website[10] and in newspapers such as *The Wall Street Journal*.

3) The NYMEX prices match well with the average New Zealand oil import price, as the comparison in Table 1 below indicates:

Table 1: NZ Import Price vs. WTI Spot Price[11]

March Year	NZ Import Price (US$/barrel)	Average Daily WTI Spot Price (US$/barrel)
2001	30.23	30.34
2002	24.70	23.29
2003	28.71	29.18
2004	31.61	31.39
2005	44.59	45.07.

[10] See http://www.nymex.com/lsco_fut_cso.aspx.

[11] New Zealand import prices are from unpublished Ministry of Economic Development data graphed in Ministry of Economic Development, *New Zealand Energy Data File*, July 2005, Chart 1.9a, http://www.med.govt.nz/ers/en_stats/statistics/edf/200507/index.html; average daily WTI prices are from the U.S. Energy Information Administration website at http://tonto.eia.doe.gov/oog/ftparea/wogirs/xls/psw14.xls.

As of 24 November 2005 (New York time), the NYMEX futures prices per barrel were as shown in Table 2 below.

Table 2: NYMEX Futures Prices per Barrel

Date	Prices Nominal US$	Prices 2005 US$
January 2006	58.71	58.71
December 2006	60.41	59.22
December 2007	58.96	56.67
December 2008	57.11	53.82
December 2009	55.61	51.38
December 2010	54.53	49.39
December 2011	53.88	47.84
December 2012	53.58	46.64

The first column shows the prices in the nominal U.S. dollars in which the NYMEX oil futures are actually contracted. The second column shows these prices converted to real 2005 U.S. dollars, assuming 2% annual U.S. inflation (the assumption used by the International Energy Agency[12]). Since SADEM does everything in terms of real dollars, it is this second column that is of greatest interest to us. Overall, the futures market is telling us that it expects oil prices to decline over the next six years, but to still remain "high" by historical standards (compare to Figure 1).

Oil futures prices fluctuate constantly, reflecting the market's ever-changing expectations about the future supply and demand for oil. An inconvenient implication of basing our oil price assumptions on futures prices is that we may need to revise our oil price assumptions should the futures prices change significantly. However, such a revision would be appropriate, since it would indicate a significant shift in the market's expectations has taken place.

[12] See International Energy Agency, *World Energy Outlook 2005*, p. 64.

3.2 Industry Analysts

The best current source of comparative oil price projections by industry analysts is found in the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook 2005*,[13] shown in Table 3 below.

Table 3: Forecasts of World Oil Prices, 2010 – 2025

	(2003 U.S. dollars per barrel)			
Forecast	*2010*	*2015*	*2020*	*2025*
AEO 2004 (reference case)	*24.53*	*25.44*	*26.41*	*27.40*
AEO 2005				
Reference	*25.00*	*26.75*	*28.50*	*30.31*
High A world oil price	*33.99*	*34.24*	*36.74*	*39.24*
High B world oil price	*37.00*	*40.67*	*44.33*	*48.00*
October oil futures	*30.99*	*32.33*	*33.67*	*35.00*
Low world oil price	*20.99*	*20.99*	*20.99*	*20.99*
G11	*27.08*	*25.58*	*26.66*	*27.12*
IEA (reference scenario)	*23.25*	*25.37*	*27.48*	*29.07*
IEA (high oil price case)	*37.00*	*37.00*	*37.00*	*37.00*
Alton	*21.92*	*22.67*	*23.93*	*24.60*
PEL	*25.00*	*27.00*	*27.00*	*29.00*
PIRA	*34.75*	*39.15*	*NA*	*NA*
DB	*24.00*	*24.00*	*24.00*	*24.00*
EEA	*26.58*	*25.55*	*24.93*	*NA*
SEER	*26.13*	*28.40*	*28.25*	*29.00*
EVA	*28.99*	*28.39*	*30.97*	*34.77*

NA = not available

AEO 2005' refers to the U.S. Energy Information Administration's own forecasts, as published in the *Annual Energy Outlook 2005*. 'AEO 2004' refers to the *Annual Energy Outlook 2004*. The IEA is the International Energy Agency. The remaining forecasts[14] are from industry consulting firms, with the exception of DB, which is Deutsche Bank.

The most noticeable feature of all of these projections is that, without exception, they predict that prices out to 2025 will be lower than current prices. In fact, their 2010 prices are substantially lower than the NYMEX futures prices quoted above. There are at least two possible explanations for this discrepancy. First, as the EIA notes, not all of these forecasts are for the same type of crude oil. The EIA notes that

> "In some projections, the measure is the spot price for WTI, Brent, or a basket of crude oils. AEO 2005 uses the annual average U.S. refiner's acquisition cost of

[13] February, 2005, p. 114, http://tonto.eia.doe.gov/FTPROOT/forecasting/0383(2005).pdf .

[14] GII = Global Insight, Inc., Altos = Altos Partners, PEL = Petroleum Economics, Ltd., PIRA = Petroleum Industry Research Associates, Inc., EEA = Energy and Environmental Analysis, Inc., SEER = Strategic Energy & Economic Research, Inc., EVA = Energy Ventures Analysis, Inc.

> imported crude oil, including transportation and fees. There is no simple way to put the forecasts for oil prices on a common basis."[15]

Earlier in the volume they explain that:

> "World oil prices in AEO 2005 are defined on the basis of 'average refiner acquisition cost' of imported oil to the United States (IRAC). The IRAC price tends to be a few dollars less than the widely cited West Texas Intermediate (WTI) spot price, and in recent months it has been as much as 6 dollars a barrel lower than the WTI."[16]

Second, EIA gives no indication as to how old these forecasts are, but they were certainly at least several months old when they were published in the Annual Energy Outlook 2005 in February 2005, and probably older. Some of these projections may not have been updated to reflect the 2004 and early 2005 crude oil price increases. Nevertheless, some of these projections may actually reflect their author's belief that the NYMEX futures prices are too high. This is likely to be the case for the analysts who believe current oil prices will lead to reduced demand and increased oil supply. In any case, it is clear that the analysts believe prices are going to be lower than today's prices out to 2025, generally in the US$25-US$40 per barrel range.

[15] U.S. Energy Information Administration, *Annual Energy Outlook 2005*, p. 114, http://tonto.eia.doe.gov/FTPROOT/forecasting/0383(2005).pdf .

[16] U.S. Energy Information Administration, *Annual Energy Outlook 2005*, p. 114, http://tonto.eia.doe.gov/FTPROOT/forecasting/0383(2005).pdf, p. 40.

More recently, the International Energy Agency has released the *World Energy Outlook 2005*, which contains a new set of oil price projections significantly higher than those shown in Table 3 above. These are shown in Table 4 below.

Table 4:IEA World Energy Outlook 2005 Oil Price Assumptions[17]

Scenario	Currency	2010	2020	2030
Reference	Real 2004 US$	35	37	39
	Nominal US$	40	50	65
Deferred Investment	Real 2004 US$	41	46	52
	Nominal US$	47	63	86
Alternative Policy	Real 2004 US$	29	31	33

The "Reference Scenario" assumes governments stick with current policies and that the substantial investments required of the oil exporting countries of the Middle East and North Africa are, in fact, made.[18] The "Deferred Investment Scenario" assumes a 23% drop in cumulative upstream oil investment by the exporting countries of the Middle East and North Africa over the period 2004-2030 compared to the Reference Scenario. The result is a drop in oil production by about one-third compared to the Reference Scenario, and correspondingly higher prices.[19] The Alternative Policy Scenario assumes that consuming countries take aggressive action to reduce their oil demand by 10% in 2030 compared to the Reference Scenario.

The prices shown in Table 4 are average IEA crude oil import prices. The IEA notes that

> "Prices of the major benchmark crude oils, West Texas Intermediate and Brent, will be correspondingly higher. In 2004, the average IEA crude oil import price was $5.11 per barrel lower than first-month WTI and $1.89 lower than dated Brent."[20]

Overall, we conclude that although the IEA has revised their price projections upward, they still foresee future prices lower than those prevailing today, probably below US$45 per barrel for WTI in 2030.

This is also perhaps an appropriate place to note that the October, 2005 edition of *Australian Energy: National and State Projections to 2029-2030* (the Australian publication comparable

[17] All prices from International Energy Agency, *World Energy Outlook 2005*. Reference case prices from Table 1.1, p.64. Deferred Investment case prices from Table 7.2, p. 235. The publication does not specifically provide prices for the Alternative Policy Scenario. The prices shown are inferred from the text on p. 275 which states "The oil price [in 2030] averages $33 per barrel in the Alternative Policy Scenario. This is $6, or 15%, *lower* than in the Reference Scenario, because lower demand depresses prices."

[18] See International Energy Agency, *World Energy Outlook 2005*, p. 43-44.

[19] See International Energy Agency, *World Energy Outlook 2005*, p. 48.

[20] See International Energy Agency, *World Energy Outlook 2005*, p. 64.

to *New Zealand Energy Outlook*) uses a reference oil price path that declines to US$34/barrel by 2009-2010 and continues to decline to US$24.80/barrel by 2029-2030.[21]

There is a minority of industry analysts who have a very different perspective on the future of the oil market. In their view, oil resources are being rapidly depleted, with current production levels already at or near their ultimate peak levels. Hence, this perspective tends to be referred to as the "Peak Oil" perspective. Probably the two most visible spokespeople for the Peak Oil perspective are Colin J. Campbell, founder of the Association for the Study of Peak Oil and Gas (ASPO)[22], and Matthew R. Simmons, investment banker and author of a recent book that has attracted widespread attention[23]. Those who hold the Peak Oil perspective foresee a future of much higher oil prices, potentially leading to a serious economic crisis. Because the Peak Oil perspective on future oil prices is so different from what might be labelled as the "mainstream" perspective, and is essentially irreconcilable with it, we propose to handle Peak Oil as a separate case, discussed in Section 4 below.

[21] See Muhammad Akmal and Damien Riwoe, *Australian Energy: National and State Projections to 2029-30*, abare eReport 05.9, Australian Bureau of Agricultural and Resource Economics, October, 2005, Table 8, http://www.abareconomics.com/publications/energy/2005/e-reports/eR05_10_energy.pdf. Prices quoted are in 2003-2004 US dollars.

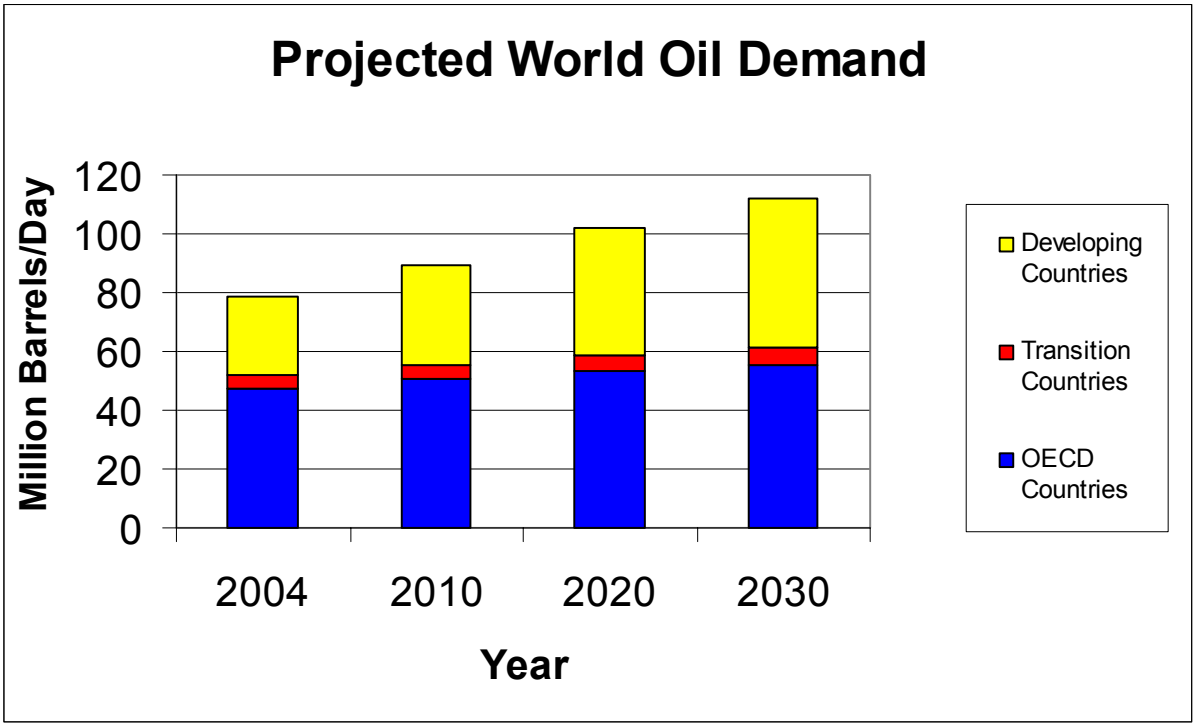
[22] See the ASPO website, www.peakoil.net.

[23] Mathew R. Simmons, *Twilight in the Desert; The Coming Saudi Oil Shock and the World Economy*, John Wiley & Sons, 2005.

3.3 Our Own Understanding of the Market Fundamentals

As a reality check, it is useful to briefly look at the fundamentals of the oil market in order to understand the basic forces that are driving today's prices. According to the IEA[24], world demand for oil is expected to grow steadily over the next 25 years, from 82 million barrels per day in 2004 to around 115 million barrels per day by 2030. Developing and 'Transition' (that is, the former Soviet Union and its former allies) countries will account for about three-quarters of the growth in demand. Consumption growth rates in these countries are expected to be about 2.3% annually, compared to 0.6% annually in the industrialized countries of the OECD. China's demand growth is expected to be especially rapid, averaging 2.9% annually. See Figure 2.

Figure 2[25]



Most of this growth is driven by growth in transport demand. On a worldwide basis, transport accounted for 47% of primary oil consumption in 2002[26], and will account for two-thirds of the incremental growth in oil demand to 2030.[27] Oil has a unique position in transport, since there are generally no economic substitutes available for liquid fuels in road vehicle, aircraft, or watercraft applications, and consequently 95% of the energy used for transport worldwide comes from oil.[28] Given the lack of substitutes, most of this demand for oil is quite price-

[24] International Energy Agency, *World Energy Outlook 2005*, Table 2.2, p. 83.

[25] Data taken from International Energy Agency, *World Energy Outlook 2005*, Table 2.2, p. 83.

[26] International Energy Agency, *World Energy Outlook 2004*, p. 84-85.

[27] International Energy Agency, *World Energy Outlook 2005*, p. 81.

[28] International Energy Agency, *World Energy Outlook 2004*, Paris, p. 84.

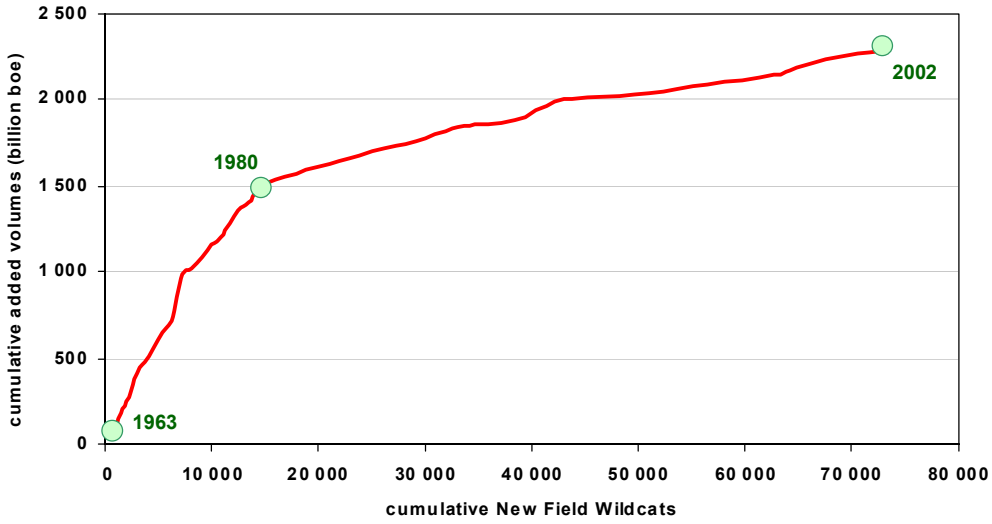
insensitive. The same can be said for vehicular agricultural and construction equipment, which accounts for much of the non-transport oil demand.

So the big question is, can this demand be met at a reasonable price? The only "hard" figures we have to work with on the supply side are historical rates of production and statistics on reserves. Reserve statistics, even if they were accurate and uniformly measured (which they are not), are of very limited use. Reserves represent resources that have already been developed enough to measure their extent. That development requires investment. No one should rationally make this investment before they have to. That is why reserves typically represent only a relatively small number of future years' production.

As Figure 3 shows, the number of large new field discoveries declined after 1980, meaning that if this projected demand growth is to be met, it must come from lots of small new discoveries, enhanced recovery from existing fields, unconventional oil (such as oil sands, shale oil, and extra-heavy oil), or synthetic oil. The cost of any of these today seems likely to be higher than the historical norms for the price of oil, although new technology will certainly lower today's costs. A related cause for concern is that the oil exporting countries may be unable or unwilling to invest the large sums required to develop their resources.[29]

Figure 3

Cumulative Oil Discoveries and New Wildcat Wells Drilled[30]

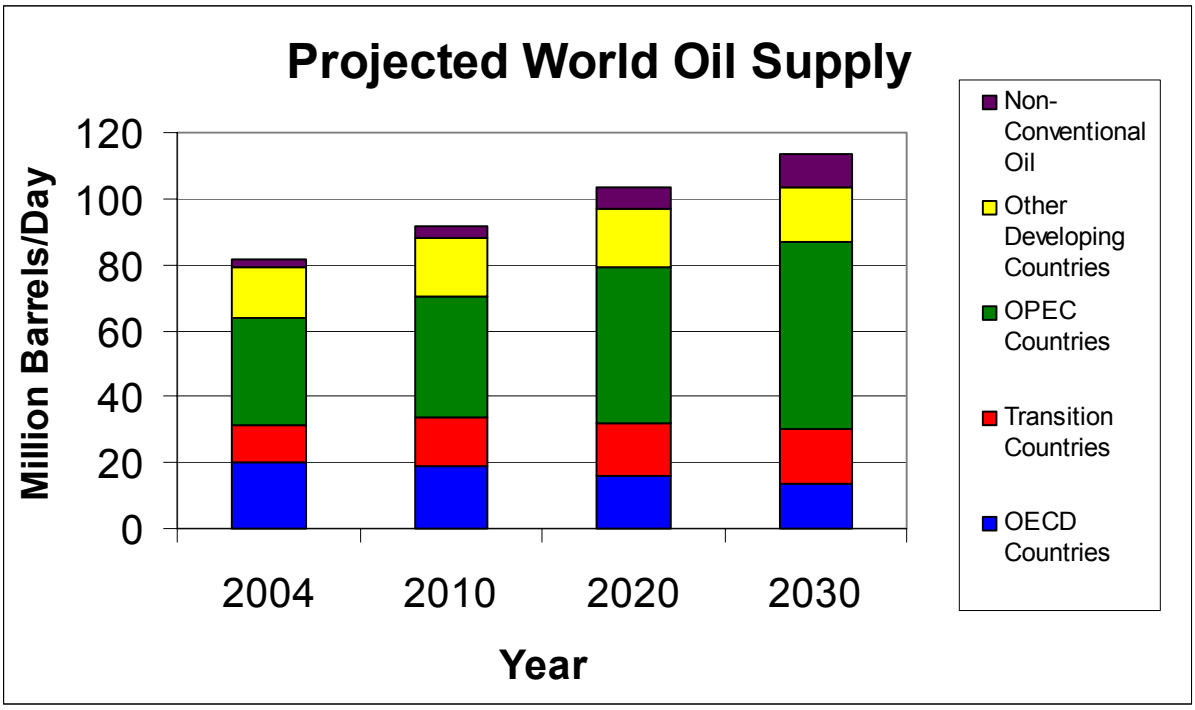


[29] The uncertainties surrounding future levels of investment in Middle East and North African oil production is a major theme of International Energy Agency, *World Energy Outlook 2005*. See especially pp. 94-95.

[30] From International Energy Agency, *World Energy Outlook 2004*, Paris, Figure 3.16, p. 99.

At the same time, as noted above, the world is likely to become increasingly dependent upon OPEC countries for oil, since the Middle East is the one part of the world where low-cost resources remain abundant. As shown in Figure 4, the IEA projects that the OPEC countries' share of world oil production will rise from 39% in 2004 to 50% by 2030. This suggests to us that the pricing power of OPEC countries is likely to increase, resulting in an increasing ability of these countries to hold oil prices above "competitive" levels.

Figure 4[31]



This combination of growing demand, tight supply, and growing OPEC pricing power suggests to us that prices are likely to remain "high" by historical standards over the next 25 years, although not necessarily higher than they are today. At the risk of assigning a dollar figure, we would look for prices to remain in the US$40-$60/barrel range.

[31] Data taken from International Energy Agency, *World Energy Outlook 2005*, Table 2.4, p. 90.

4 Recommended Assumptions

In light of the above discussion, what oil price assumptions should we use in the next edition of the New Zealand Energy Outlook? Recall that we suggested that our general preference for projecting the world oil market should be based on what the futures markets are saying directly, what well-known industry analysts are saying, and one's own analysis of the market, in that order.

Certainly, for the year 2010, we should pick a base case price equal to the current NYMEX futures price of around US$60/barrel. Alas, there are no NYMEX futures markets for later periods, so we must look to the analysts' forecasts. These, it will be recalled are generally in the range of US$25-40/barrel in 2025. Given our own analysis of the fundamentals of the market, as well as the possibility that at least some of these forecasts are for grades of oil that trade at a lower price than the West Texas Intermediate deliverable under the NYMEX contract, or that some of the forecasts may be outdated, we would propose to lean toward the high end of this range. Therefore, we would propose that the oil price declines after 2010 to US$40 per barrel in 2015 and then remains flat to 2025 in the base case.

We should also select one or two alternative cases. In a normal modelling exercise, one would generally choose a low price case and a high price case. However, while low prices would certainly benefit consumers, they would not yield results in SADEM very different from the base case. The difference between, say, US$25/barrel and US$40/barrel amounts to only about a NZ$0.13/litre reduction in the price of motor fuel in New Zealand[32], which is not enough to impact demand in the transport sector significantly.

Therefore, we would propose only one alternative oil price case: a "high" oil price case. The lack of a low-price case should not be interpreted as a dismissal of the prospects for prices lower than our base case, which is, after all, still quite high by historical standards. Lower prices than the base case are certainly also a potential outcome.

For our "high" oil price case, we would look at the impact that an early peak in conventional oil production might have on energy demand. We propose assuming that conventional oil production peaks in 2008, the current prediction of Colin Campbell of the Association for the Study of Peak Oil and Gas.[33]

Specifically, we propose assuming in the high price case that oil prices continue to rise steadily to average US$80 per barrel in 2008, before jumping after the peak to US$100 per barrel in 2009, and then US$120 per barrel in 2010 at which level it would stay until 2015. After 2015, it declines steadily to US$75 per barrel in 2020, remaining at that level for the rest of the outlook period. Note that we are assuming that only *conventional* oil production peaks in 2008. This case is, therefore, not consistent with the more extreme versions of the peak oil perspective, which would have all oil production peaking in the next few years. This

[32] There are 159 litres/barrel and the New Zealand dollar is currently worth about US$.70. So as a rule of thumb, a US$1/barrel = US$1/barrel / (159 litres/barrel x US$.70/NZ$) = NZ$.0090/litre.

[33] See Uppsala Hydrocarbon Depletion Study Group, "Oil and Gas Liquids 2004 Scenario", Updated by Colin J. Campbell, 2004-05-15, http://www.peakoil.net/uhdsg/Default.htm.

is highly speculative of course, but the argument for the decline after 2015 is that, given adequate lead times for R&D and investment, there should be opportunities to produce alternative liquid fuels for US$75/barrel.[34]

These price levels are sufficiently high to have a significant impact on demand, and will therefore produce results significantly different from the base case. In fact, we have some concerns that these prices may be beyond the capabilities of our models to analyze accurately, since sustained prices at this level will have effects on the broader economy not reflected in SADEM. However, we will recognize the limitations of our models and present a qualitative discussion of their effects.

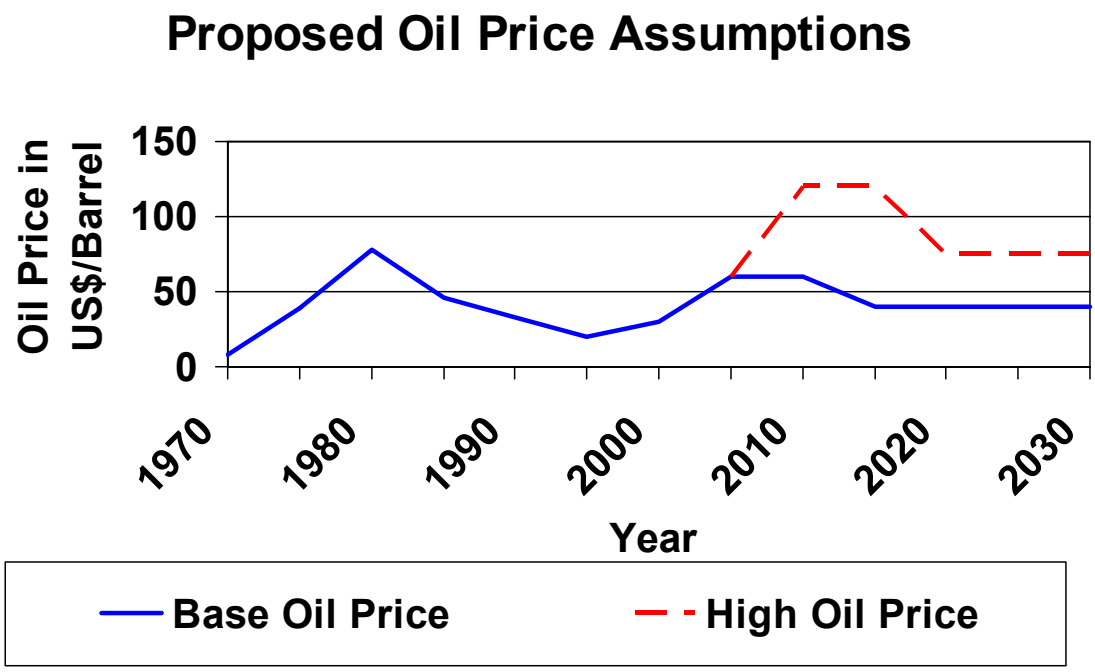
The rationale behind the shape of the high oil price case price path is that it is similar to that which has already played out in the oil industry in the 1970's and 1980's (see Figure 1). Sustained high oil prices would act to reduce demand, while supply from conventional and non-conventional sources would be boosted by the new high oil price environment. From the first oil spike in 1974, it took twelve years before the market returned to prices closer to earlier levels on an inflation-adjusted basis. This case mimics this timeframe if we take 2003 as the beginning of the current high price era.

[34] For a quite thorough discussion of likely long-term unconventional oil production costs see H-H. Rogner, "An Assessment of World Hydrocarbon Resources", *Annual Review of Energy and the Environment*, vol. 22 (1997), pp. 217-262. See especially p. 251.

5 Conclusions

In Section 2, we proposed a preference hierarchy of methods for projecting future oil prices. Oil futures markets are at the top of the hierarchy, since we argued that they are theoretically and empirically the best predictors. Projections of industry analysts and our own projections make up the remainder of the hierarchy. In Section 3, we looked at what each of these methods is currently saying about future oil prices. The NYMEX oil futures market is currently predicting that prices around US$60 per barrel will be maintained out to 2011. Unfortunately, price quotes beyond 2011 are not available. Industry analysts are projecting long-term oil prices in the US$25-40 range, however, these projections may be outdated at this point, and may be for cheaper crudes than the widely-quoted West Texas Intermediate deliverable under the NYMEX contract. Finally, our own analysis suggests that prices will remain "high" by historic standards, although not necessarily higher than today's prices.

Figure 5



In Section 4, we proposed a set of price assumptions for use in the next Energy Outlook. These price assumptions, along with historical prices since 1970, are shown in Figure 5 above. The base case assumes the NYMEX price of around US$60/barrel in 2010 and 2015, dropping to the high end of the industry analysts' projections of US$40/barrel in later years. The high price case assumes a spike to US$120/barrel in 2010 and 2015, reflecting a peak in conventional oil production in 2008, followed by a decline to a still historically high US$75/barrel in later years.