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Ireland's Oil Dependence: Trends, Prospects & Options

Prepared for

Forfás

by Amárach Consulting & Dr. Robert Hirsch

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About the Authors

Amárach Consulting specializes in strategic research and forecasting. Its group of companies has a total of 50 executive and support staff in Ireland and the UK. Amárach has pioneered research into energy issues in Ireland, having conducted a number of studies and surveys relating to business and household energy use and preferences. Amárach's directors have spoken and written regularly on energy and oil issues at conferences and senior management briefings for clients, as well as publishing articles and reports relating to Ireland's energy situation and prospects.

Dr. Robert Hirsch is a Senior Energy Program Advisor at SAIC and a consultant in energy, technology, and management. Previously, he was a senior staff member at RAND, where he did energy policy analysis. He has managed technology programs in oil and natural gas exploration and production, petroleum refining, synthetic fuels, fusion, fission, renewables, defense technologies, chemical analysis, and basic research. He is immediate past Chairman of the Board on Energy and Environmental Systems of the National Research Council, the operating arm of the National Academies. In 2005, he co-authored a report on 'Peaking of World Oil Production: Impacts, Mitigation and Risk Management' for the US Department of Energy.

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Introduction

There is a growing level of evidence to suggest that as the era of a plentiful supply of cheap oil approaches an end, geologists agree that at some future date, conventional oil supply will no longer be capable of satisfying world demand. At this point world conventional oil production will have peaked and begin to decline. Though this subject is very much clouded by a low level and quality of accurate and credible data, there is near global consensus that the potential consequences of peak oil for governments, economies, businesses and indeed individual consumers must be now be considered.

Although we have only recently begun to see the trickledown impact of rising oil prices, in that fuel costs have more than doubled over the past two years, prompting the International Energy Agency to publish a report last year 'Saving Oil in a Hurry,' interest in the subject of peak oil is not a new phenomenon. Industry experts, analysts and indeed those who work 'on the ground' have long been aware of the possibility of peak oil and as such, reports in this area date back to the previous decade. There has however been an explosion in interest and citations in the public domain that now refer to the term 'peak oil.'

Whilst the timing of peak oil is widely debated, the potential problems are not, in that as peaking is approached, liquid fuel prices and price volatility will increase dramatically, and governments, businesses and economies at large, will face unprecedented economic and social change. Indeed, the rapid rise in world oil prices over the past twelve months could well appear modest in comparison to the price escalations and oil shortages that are likely to accompany the peaking of world conventional oil production. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact on a world scale, they must be initiated more than a decade in advance of peaking; "Reliable, secure and competitively priced energy supply is a vital ingredient in the competitiveness of industry and long term economic development" (National Competitiveness Council, ACR 2004). It is against this backdrop that Forfás has decided to undertake a baseline study on oil dependence in Ireland

Amárach Consulting in conjunction with its international research partner, Dr. Robert L. Hirsch, were commissioned to carry out the research.

Objectives

The overall objective of this study is to assess Ireland's reliance on a single volatile resource as a key input into the Irish economy. In tackling what is possibly an unprecedented risk management problem, the challenge from the outset is three-fold; to ensure that a common level of understanding exists around the area of peak oil and to recognise that at some point, mitigation strategies must be considered. Secondly to assess what implications peak oil potentially holds for the Irish economy and finally to identify the correct approaches which could be adopted in a timely and effective manner.

The key objectives are thus to:

- Review the literature on energy both globally and in Ireland in terms of trends, issues and indicators, oil peaking forecasts, developed energy scenarios, security of supply and renewable energy sources.
- Profile the Irish oil market in terms of suppliers, both domestic and multinational.
- Analyse current energy requirements of the electricity, transport and enterprise sector in terms of electricity requirements and the use of oil as a direct (e.g. as a raw material) and indirect input, in terms of their reliance on oil both directly and indirectly.
- Identify the major existing sectors of the Irish economy at risk in the event of an oil peak.
- Identify emerging sectors in the Irish economy that may also be at risk.

- Examine Ireland's vulnerability in the event of an oil shock / oil peak (using a number of oil price / availability scenarios to 2030) relative to other countries and the impact on Ireland's overall competitiveness.
- Identify existing polices that may need to be reviewed in light of the findings of this particular study
- Make policy recommendations to ensure that Ireland's competitiveness is maintained and strengthened in terms of its reliance on oil.

Research Methodology

The work programme involved a combination of approaches all of which aimed to address the aforementioned research objectives, comprising:

Literature Review: A national and international review of contemporary reports, trends and views on both global and Irish dependence of oil

In-depth Interviews with Industry Experts: A consultation process was undertaken with a diverse and representative range of experts both in Ireland, Europe and the United States

Data Analysis: Amárach and their research partner analysed data collected during the research phase to input into various scenario modeling techniques.

Workshops: Amárach Consulting and Forfás hosted two workshops designed to undertake a practical process with a diverse audience aimed at discussing the findings of the research to date and the implications this holds for policy options Ireland faces.

Report Layout

This report is divided into the following sections:

Chapter 1 presents a review of the national and international literature on the subject of Peak oil

Chapter 2 examines in detail Ireland's oil requirements

Chapter 3 identifies sectors of the Irish economy at risk from an oil peak

Chapter 4 sets out mitigation scenarios in the event of a Peak oil induced shock at global level

Chapter 5 assesses policy options and recommendations to ensure Ireland's competitiveness is maintained.

The appendices list those who were interviewed as part of this study or who participated in one or more workshops. The authors wish to stress that the opinions and views set out in the following document are not necessarily those of the interviewees nor of the participants in the workshops.

Executive Summary

There is a growing level of evidence to suggest that as the era of a plentiful supply of cheap oil approaches an end, geologists agree that at some future date, conventional oil supply will no longer be capable of satisfying world demand. At this point world conventional oil production will have peaked and begin to decline. Though this subject is very much clouded by a low level and quality of accurate and credible data, there is near global consensus that the potential consequences of peak oil for governments, economies, businesses and indeed individual consumers must be now be considered.

In the context of a global dependence on conventional oil, this study carries the overall objective of assessing Ireland's reliance on a single volatile resource as a key input into the Irish economy.

The study therefore seeks to provide an overview of current literature on the topic of peak oil, with the intention of feeding into a more focused analysis of Ireland's oil industry and the implications for various sectors of the economy in light of peak oil and Ireland's current and future energy requirement. An analysis of possible scenarios in light of peak oil is undertaken as is a review of current energy policy in Ireland and what implications this holds for our recommendations in view of the above objectives.

'Peak oil' refers to the forecast that global oil output will eventually peak and then fall at some point in the next number of years – or decades. The timing of the peak in oil output is difficult to forecast due to uncertainties about the likely output of existing oil fields in the future, as well as about the expected output of new oilfields. As such, there is a wide range of forecasts for the timing of peak oil, from forecasts that the global peak will occur before 2010 to others that put the peak out beyond 2030.

Our analyses of the timing of peak oil suggest that there is a probability greater than 50% that the peak will occur sometime in the next 15 years. We consider this probability to be sufficiently high to warrant preventative measures in Ireland to mitigate some, though probably not all, of the consequences of the onset of a permanent shortage of global oil supplies relative to the amount required to support sustained economic growth.

Ireland has grown increasingly dependent on oil to fuel its economic growth – with consumption per capita rising by more than 50% in the past 15 years. Some of this higher level of dependence is inevitable given the island nature of our economy. Some, however, is a matter of choice, and generally Ireland has chosen to adopt patterns of energy usage that are oil intensive, such as transportation and electricity production.

Continued economic growth in Ireland is expected to give rise to further increases in the absolute levels of oil requirements, even as the relative importance of oil to output continues to decline. Though the wider economic impact of oil price rises are well known, it is less clear just how a potential oil shock of the magnitude and duration of peak oil would actually affect different sectors of the economy.

In the case of the services sector, oil consumption has remained relatively unchanged in volume terms over the past fifteen years, and has fallen substantially as a share of total fuel usage – giving way to gas and electricity. The direct impact of peak oil on the services sector will therefore be quite limited – though the indirect impacts (through the wider economic consequences) will be more significant. Similarly, the manufacturing sector has only limited direct exposure to oil – and it is the indirect effects that will be more important in the future

The residential sector primarily uses oil for space heating (approximately half of all adults have this requirement), as well of course for transportation, and the agricultural sector uses oil directly in relation to operating tractors and self-propelled machinery, as well as for transportation. The indirect use of oil via sub-contractors is a larger contributor to oil consumption in relation to agriculture.

Ireland is especially vulnerable to the consequences of a peak oil induced shock to the world economy. The timing of mitigation strategies is critical – on a global scale, it is likely that it will take 20 years before the onset of peak oil to put in place adequate measures, practices and technologies to fully offset the consequences of a permanent oil supply shortfall. Leaving the onset of mitigation strategies until peak oil is imminent or has occurred will inevitably lead to a gap in energy availability relative to the requirements of a growing economy and population.

In the short term, Ireland can initiate measures to reduce oil consumption in transportation relatively quickly – and with the likely support of commuters for some, though by no means all of the measures.

A number of recommendations have been made in relation to energy, transportation, telecommunications and competitiveness policies designed to mitigate the impact of peak oil in the next 10-20 years.

Energy policy recommendations include the negotiation of long-term contingency supply contracts that provide an agreed volume of oil for Ireland's economy in the event of a global shortage, priced at premium as necessary to guarantee delivery. Support the development of non-fossil fuel electricity generation, with back up generation capacity in reserve, through a combination of renewables and nuclear power.

The latter is best developed jointly with the UK, and we would recommend 'purchasing' a nuclear power station due for de-commissioning by the UK in the next 5 years, giving Ireland security of generation, coupled with an interconnector between the power station and Ireland.

Fast track the adoption of the Energy Performance Building Directive to maximize the energy savings benefits in terms of electricity and oil for space

Transportation recommendations include the adoption of more radical tax incentives to encourage hybrid car purchases (along the lines of the 'scrappage scheme') sufficient to facilitate their widespread adoption as replacement cars, phasing out the incentives as new public transport facilities come on stream

Accelerate, where possible, those elements of the Transport 21 investment programme relating to public transportation – even if it delays some of the road related initiatives. Also it is recommended to only use congestion charges and other incentives to discourage private car usage as adequate public transport facilities come on stream.

Support employers to encourage staff to adopt teleworking practices. The main network providers – eircom, Vodafone and O2 – should also be supported to develop more pervasive and more robust networks on a nationwide basis, sufficient to meet a rapid increase in traffic in the event of a short term adjustment to peak oil.

Setting clear, public domain goals for delivering security of electricity supply in the next five years and supporting those operators who can provide a reliable and competitively priced supply of electricity to business users have also been recommended.

Glossary of Terms

GB	Giga barrel, or thousand million barrels, or one billion barrels
Mb/d	Million barrels per day, also referred to as MMBD and MBD
b/d	Barrels per day, also known as bbl/d
boe/d	Barrels of oil equivalents per day
APEC	Asia Pacific Economic Cooperation
Depletion	The decline in oil reserves in a given year due to production.
Depletion rate	The rate at which reserves are declining in a given year
EPBD	Energy Performance Building Directive
IFSC	Irish Financial Services Centre
IOC	International Oil Companies
OPEC	Organisation of Petroleum Exporting Countries
OECD	Organisations for Economic Co-operation and Development
CSIS	Center for Strategic & International Studies
MENA	Middle East & North African countries
NOC	Nationalised Oil Companies
EIA	Energy Information Administration
IEA	International Energy Agency

1. Peak Oil

Summary of Chapter 1

'Peak oil' refers to the forecast that global oil output will eventually peak and then fall at some point in the next number of years – or decades. The timing of the peak in oil output is difficult to forecast due to uncertainties about the likely output of existing oil fields in the future, as well as about the expected output of new oilfields (and of non-conventional oil sources such as oil sands).

There is a wide range of forecasts for the timing of peak oil, from forecasts that the global peak will occur before 2010 to others that put the peak out beyond 2030. There is an emerging consensus that non-OPEC oil output will peak around 2010, but considerably less consensus about the timing of the peak in OPEC's output. Most of the differences in relation to the timing of peak oil therefore relate to differences in assumptions about the future production capabilities (and preferences) of OPEC.

Nevertheless, there is clear consensus that sustaining continued growth in the world's economy – particularly in China and India – will require a growing supply of oil due mainly to rising demand for private transport (i.e.: cars). In an 'unconstrained' scenario, world demand for oil is expected to grow from an average daily requirement for under 85 million barrels per day in 2005 to over 115 million barrels per day in 2030.

Economic growth and oil consumption remain inextricably linked at a global level. It follows that any reduction in the global supply of oil will reduce global economic output, due especially to sharply rising oil prices and the resultant fall in disposable income.

Our analyses of the timing of peak oil suggest that there is a 50% probability that the peak will occur sometime in the next 15 years. We consider this probability to be sufficiently high to warrant preventative measures in Ireland to mitigate some, though probably not all, of the consequences of the onset of a permanent shortage of global oil supplies relative to the amount required to support sustained economic growth.

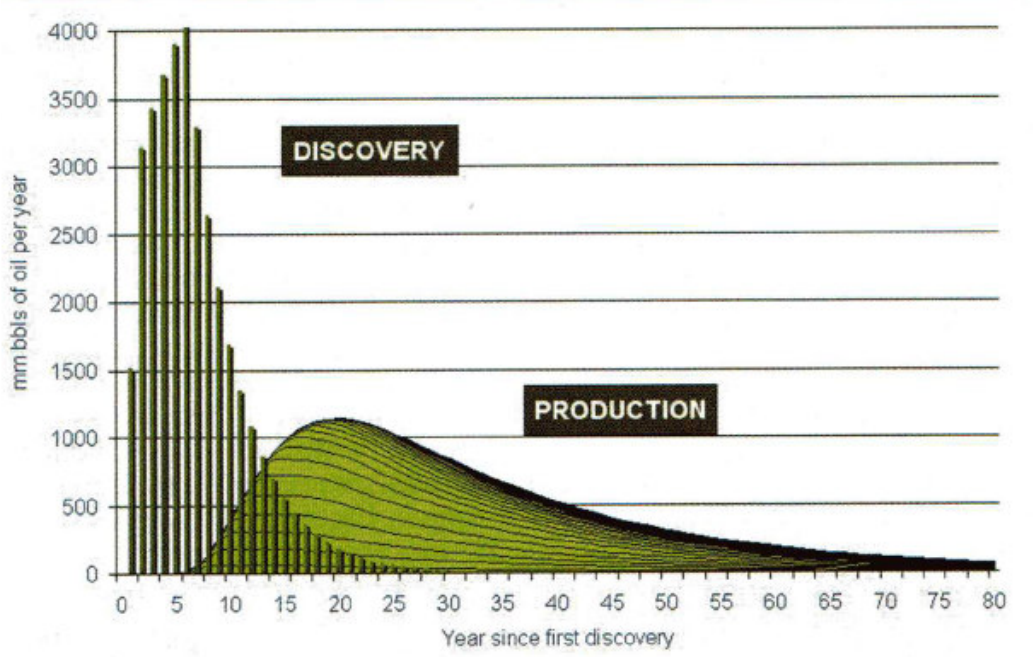
An Introduction to Peak Oil

There is nothing new about the concept that oil production in a given well or field or region eventually peaks and then goes into decline. Such as been the experience of oil producers since the commercial production of oil began in the 19th century. More recent, however, has been the awareness that production can peak at a country level, and the extrapolation from this that a global peak in production is inevitable.

One of the pioneers of peak oil analyses was an American geologist, M. King Hubbert. Hubbert examined the cumulative data for oil production in the Lower 48 states of the United States of America during the 1950s, and concluded that America's production would peak around 1970 – which it did. Hubbert posited the basic premise that oil is a finite resource in any geographical location, so some time after discoveries in a location have peaked there will inevitably follow (at a lag) a peaking in the production of the previously discovered oil.

Geologists stress that when oil production peaks it does not mean that the oil has 'run out'. Rather, peaking refers to an oil field's maximum oil production rate, which typically occurs after roughly half of the recoverable oil in the field has been produced. The peak in the production rate usually occurs due to falling pressures in the wells as more and more oil is extracted – after which the injection of water or CO2 can be used to maintain pressure and thereby slow down the decline in production that occurs after the rate peak. An illustrative example of the link between discovery and production is shown below in Figure 1 and highlights the lag between peak production and peak discovery.

Figure 1: The lagged link between Discovery & Production Peaks



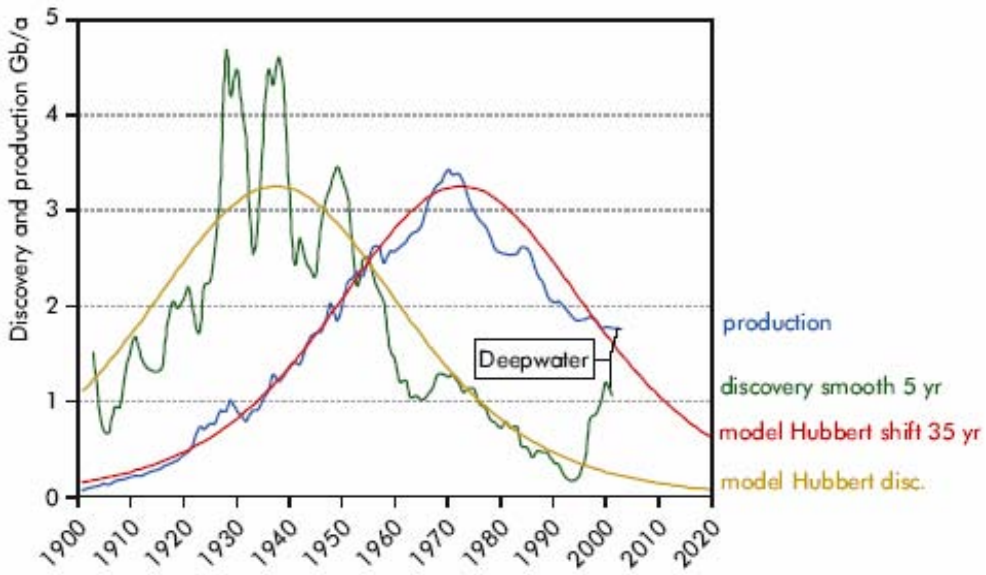
Source: Putting Paid to Unrealistic Demand Projections, Dr. Michael R. Smith, Petroleum Review, October 2005

Peak oil – in a global context – describes a situation in which the rate of world oil production reaches a point where it can no longer increase any further, giving way to a declining level of production for some time afterwards (the 'long tail' after the peak in Figure 1). Here it is also important to clarify the difference between reserves (the amount of oil 'in the ground') and production (the amount produced at any one time). An oil field can have large estimated reserves, but if the field is past its maximum production, the remaining reserves will be produced at a declining rate. It is also important to note also that new reserves can be discovered after the production peak in a given field, region or country, but as they are almost always smaller discoveries than the main ones made at the outset, then by definition their eventual production cannot offset the declining output from the earlier discoveries once production has peaked.

In a recent study – 'Resources to Reserves'[1] – the International Energy Agency (IEA) illustrated Hubbert's concept of discovery and (lagged) production curves using trends in annual discoveries and production for the USA Lower 48 States, illustrated below in Figure 2:

[1] Resources to Reserves - Oil & Gas Technologies for the Energy Markets of the Future, IEA, September 2005.

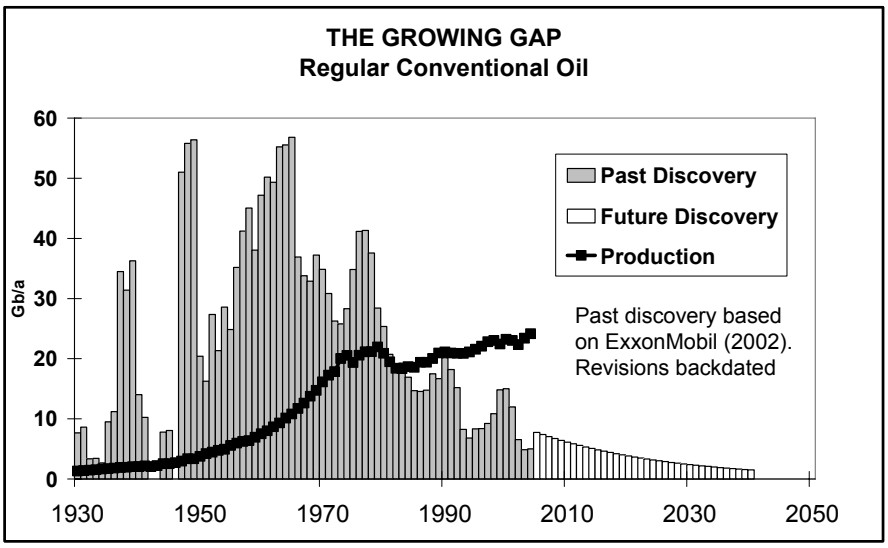
Figure 2: America's Peak – Hubbert's Model applied to the Lower 48 States



Here we see the peak in discoveries in the 1930s leading to a peak in production in the 1970s. The logical extrapolation by many geologists arising from Hubbert's model (and from similar analyses by others – see bibliography) is that global production must shortly reach its own peak due to the global peak in discoveries during the 1960s and 1970s. Note, however, that real discovery and production peaks are rarely as smooth as implied by Hubbert's model, even in the case of the Lower 48 States – which has lead some forecasters to use alternative methodologies, such as field-by-field estimates of current and potential output built up to provide a complete world model of output.

At a global level we can observe a similar peak in world oil discoveries in the 1960s. Figure 3 below overlays the trend in world production on that for discoveries (past and extrapolated future). Those concerned about peak oil propose that a similar 'double hump' picture to that in the in USA above will emerge at a global level. With global production peaking in the relatively near future.

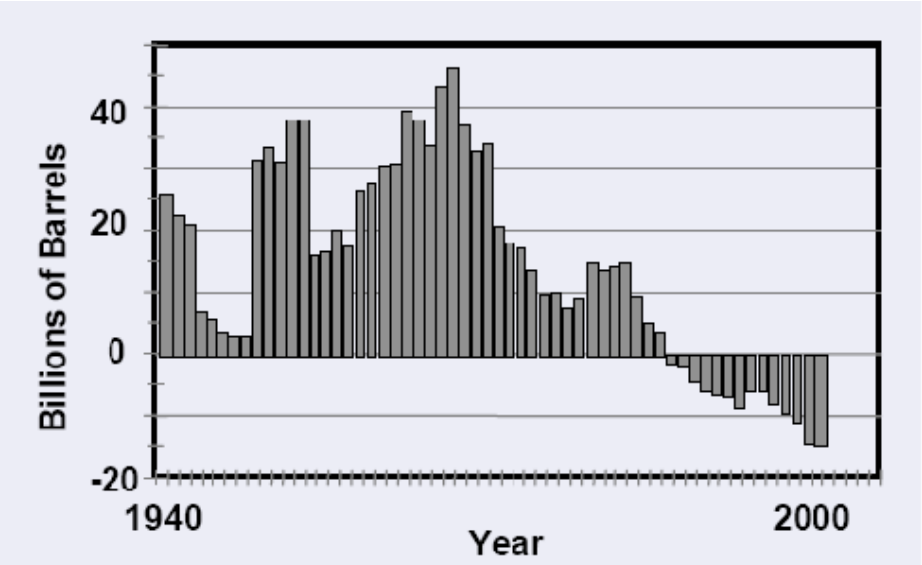
Figure 3: Global Production & Discovery Trends



Source: Association for the Study of Peak Oil (ASPO)

Indeed, the world has on average been consuming more oil each year than is discovered since 1981. The relatively poor volume of discoveries in recent years – against a background of rising oil consumption – means that the gap is widening. Figure 4 below highlights the net difference between annual world oil reserves additions and annual oil consumption, which has been declining for decades and shows the long-term trend towards an era in which annual additions are falling increasingly short of annual consumption. Hirsch[2] points out that 33 of the world's 48 largest oil-producing countries now have declining oil production levels:

Figure 4: The Trend in the Volume of Oil Discoveries minus Production Volumes



Source: ASPO

It follows that if large quantities of new oil are not discovered and brought into production somewhere in the world, then world oil production will no longer satisfy demand at some stage in the future. That point is called the peaking of world conventional oil production.

Peak Oil Projections

As a result of these trends in discoveries and production, a growing number of geologists, engineers and economists have concluded that neither OPEC nor non-OPEC countries can meet future requirements. Various individuals and groups have used available information and geological estimates to develop projections for when world oil production might peak. However, there is no clear consensus as yet about the likely timing of peak oil – with some commentators expecting an imminent peak (in the next few years), while others push the date out to beyond 2030. Indeed, previous forecasts of the timing of the global peak have been proved wrong as the projected date has come and gone without any peak in production.

As the table below shows – from a recent Dutch study on peak oil[3] – there is considerable diversity in the views of many different authorities and commentators on the imminence of peak oil:

[2] Hirsch, R, "The Atlantic Council of the United States," October 2005
[3] World Oil Production & Peaking Outlook, Rembrandt H.E.M. Koppelaar, Peak oil Netherlands Foundation, November 2005

Table 1(a) Projections of the Peaking of World Production

Source of Projection	Projected date	Source of Projection	Projected date
Individual Experts		**Governments**	
A. Bakthiari	2006-2007	Dutch Government (IEA HI copy)	After 2030
M. Simmons	2007-2009	French Government	2020-2030
C. Skrebowski	2007-2010		
K. Deffeyes	2005-2009	**Analyst firms**	
J. Laherrère	2010-2020	IHS Energy*	2011-2020
P. Odell	2060	Douglas Westwood	2010-2020
B. Pickens	2005-2007	Energy Files	2010-2020
M. Lynch	After 2030	PFC Energy	2014-2025
C. Campbell	2010		
S. Al-Husseini	2015	**Energy advisory organisations**	
J. Gilbert	2010	World Energy Council	After 2020
T. Petrie	Before 2010	Energy Research Center Netherlands	2010-2035
		CERA	After 2020
Oil Companies		ASPO	2010
CNOOC	2005-2010	IEA deferred investment scenario	Around 2020
Total	2020-2025	IEA high resource case	After 2030
Shell	After 2025		
BP	We cannot know	**Other Organizations**	
Exxon-Mobil	After 2030	Volvo	2010-2015
		Ford	2005-2010

Production by the largest producers is shown in Table 1(b).[4] The table also lists the top 20 oil-consuming countries and their respective consumption. In total, the top 20 countries consume over 75 percent of the average daily production. Beyond these larger consumers, oil is also utilized in all the world's 194 remaining countries.

Table 1(b) Top World Oil Producing and Consuming Countries; 2002

Producers				Consumers			
Rank	Country	MM bpd	Percent	Rank	Country	MM bpd	Percent
1	United States	9.0	11.7	1	United States	19.8	25.3
2	Saudi Arabia	8.7	11.3	2	Japan	5.3	6.8
3	Russia	7.7	10.0	3	China	5.2	6.6
4	Mexico	3.6	4.7	4	Germany	2.7	3.5
5	Iran	3.5	4.6	5	Russia	2.6	3.3
6	China	3.5	4.6	6	India	2.2	2.8
7	Norway	3.3	4.3	7	Korea, South	2.2	2.8
8	Canada	2.9	3.8	8	Brazil	2.2	2.8
9	Venezuela	2.9	3.8	9	Canada	2.1	2.7
10	United Kingdom	2.6	3.3	10	France	2.0	2.5
11	United Arab Emirates	2.4	3.1	11	Mexico	2.0	2.5
12	Nigeria	2.1	2.8	12	Italy	1.8	2.4
13	Iraq	2.0	2.7	13	United Kingdom	1.7	2.2
14	Kuwait	2.0	2.6	14	Saudi Arabia	1.5	1.9
15	Brazil	1.8	2.3	15	Spain	1.5	1.9
16	Algeria	1.6	2.0	16	Iran	1.3	1.7
17	Libya	1.4	1.8	17	Indonesia	1.1	1.4
18	Indonesia	1.4	1.8	18	Taiwan	0.9	1.2
19	Kazakhstan	0.9	1.2	19	Netherlands	0.9	1.1
20	Oman	0.9	1.2	20	Australia	0.9	1.1

[4] Ibid

There are a number of factors that could conceivably impact the peaking of world oil production. Here is a list of possible factors that could either mitigate the timing of any production peak, and others that could exacerbate the timing:

A. Upsides – Things That Might Mitigate the Problem of World Oil Peaking

- The pessimists are wrong again and peaking does not occur for many decades.
- Middle East oil reserves are much higher than publicly stated.
- A number of new super-giant oil fields are found and brought into production; well before oil peaking might otherwise have occurred.
- High world oil prices over a sustained period (a decade or more) induce a higher level of structural conservation and energy efficiency.
- The United States and other nations decide to institute significantly more stringent fuel efficiency standards well before world oil peaking.
- World economic and population growth slows and future demand is much less than anticipated.
- China and India decide to institute vehicle efficiency standards and other energy efficiency requirements, reducing the rate of growth of their oil requirements.
- Oil prices stay at a high enough level on a sustained basis so that industry begins construction of substitute fuels plants well before oil peaking.
- Huge new reserves of natural gas are discovered, a portion of which is converted to liquid fuels.
- Some kind of scientific breakthrough comes into commercial use, mitigating oil demand well before oil production peaks.

B. Downsides - Things That Might Exacerbate the Problem of World Oil Peaking

- World oil production peaking is occurring now or will happen soon.
- Middle East reserves are much less than stated.
- Terrorism stays at current levels or increases and concentrates on damaging oil production, transportation, refining and distribution.
- Political instability in major oil producing countries results in unexpected, sustained world-scale oil shortages.
- Market signals and terrorism delay the realization of peaking, delaying the initiation of mitigation.
- Large-scale, sustained Middle East political instability hinders oil production.
- Consumers demand even larger, less fuel-efficient cars and SUVs.

This - by no means exhaustive - list of the factors influencing the timing of any global peak in oil production illustrates the difficulties in forecasting future oil demand and supply. Clearly geology alone is not necessarily the main influence on oil production in the short to medium term. As Michael Lynch – a critic of the peak oil prognosis – has noted, some modelers of peak oil 'have repeatedly misinterpreted political and economic effects as reflecting geological constraints, and misunderstood the causality underlying exploration, discovery and production'[5]. This reinforces the need for caution regarding too premature a conclusion about the timing of peak oil, not least because of the multiple uncertainties about the influences on oil production (and demand).

However, one forecast about which there is universal consensus is that continued, sustained growth in the world's economy will require significant, steady increases in the availability of oil to fuel that growth in the medium to long term.

[5] The New Pessimism about Petroleum Resources: Debunking the Hubbert Model (and Hubbert Modelers), Michael C. Lynch, SEER, 2003

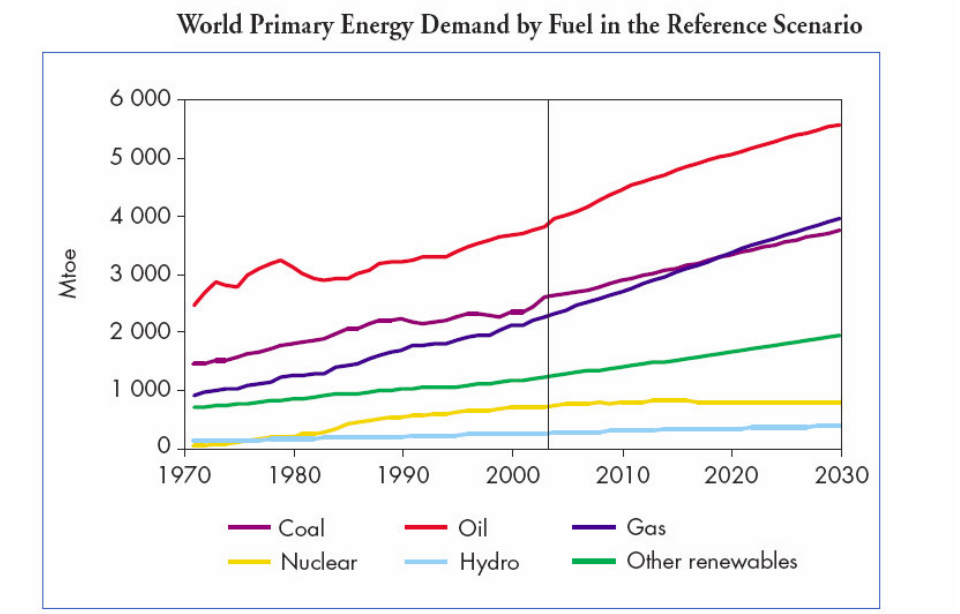
Fuelling the Future

The most recent 'World Energy Outlook' (WEO) report from the International Energy Agency [6] illustrates the likely level of demand for oil on the basis of long run assumptions about continued growth in the world's economy and population. Fundamental to the IEA's 'Reference Scenario' are the following assumptions:

- The world's population will grow by an average of 0.9% per annum to 2030.
- Global oil demand is expected to grow by 1.4% per annum to 2030.
- The inflation-adjusted price of oil will rise from $36 to $39 by 2030.
- Oil's share of the total primary energy mix in use will fall only slightly to 34% by 2030 (from 35% today).

The fuel demand forecast is given in figure 5 below, showing oil continuing to provide the bulk of the world's fuel needs for the next 25 years:

Figure 5: Fuel Demand Forecast to 2030



Source: World Energy Outlook 2005, IEA

The WEO report's reference scenario projects the levels of demand for oil in each of the major economies, and it is clear that demand is expected to continue to grow strongly, by a cumulative increase of over 40%, as evident in Table 2 below.

[6] World Economic Outlook 2005 – Middle East & North Africa Insights, IEA, November 2005

Table 2: Oil Demand Forecast by country to 2030

World Oil Demand in the Reference Scenario (million barrels per day)

	2003	2004	2010	2020	2030	2004 - 2030*
OECD	**47.0**	**47.6**	**50.5**	**53.2**	**55.1**	**0.6%**
OECD North America	24.1	24.9	26.9	29.1	30.6	0.8%
OECD Europe	14.5	14.5	15.0	15.4	15.7	0.3%
OECD Pacific	8.4	8.3	8.6	8.7	8.8	0.3%
Transition economies	**4.2**	**4.4**	**4.9**	**5.6**	**6.2**	**1.3%**
Russia	2.5	2.6	2.9	3.3	3.5	1.2%
Developing countries	**25.0**	**27.0**	**33.9**	**42.9**	**50.9**	**2.5%**
China	5.4	6.2	8.7	11.2	13.1	2.9%
India	2.5	2.6	3.3	4.3	5.2	2.8%
Other Asia	5.1	5.4	6.6	8.3	9.9	2.3%
Latin America	4.5	4.7	5.4	6.5	7.5	1.9%
Brazil	*2.0*	*2.1*	*2.4*	*3.0*	*3.5*	*2.0%*
Africa	2.6	2.6	3.3	4.5	5.7	3.0%
North Africa	*1.2*	*1.3*	*1.5*	*2.0*	*2.4*	*2.4%*
Middle East	5.1	5.4	6.5	8.1	9.4	2.2%
International marine bunkers	3.0	3.1	3.1	3.2	3.3	0.3%
World	**79.2**	**82.1**	**92.5**	**104.9**	**115.4**	**1.3%**

Source: World Energy Outlook 2005, IEA

The greater part of the extra growth will come from the developing countries – in particular from China. On the other hand, three quarters of the additional supply required by this demand scenario is projected to come from the OPEC countries – as shown in Table 3 below.

Crucially in this IEA scenario, non-OPEC supplies (mainly North America, including Mexico, the Former Soviet Union and the North Sea) are essentially expected to peak between 2010 and 2020, with OPEC supplies required to increase substantially to make up for the shortfall. OPEC – in its own long-term forecasts[7] – has set out a broadly similar forecast, suggesting that non-OPEC oil supplies will peak between 2015 and 2020 (Table 3). Of the major, public domain forecasts for global oil production, only the Energy Information Administration of the Department of Energy in the United States assumes continued growth in non-OPEC output to 2030[8]. Indeed, the unexpectedly high decline rates in off-shore fields has lead some analysts to forecast a peak in total non-OPEC production as soon as 2008[9].

A key question then in relation to the potential for a global peaking in oil production is whether OPEC can and will increase its output of oil by 77% over the next 25 years to meet the likely level of 'required supply' given continuing growth in the world's economy and population?

[7] Oil Outlook to 2025, Organization of Petroleum Exporting Countries, September 2004
[8] International Energy Outlook 2005, Energy Information Administration, USA, July 2005
[9] The Oil Supply and Demand Context for Security of Oil Supply to the EU from the GCC Countries, Dr. Robert Skinner & Dr. Robert Arnott, Oxford Institute for Energy Studies, April 2005

Table 3: World Oil Production (OPEC & Non-OPEC) to 2030

World Oil Production in the Reference Scenario
(million barrels per day)

	2004	2010	2020	2030	2004-2030*
Non-OPEC	**46.7**	**51.4**	**49.4**	**46.1**	**0.0%**
OECD	**20.2**	**19.2**	**16.1**	**13.5**	**–1.5%**
OECD North America	13.6	14.4	12.6	10.8	–0.9%
US and Canada	*9.7*	*10.5*	*8.8*	*7.4*	*–1.1%*
Mexico	*3.8*	*3.9*	*3.7*	*3.4*	*–0.5%*
OECD Europe	6.0	4.4	3.1	2.3	–3.7%
OECD Pacific	0.6	0.5	0.4	0.4	–1.4%
Transition economies	**11.4**	**14.5**	**15.6**	**16.4**	**1.4%**
Russia	9.2	10.7	10.9	11.1	0.7%
Developing countries	**15.2**	**17.7**	**17.6**	**16.3**	**0.3%**
China	3.5	3.5	3.0	2.4	–1.5%
India	0.8	0.9	0.8	0.6	–1.2%
Other Asia	1.9	2.1	1.7	1.3	–1.7%
Latin America	3.8	4.7	5.5	6.1	1.8%
Brazil	*1.5*	*2.5*	*3.3*	*4.1*	*3.8%*
Africa	3.3	4.9	5.2	4.7	1.4%
Middle East	1.9	1.7	1.5	1.4	–1.3%
OPEC	**32.3**	**36.9**	**47.4**	**57.2**	**2.2%**
OPEC Middle East	22.8	26.6	35.3	44.0	2.6%
Other OPEC	9.6	10.3	12.1	13.2	1.3%
Non-conventional oil	**2.2**	**3.1**	**6.5**	**10.2**	**6.1%**
of which GTLs	*0.1*	*0.3*	*1.3*	*2.3*	*13.9%*
Miscellaneous**	0.9	1.1	1.6	1.9	2.9%
World	**82.1**	**92.5**	**104.9**	**115.4**	**1.3%**
MENA	**29.0**	**33.0**	**41.8**	**50.5**	**2.2%**
Middle East	24.6	28.3	36.8	45.3	2.4%
North Africa	4.3	4.7	5.0	5.1	0.7%

The supply requirements set out in the IEA's current outlook raise major challenges about the ability to meet such high levels of production in the future. A recent CSIS report[10] has noted that: "there is, however, serious global risk and uncertainty on the supply side in both the short and long term that such forecasts only partially consider."

The CSIS authors note that, in the short-term, such uncertainty includes:

- Some oil firms have downgraded their reserve estimates of certain oil fields.
- The surge in oil demand has pushed many producing countries to produce at their maximum capacity, which instilled fears of the lack of spare capacity in case of further spikes in the market.
- Oman has falling production levels.
- Kuwait and the UAE have been slow to modernize production facilities and techniques.
- The world oil market is losing 1.0 million barrels per day (mb/d) from depletion every year.
- Uncertainty about the flow of Iraqi oil exports in the face of the high level of internal turmoil and the lack of any infrastructure of technological upgrade in the oil infrastructure since the Gulf War.

[10] The Changing Risks in Global Oil Supply and Demand: Crisis or Evolving Solutions? Anthony H. Cordesman & Khalid R. Al-Rodhan, Center for Strategic and International Studies, October 2005

- Continued political uncertainties in Iran and unrealistic policies towards foreign investment by the current Iranian government.
- Damage inflicted on U.S. Gulf Coast and offshore oil installations following hurricanes Charley, Frances, Ivan, Katrina, and Rita.
- Capacity constraints (upstream, downstream, and transportation).
- In addition, Venezuelan political instability, Nigerian labor strikes, and internal strife between the Russian government and oil giant, Yukos, also contributed to push crude oil and other petroleum prices higher in 2005.

They also point out that, in the longer-term, such uncertainty includes:

- The actual level of producible reserves in virtually all developing states at given levels of price and technology. Experts like Simmons seriously question whether current estimates seriously exaggerate such capability. The country-by-country analyses of the EIA indicate that major additional proven reserves await discovery in Saudi Arabia and virtually every MENA (Middle East & North Africa) country.
- The real world cost of incremental production capacity. Current EIA, IEA, and OPEC estimates almost certainly use cost estimates that are too low for Saudi Arabia and other MENA countries, and that understate the full cost of infrastructure and advanced recovery techniques. What is not clear is what the real cost will be.
- Debates over the commercially recoverable oil in existing oil fields and countries, the sustainability of production with current recovery techniques, and future technology gain.
- The rate of maturity and decline in given oil fields with present and future technology.
- The future commercial potential of tar sands and heavy oil is a factor that could sharply change the distribution of the world's commercial reserves, if resources like Canadian tar sands become as cost effective as nations like Canada hope.
- Major uncertainties over the ability to find and produce oil beyond the levels counted in proven reserves.
- Long-term substitution effects that bring alternative fuels on-line at competitive prices at whatever petroleum price levels emerge over time.

Furthermore, the CSIS study adds that supply disruptions continue to be a constant risk, and have contributed to the high oil prices in recent years. For example, the global energy market has experienced supply disruptions due to labor strikes, oil infrastructure sabotages, and natural disasters – all of which have exacerbated the short term supply situation.

Perhaps more disturbing is the increasing doubts about OPEC's willingness - let alone ability - to increase supply to the extent required in scenarios from the IEA and others. In its own 'Oil Outlook to 2025'[11], OPEC notes that:

> There is nevertheless a large degree of uncertainty over the demand and supply outlook and, hence, the required additional OPEC oil. … Despite the uncertainties, in the longer term, a key challenge will be to anticipate, in a timely and effective manner, the appropriate scale of investment needed to maintain and expand upstream capacity, as well as the corresponding downstream infrastructure.
>
> However, over the medium term, a rather different challenge could arise. While, in the reference case, demand is predicted to grow at robust rates, it is expected to be accompanied, over the medium term, by strong increases in non-OPEC production, leaving little room for increases in OPEC output. OPEC capacity is, meanwhile, expected to increase gradually over the medium term. This, in turn, suggests that OPEC capacity utilisation rates are very sensitive over the medium term to, among other things, the pace of global economic growth; should the robust rates of the reference case not be sustained, significant increases in idle capacity could appear in OPEC Member Countries. Concern over medium-term oil market stability can become

[11] Ibid

> even more alarming if some of the other downside risks to oil demand growth are considered.
>
> The long-term picture points to the need for increased investment in oil production capacity, but the magnitude of the required expansion is far from clear, even in the short and medium terms. This is partly due to the wide range of feasible demand growth scenarios, but it is also reinforced by contrasting views on the potential evolution of non-OPEC production. The challenge of enhancing market stability and ensuring that sufficient capacity exists therefore involves anticipating, in a timely and effective manner, the investment required over the coming decades.

OPEC's report also notes:

> However, there is concern that, in the pursuit of market stability, lower OPEC supply levels would be needed in the coming years that would result in substantial amounts of unused capacity. Over the medium term, in particular, there are risks of downward pressures on oil prices, which could sow the seeds of instability. It is important, then, to recognise the need for continued cooperation and dialogue among all players in the oil market, in the pursuit of the stability that is of interest to all parties.

OPEC is essentially asking for 'Security of Demand' in return for providing the rest of the world with 'Security of Supply'. OPEC's comments reinforce the difficulties associated with projecting future oil supplies in a context of considerable uncertainty, not least about where the oil is going to come from. Even within Saudi Arabia, key figures are questioning the desirability and feasibility of pushing the kingdom's output to substantially higher levels than at present, with commentators such as Sadad Husseini, a former senior figure in Saudi Aramco, suggesting that it would be prudent for Saudi Arabia to curtail its output to a level not much above its current capacity to avoid depleting oil reserves more quickly than necessary[12].

Peaking Into the Future

No one can predict when peak oil will occur at a global level. Indeed, it has often been remarked that we will only know global oil production has peaked by 'looking in the rearview mirror'. We can assume that the world's population will grow for the foreseeable future, and that the world's economy will grow with it. This will give rise to growing demand for oil – especially for transport. Therefore the 'required supply' to meet future demand will have to be substantially higher than current supply, in line with the forecasts of the IEA, OPEC and EIA.

We can also assume that the 'installed base' of existing oil production facilities - plus those scheduled to come on stream over the next 5 years – will represent almost all of the supply available to the end of the decade. Though some new technologies may be developed in the future to enhance oil production, these are unlikely to be installed and operated in existing facilities to any significant scale over the next 5 years. Finally, whilst there are likely to be new discoveries of oil over the next five years, these are unlikely to come on stream as production within that time frame.

Building on these assumptions, there appears to be a growing consensus that the global outlook for oil production can be described in three broadly distinct phases as follows:

[12] Interviewed in New York Times Magazine, 21 August 2005

Phase 1: 'Fragile Balance'
This phase will see a number of major new oil fields coming on stream, which - on balance – should be sufficient to both provide for increasing demand and to offset the decline in those older fields that have passed their peak output (unless the decline rate in the older fields accelerates).

Phase 2: 'Difficult Transition'
This phase will see a peak in non-OPEC oil output resulting in a requirement for OPEC to accelerate its own output to compensate for declining non-OPEC supplies and to meet the need for continued growth in additional supply from the world's economy.

Phase 3: 'Falling Behind'
In the final phase, the ageing oil fields of Saudi Arabia, and ultimately those of the rest of OPEC, will no longer be able to keep up with expanding world demand, and will enter a permanent downward trend in output, heralding the onset of global peak oil production.

Something similar to this phased perspective is set out in a recent paper by R. A. Wells in Oil & Gas Journal[13]:

> As the different components of supply reach their maximum production rate, a series of crises in oil supply is likely over the coming decades.
>
> The first, related to the peak and decline of non-OPEC production, is practically upon us and underpins the currently high oil prices. Other factors are burgeoning world oil demand, driven primarily by China and the USA, and restricted output from Iraq.
>
> The imminent inability of non-OPEC production to meet incremental demand and its decline after 2010 precipitates the second crisis as OPEC's diminishing spare capacity (even with Iraq's production back to pre-invasion levels) becomes less and less able to accommodate short-term fluctuations in demand. The timing and depth of the crisis depend on world oil demand and OPEC investment in new capacity. While OPEC countries will have every incentive to make the necessary investments, the pace of past decision-making is not encouraging, and enough spare capacity may not be available in time.
>
> The third crisis, due to OPEC's incremental supply being unable to meet incremental demand, follows in the first half of the next decade. This assumes that OPEC's reserves are as published-882 billion bbl. If OPEC's reserves are higher than published, this crisis may not occur until the latter half of the next decade and may be muted, particularly if demand moderates.
>
> These crises will have global economic and geopolitical significance: The oil price will be high and volatile, and demand growth will have to be curtailed.

As for the timing of these three phases, we can only deal in probabilities rather than certainties. Our best estimate, reviewing many current analyses of global supply prospects, is as follows:

Phase 1: 'Fragile Balance' from 2005 to 2010

Phase 2: 'Difficult Transition' from 2010 to 2020

Phase 3: 'Falling Behind' from 2020 to 2030

Yet, for all the reasons cited earlier, peak oil might come sooner rather than later – or it could be deferred until 2030 and beyond. Our own interpretation of the dynamics now shaping the global market for oil supplies suggests that there is a smaller probability of peak oil occurring before 2010 (of the order of 20%-30%); and a higher probability of peak oil occurring before 2020 (of

[13] Oil Supply Challenges 2: What can OPEC Deliver? Peter R.A. Wells in Oil & Gas Journal, March 7 2005

the order of 40%-50%). In the context of the mitigation strategies and scenarios discussed in Chapter 3, we consider it unlikely that peaking will be delayed to the end of the projected Phase 3 timeframe, i.e.: twenty five years time or around 2030.

Though geology ultimately sets the boundaries for the debate about the production level at which peak oil will occur, economics has a strong role to play in how quickly we reach the peak (and how steep the decline is on the far side of the peak). Therefore no assessment of the nature and impact of peak oil is complete without reference to the economic context and consequences of peaking oil.

The Economics of Peak Oil

Of course, the onset of peak oil – whilst an interesting geological phenomenon – might not matter if we could be sanguine about the wider economic consequences. There have been numerous studies on the impact of oil shocks on national economies, as well as at a global level. These studies have examined the impact of major events such as the OPEC embargoes of the 1970s, as well as the changing susceptibility of developed and developing economies to oil price rises over time. They all point to a negative impact on economic growth from shortage induced oil price increases – with the severity of the impact being determined by the duration of the shortage.

A recent summary of the economic impact of higher oil prices[14] illustrates just how widespread the impact can be:

Economic impacts of higher oil prices

Economic output: Increases in oil prices will reduce economic growth in many economies leading to higher unemployment. Impacts on individual economies will vary depending on their domestic macroeconomic and sectoral policies. Higher prices result in large income transfers from oil importing economies to net oil exporting economies. The negative impacts are therefore largest in oil importing economies with high oil intensity. While oil exporting economies will benefit from higher export earnings from higher oil prices, it is possible that economic growth may slow for some oil exporters as a result of flow-on effects from other economies, such as reduced demand for other exports.

Inflation/wages: Higher oil prices lead to increased wage and inflationary pressures in many economies, although the magnitude will in part depend on the fiscal and monetary policy responses employed by individual economies. There could be upward pressure on interest rates as central banks attempt to limit inflation. Overly contractionary policies could exacerbate the decline in economic growth and increase unemployment in some economies.

Trade balance: For net oil importing economies, the increase in the price of oil imports will cause trade balances to worsen — that is, the value of imports will increase more than the value of exports. Conversely, oil exporting economies will experience an improvement in their trade balance.

Exchange rates: Higher world oil prices are likely to place downward pressure on exchange rates in some oil importing economies as their balance of payments deteriorates.

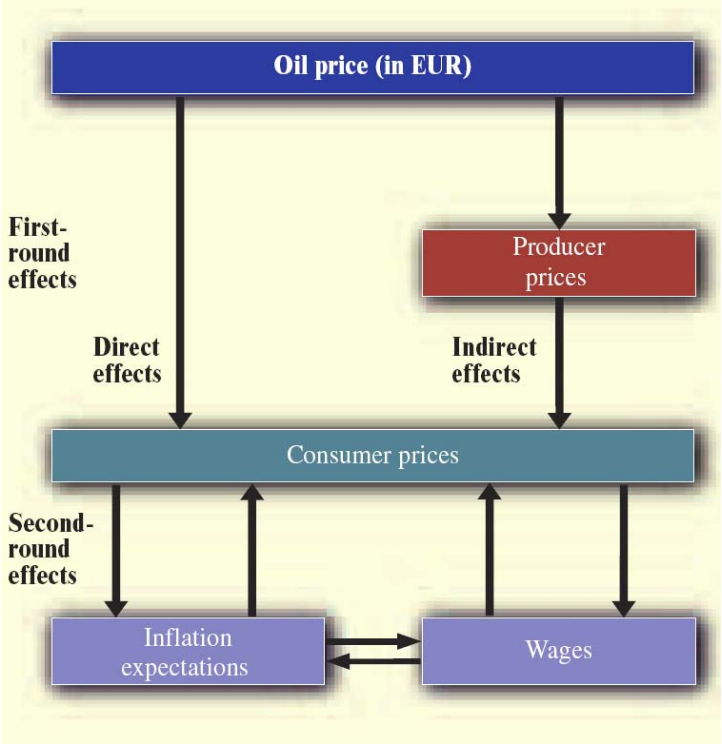
Oil price increases transfer income from oil importing to oil exporting countries, and the net impact on world economic growth is negative. For oil importing countries, increased oil prices reduce national income because spending on oil rises, and there is less available to spend on other goods and services.[15] Not surprisingly, the larger the oil price increase and the longer higher prices are sustained, the more severe is the macroeconomic impact.

[14] Impact of Oil Prices on trade in the APEC region, ABARE Research Report 05.3 for the APEC Energy Working Group, October 2005

[15] "The Impact of Higher Oil Prices on the World Economy," OECD Standing Group on Long-Term Cooperation, 2003.

The mechanism by which oil impacts on the economy – set out in a recent European Central Bank study[16] - is illustrated below in Figure 6.

Figure 6: Economic Impact of Oil, ECB Monthly Bulletin



These first round and second round effects - direct and indirect – mean that rising oil prices work there way through the economy, but the full effect is not immediate.

Higher oil prices result in increased costs for the production of goods and services, as well as inflation, unemployment, reduced demand for products other than oil, and lower capital investment. Tax revenues decline and budget deficits increase, driving up interest rates. These effects will be greater the more abrupt and severe the oil price increase and will be exacerbated by the impact on consumer and business confidence.

Other than its impact on the headline rate of economic growth, oil price shifts predominantly affect the relative purchasing power of oil exporting and oil importing countries. With rising prices, it is not surprising that oil importing countries will suffer, but to what extent will be dictated to by the countries level of oil intensity in production (the ratio of the amount of oil used to real GDP) and the price elasticity of demand for oil. Likewise, oil exporters such as Middle Eastern economies and Norway, would benefit through increases in income of their exports.

The incidence however of oil price increases can be borne by either the consumer and producer; the latter in the instance where oil is an input into the final good and the producer is operating in a competitive environment where they are unable to pass on input cost increases. The adverse effect this has on returns on capital means that in the long run, where capital is more flexible, capital will move from energy intensive areas to sectors with high rates of return. The most worrying effect on economic activity is the introduction of a greater degree of uncertainty in the investment and domestic demand levels.

[16] Oil Prices and the Euro Area Economy, ECB Monthly Bulletin, November 2004

The consumer does however bear considerable income loss where the demand for oil price products is inelastic, such as the case with petrol. In the long term, it is suggested that rational consumers and producers adjust their behaviour in line with oil price rises as the price elasticity in the long run is higher than in the short term. Table 4 below shows Ireland in a comparative context in relation to price elasticities of demand:

Table 4: Elasticities of Demand for Oil, OPEC

	Oil consumption % growth per capita	Real GDP % growth per capita	Price elasticity Short-run	Long-run
Australia	–0.3	1.7	–0.034	–0.068
Austria	–0.7	3.1	–0.059	–0.092
Canada	–1.3	1.6	–0.041	–0.352
China	3.6	8.6	0.001	0.005
Denmark	–2.5	1.5	–0.026	–0.191
Finland	–1.2	2.1	–0.016	–0.033
France	–1.5	1.7	–0.069	–0.568
Germany	–1.4	1.2	–0.024	–0.279
Greece	2.2	1.5	–0.055	–0.126
Iceland	0.5	2.2	–0.109	–0.452
Ireland	0.2	3.9	–0.082	–0.196
Italy	–0.4	2.2	–0.035	–0.208
Japan	–1.0	8.1	–0.071	–0.357
Korea	8.3	6.4	–0.094	–0.178
Netherlands	–0.5	1.7	–0.057	–0.244
New Zealand	–0.4	1.4	–0.054	–0.326
Norway	0.2	2.9	–0.026	–0.036
Portugal	3.0	2.9	0.023	0.038
Spain	1.3	2.1	–0.087	–0.146
Sweden	1.3	2.8	–0.043	–0.289
Switzerland	–0.7	0.9	–0.030	–0.056
United Kingdom	–1.1	2.0	–0.068	–0.182
Unites States of America	–0.7	2.0	–0.061	–0.453

The study – from OPEC[17] – shows that Ireland has a low to average sensitivity to oil price increases, over the period 1979-2000. For the eurozone as a whole, the ECB study calculates that a 50% increase in the level of oil prices will add 0.3 to 0.6 percentage points to inflation, and reduce real GDP growth by 0.1 to 0.8 percentage points in the first year[18].

Though the theoretical consequences of oil price increases are well understood, the fact is that the recent doubling in world oil prices has not had anything like the same inflationary impact on the EU or Irish economies as earlier increases. This is partly due to growing evidence of a decline in the sensitivity of developed economies in the decades since the oil price shocks of the 1970s. Hamilton[19] points to a fall in the sensitivity of US real GDP to a decline in world oil production over the course of several oil crises in the past fifty years (from a GDP fall of –3.2% in 1973 to a fall of only –0.1% during the first Gulf War). Furthermore, the OECD has highlighted the declining impact on the terms of trade of member countries of various oil crises.

[17] Elasticity of Demand for Crude Oil: Estimates for 23 Countries 1979-2000, John C.B. Cooper, OPEC Working Paper, March 2003
[18] Ibid.
[19] Oil and the Macroeconomy, August 24, 2005, James D. Hamilton, www.econbrowser.com

In the case of Ireland, our terms of trade as a percentage of GDP deteriorated by over 3.5% in the 1973-74 crisis, but by only 0.1% during the run up in prices during 2003-04[20].

However, determining the economic consequences of peak oil is quite difficult because past experience may be of limited value to determining the future impact of a permanent shortage. Firstly, previous OPEC instigated oil shocks eventually gave way to a restoration of supply (indeed, supply grew strongly in the decades that followed the last major oil shock in 1979). Indeed, rising oil prices instigated a substantial expansion of non-OPEC oil exploration and development, which in turn lead to an expansion of non-OPEC supply through the 1980s and 1990s.

With the onset of a global peak in oil production there will be no equivalent to 'non-OPEC' waiting in the wings to meet the shortfall created by a decline in OPEC's production – an involuntary decline at that. Working through the economic consequences of peak oil points to a number of issues that need to be considered:

- Despite recent rises in the price of oil, it remains below the previous peak in inflation-adjusted terms (that peak occurred in the early 1980s, whether measured in dollars or euro).
- This implies there is still some way to go before oil prices even return to their previous peak - let alone exceed it - and until such time oil will remain comparatively more affordable than it was a quarter of a century ago.
- Furthermore, high and rising prices will stimulate investment in finding new sources of conventional oil, in developing known sources of non-conventional oil, and ultimately in alternative energy sources that no longer require oil.
- Oil demand will never exceed oil supply, for the simple reason that very high demand will drive up the price of oil, leading to a fall off in demand sufficient to bring demand and supply into equilibrium.
- It follows that very high oil prices will reduce the demand for oil ('demand destruction' as it is known), which in turn could delay the onset of a production peak.

These latter points have lead some economists and other analysts of the peak oil issue to suggest that we will not experience an actual 'peak' in global oil production, but rather an 'undulating plateau'. In the case of the plateau scenario, it is suggested that – with global oil supplies coming under pressure due to the peaking phenomenon – then rising prices will destroy demand, possibly leading to a temporary 'surplus' of oil supplies (especially if the earlier price increases stimulated more exploration and development). This temporary excess will cause prices to fall, further stimulating demand – which in turn will rise until it 'bumps up against' the production peak. So another cycle of demand destruction, over supply, falling prices and a re-stimulation of demand will follow. Though unlikely, such a cycle could continue for some time – perhaps even for a decade or more as the interplay of supply, demand and prices works itself out.

Such a pattern of cyclical peaks and troughs will be exacerbated by considerable price volatility. As the OECD noted in a detailed analysis of the economic impact of recent oil price rises:

> In the short term both the global demand and non-OPEC supply elasticities are very low, leading to considerable price volatility, and this may depress investment in exploration and development needed to ensure that supply is elastic in the longer term. Higher oil prices do indeed appear to induce greater investment activity by non-OPEC producers in identifying and developing new reserves. However, price volatility may increase long-term price uncertainty, prompting oil companies to require a greater rate of return on their investment. In this respect, current uncertainties about oil prices may limit the hike in investment activity by non-OPEC oil producers that would otherwise follow from current high prices. And one consequence of the reduced investment over

[20] Oil Price Developments: Drivers, Economic Consequences and Policy Responses, in OECD Economic Outlook No. 76, December 2004

the 1990s could be limited flexibility in the supply response to higher prices over the near-term horizon.[21]

A Clear & Present Danger

In our opinion, there is a high probability of a peak in global oil production within the next fifteen years. Though this may seem a long time relative to the timescale of many of the issues we face as individuals, businesses and governments, it is barely enough time for Ireland to prepare for the adverse consequences of peak oil.

Moreover, as we will explain in the next chapter, Ireland is especially vulnerable to the risk of an imminent peak in global production in comparison with other European countries. This emphasizes all the more why we must prepare sooner rather than later for a new energy era unlike the one we have gotten used to over the past half-century.

[21] Ibid.

2. Ireland and Oil

Summary of Chapter 2

Ireland has grown increasingly dependent on oil to fuel its economic growth – with consumption per capita rising by more than 50% in the past 15 years. Some of this higher level of dependence is inevitable given the island nature of our economy. Some, however, is a matter of choice, and generally Ireland has chosen to adopt patterns of energy usage that are oil intensive, e.g.: in relation to transportation.

Nevertheless, oil consumption is not confined to transportation in Ireland. Electricity production also relies on oil for a significant share of generation, and again Ireland is comparatively more dependent on oil for electricity generation than most other EU economies.

Car usage has grown substantially in Ireland in recent decades, powered by a rapid growth in affluence. However, Ireland's car ownership levels are still below the EU average – suggesting considerable room for further growth in car ownership and usage in the decades ahead. Road haulage has also led to a substantial increase in oil-related consumption, as has air travel.

The oil importation, refining and distribution sector in Ireland is relatively small. Strategic oil storage is managed by a government agency - NORA, in compliance with IEA strategic reserve requirements. Though there were initial hopes for the development of off-shore oil production during the 1970s and 1980s, Ireland has proved to be unrewarding for oil exploration companies, despite some successes with gas development.

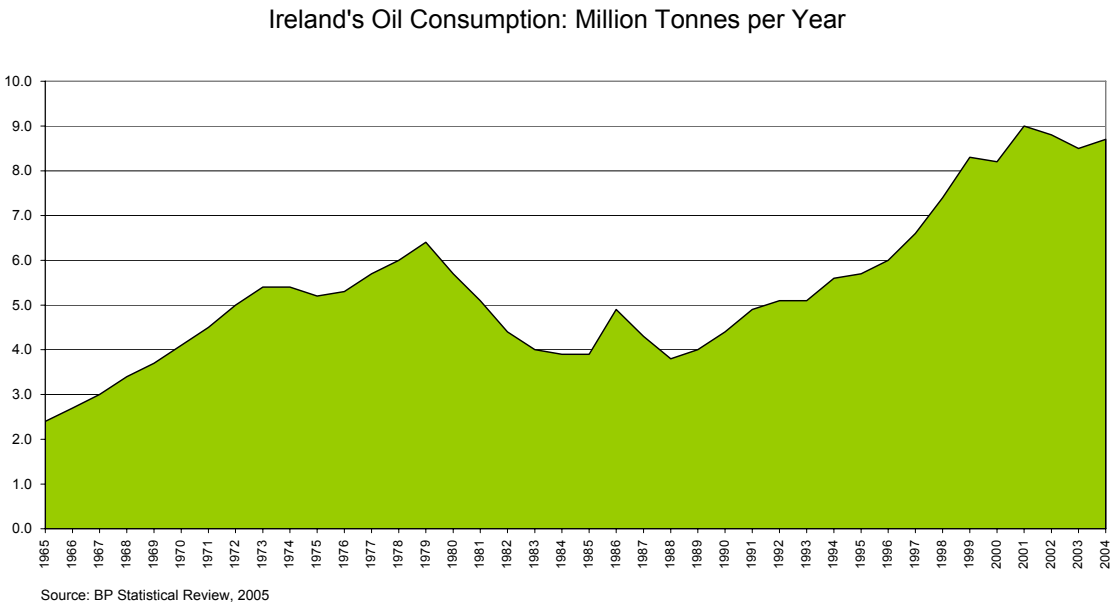
Continued economic growth in Ireland is expected to give rise to further increases in the absolute levels of oil requirements, even as the relative importance of oil to output (as measured by 'oil intensity') continues to decline. As evident in our 'Oil Vulnerability Index, Ireland is relatively more vulnerable than other countries, relating to Ireland's sensitivity towards an oil price rise, our overall dependence on imported oil and the total share of oil consumed in the economy.

The Consumption of Oil in Ireland

Ireland currently consumes nearly 9 million tonnes of oil per annum – approximately 180,000 barrels of oil per day – an amount that has doubled over the past 15 years. This is equivalent to two tonnes of oil per person each year.

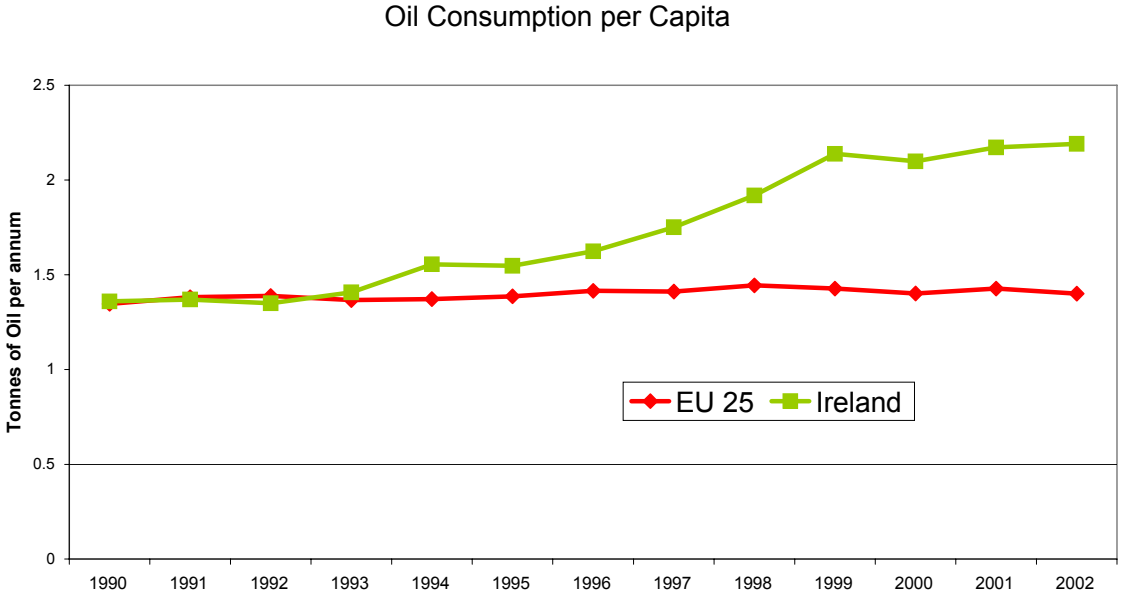
Like most developed countries, Ireland has relied on oil to help our economy grow. Our demand for oil has grown broadly in line with GDP over the past 25 years, tracking the OECD average of approximately 6% growth in oil consumption for every 10% growth in real GDP.

Figure 7:



Ireland's oil consumption declined in the wake of the 1979-80 oil shock and the worldwide recession that followed: as illustrated in Figure 7. With the onset of the 'Celtic Tiger' era of strong economic growth from the mid-1990s, a pattern of strong growth in oil demand set in. Ireland's exceptional growth in oil consumption is illustrated by the chart below, which shows per capita oil consumption for Ireland and the EU 25 countries. In the case of the latter, oil consumption remained constant on a per capita basis, whereas Ireland's consumption rose by over 50%, illustrated in Figure 8 below:

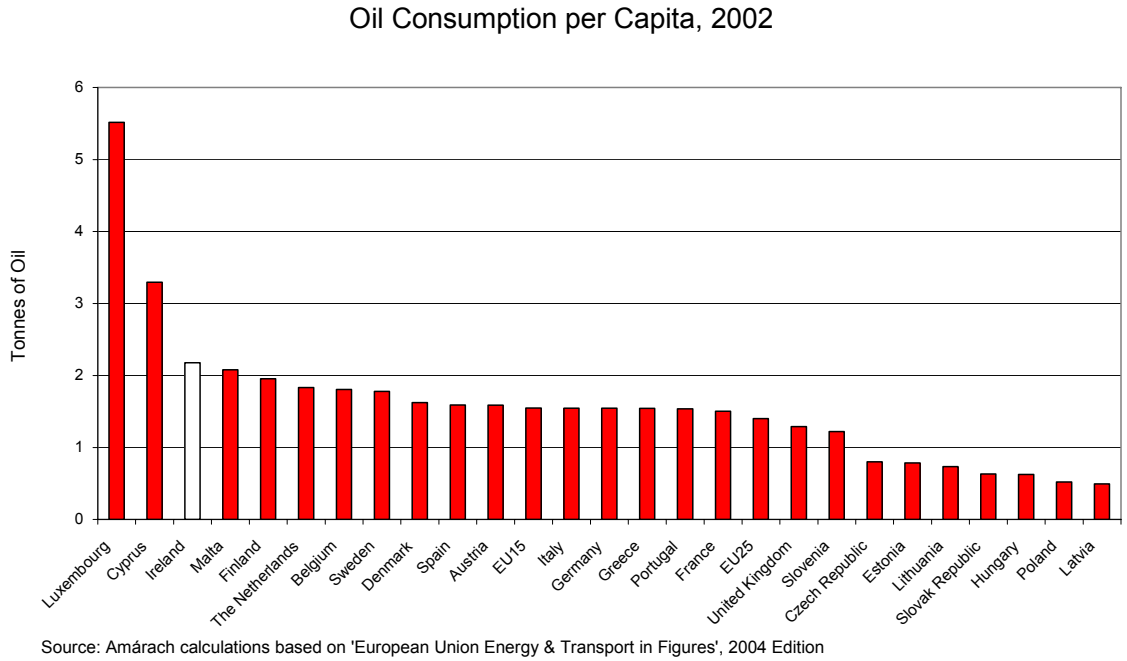
Figure 8:



Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Such has been the speed and scale of increase in Ireland's oil consumption in the past fifteen years that Ireland now ranks third among the EU 25 countries in terms of oil consumed per capita, Figure 9:

Figure 9:



Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Ireland has no indigenous oil resources; therefore all oil consumed must be imported. As a result, Ireland has a high level of import dependence on oil and on all its other hydro-carbon fuel requirements, as shown in Table 5 below. The European Commission defines import dependency as net imports divided by bunkers (or stocks in reserve) plus gross inland consumption. The table shows *imports as a proportion of total consumption* (a negative sign means that that country is a net exporter). Ireland has the fourth highest level of import dependence of all the EU 25 countries, and the third highest level of dependence on oil imports (the table is ranked by this column from highest to lowest).

Though the long run outlook for oil consumption in Ireland is for further strong growth against a background of continued economic prosperity, there are two factors have contributed to this pattern of rising oil dependence – electricity generation and transportation.

Table 5: Level of Dependence on Oil, Gas & Solid Fuels

2002	All fuels	Oil	Gas	Solid fuels
Greece	70.7	102.5	97.4	6.9
Cyprus	100.5	102.1	-	120.4
Spain	78.3	101.2	101.0	66.3
Ireland	**89.3**	**101.1**	**81.6**	**70.2**
Luxembourg	99.0	100.6	100.0	100.0
Slovenia	49.9	100.0	99.4	20.6
Malta	100.0	100.0	-	-
France	50.3	99.2	98.3	92.7
Belgium	76.4	98.8	102.1	86.2
Latvia	54.6	98.5	88.6	76.1
Slovak Republic	65.3	97.2	100.1	77.3
Poland	11.3	97.1	66.1	-28.5
Portugal	84.2	96.7	99.9	99.9
Czech Republic	26.6	95.2	102.0	-18.6
Sweden	37.5	95.2	100.0	80.3
Austria	66.0	95.1	71.5	91.4
Germany	60.5	95.0	79.5	29.6
Italy	86.7	94.7	84.1	95.6
Finland	52.6	93.9	100.0	61.0
The Netherlands	33.8	91.3	-51.5	97.2
EU25	48.0	76.8	51.3	33.2
EU15	50.2	75.5	47.3	53.2
Estonia	29.2	75.2	100.0	2.7
Lithuania	42.7	74.8	100.0	97.8
Hungary	58.2	73.7	80.6	24.7
United Kingdom	-12.8	-50.9	-8.1	48.9
Denmark	-41.1	-94.9	-64.5	88.6

Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Electricity Generation

ESB are responsible for most of the generation in Ireland, with a generation capacity of over 4,000 megawatts. Four of their fifteen stations operated in Ireland (a further four are operated outside Ireland) use oil, two exclusively and two have dual fuel functionality (oil or gas), see Table 6 below:

Table 6: Electricity Generation in Ireland, 2005

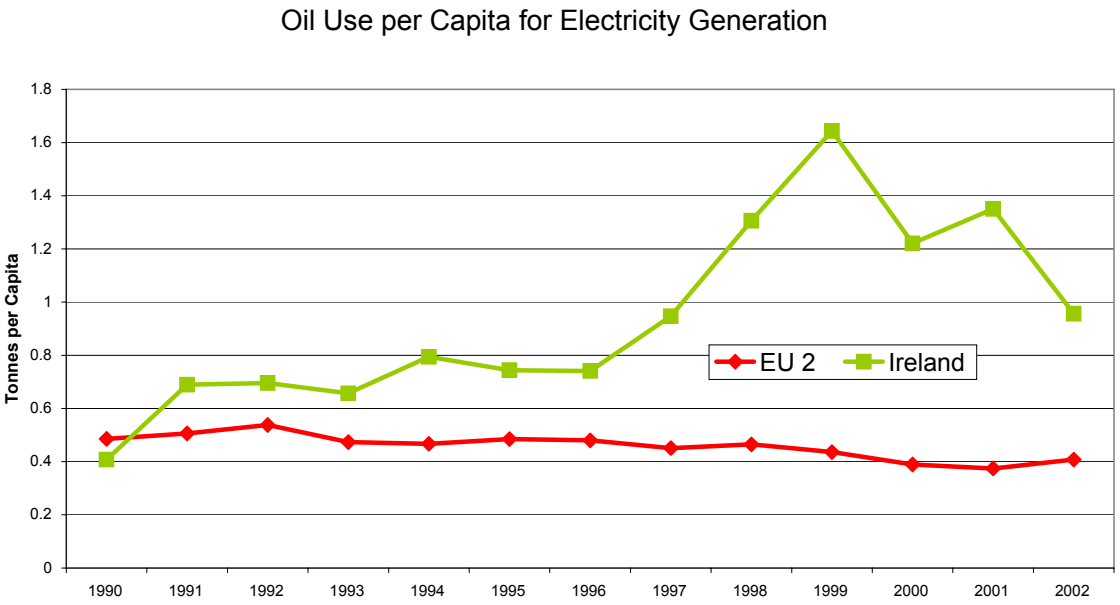
Station	Capacity (Megawatts)	Fuel Type
West Offaly	150	Peat
Lough Ree	100	Peat
Turlough Hill	292	Hydro
Liffey	38	Hydro
Ardnacrusha	86	Hydro
Erne	65	Hydro
Clady	4	hydro
Lee	27	Hydro
Moneypoint	915	Coal
Tarbert	620	Oil
Great Island	240	Oil
Aghada	525	Gas
Poolbeg	1,020	Oil & Gas
North Wall	266	Oil & Gas
Marina	115	Gas
Total Capacity:	4,463	
Total Oil:	2,146	
Oil % of Capacity:	48.1%	

Source: ESB website & Amárach calculations

The four oil-using stations combined account for almost half of ESB's generation capacity. Tarbert is the largest oil only power station, and each of its two boilers use 15 tonnes of heavy fuel oil each hour. Tarbert's stock of fuel oil is received directly from ships, capable of delivering up to 50,000 tonnes. Poolbeg is the largest station in ESB's network and also receives direct shipments of fuel oil. Poolbeg has onsite storage capacity for 140,000 tonnes of oil. Poolbeg's generators are capable of switching from oil to gas and vice versa without interrupting output.

Ireland's reliance on oil for electricity generation has fallen in recent years, due partly to increased use of gas and also the growing contribution of wind-generated electricity. Nevertheless, through most of the past fifteen years – as the next chart shows – Ireland has relied considerably more on electricity than the EU as a whole. Ireland currently uses more than twice the amount of oil per capita to generate electricity as in the EU 25 countries as a whole, illustrated in Figure 10 below:

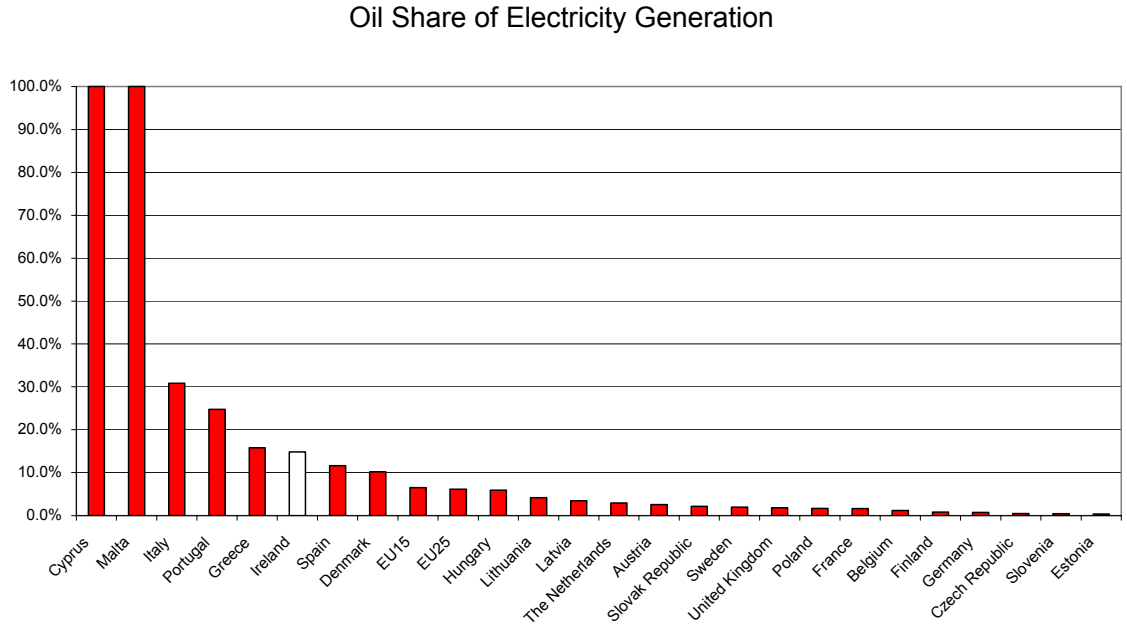
Figure 10:



Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Nevertheless, even with the recent reduction in the use of oil for electricity generation, Ireland remains the sixth most dependent country on oil for electricity generation of the 25 European Union countries, Figure 11 below:

Figure 11:



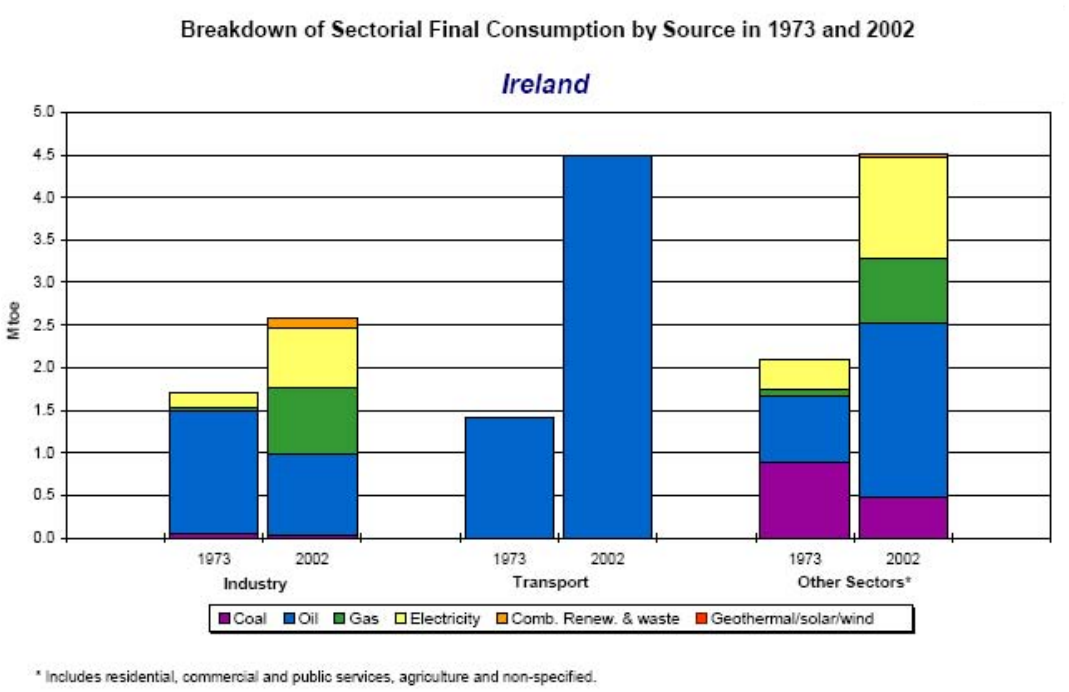
Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Though the vulnerability of Ireland to an oil shock in the context of electricity generation is obvious, clearly that vulnerability has diminished in recent years due to the increasing usage of gas and other energy sources. The same cannot be said for transport, however, which we turn to next.

The Role of Transport

Looking in more detail at why Ireland's demand for oil has increased in absolute terms over the past number of years, it is clear that the primary to consumption growth has been in turn the growth in car ownership and usage. Indeed, transportation has been the key demand component of Ireland's growing need for oil, as pointed out by the International Energy Agency's analysis of Ireland's energy patterns[22], Figure 12:

Figure 12:

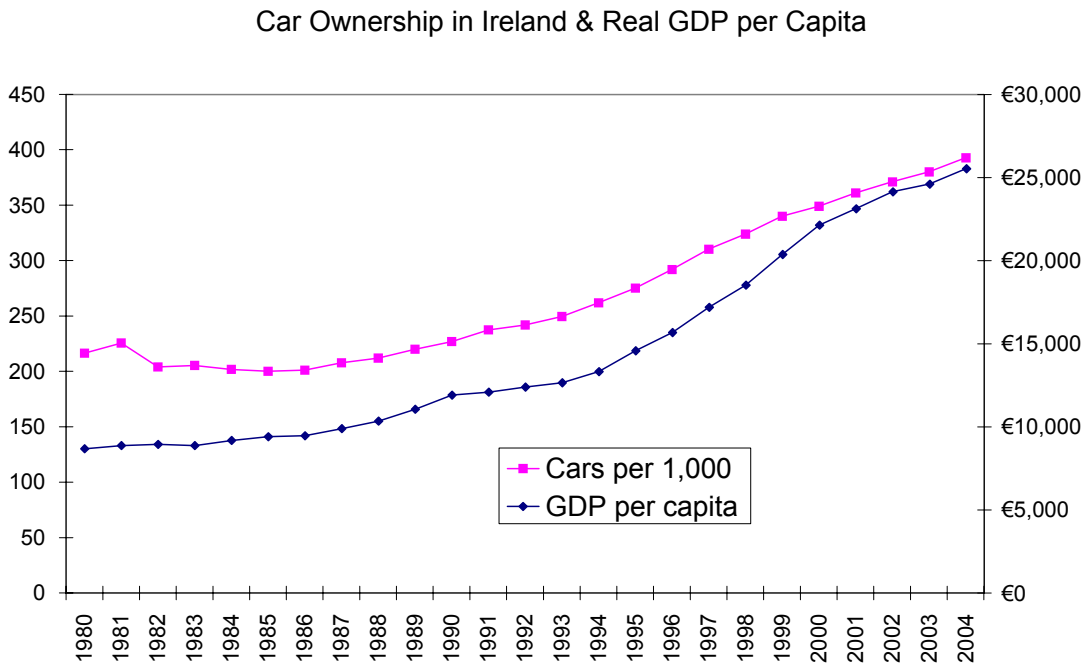


* Includes residential, commercial and public services, agriculture and non-specified.

The amount of oil required for transportation has tripled in a thirty-year period. In Ireland – as in most developed economies – economic growth has lead to a growth in car ownership, with cars per 1,000 population doubling over the past 25 years as GDP per capita more than doubled. Figure 13 highlights below that as with oil consumption, economic growth is a powerful driver of car ownership, with – again – a 10% increase in real GDP per capita leading to a 6% increase in private cars per capita over the past 25 years.

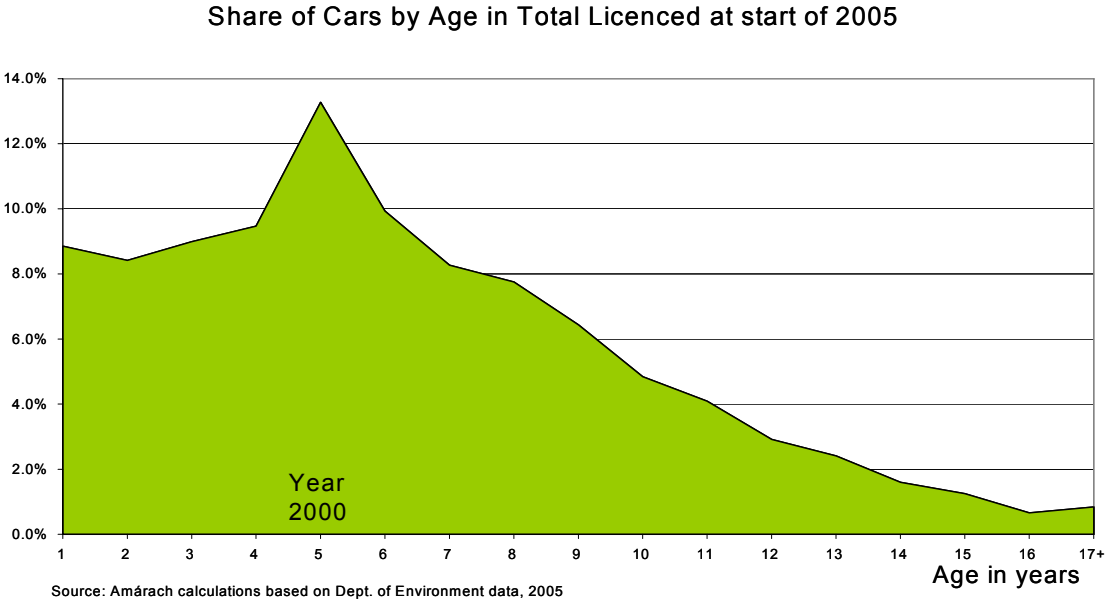
[22] Ireland 2003 Review, IEA, 2003

Figure 13:



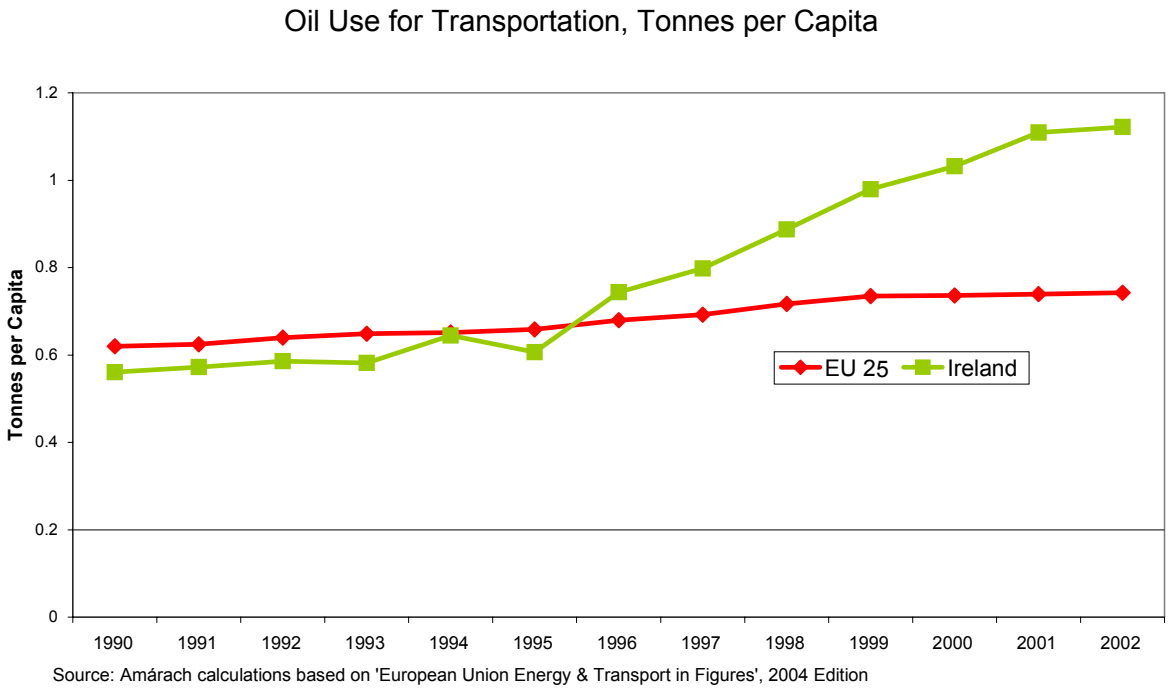
Ireland's stock of cars is quite 'young' by comparison to some other countries, partly due to the Celtic Tiger phenomenon and therefore the relative lateness of our economic take off as a developed country. As Figure 14 below shows, most licensed, private cars are relatively new in Ireland, with the average car in use now approximately 6 years old (well below, for example, the average of 9 years in the United States of America).

Figure 14:



For the early part of the 1990s, Ireland used less oil per capita for transportation than the EU 25 countries. That picture has now changed, with Ireland consuming at least 50% more per capita, evident in Figure 15 below:

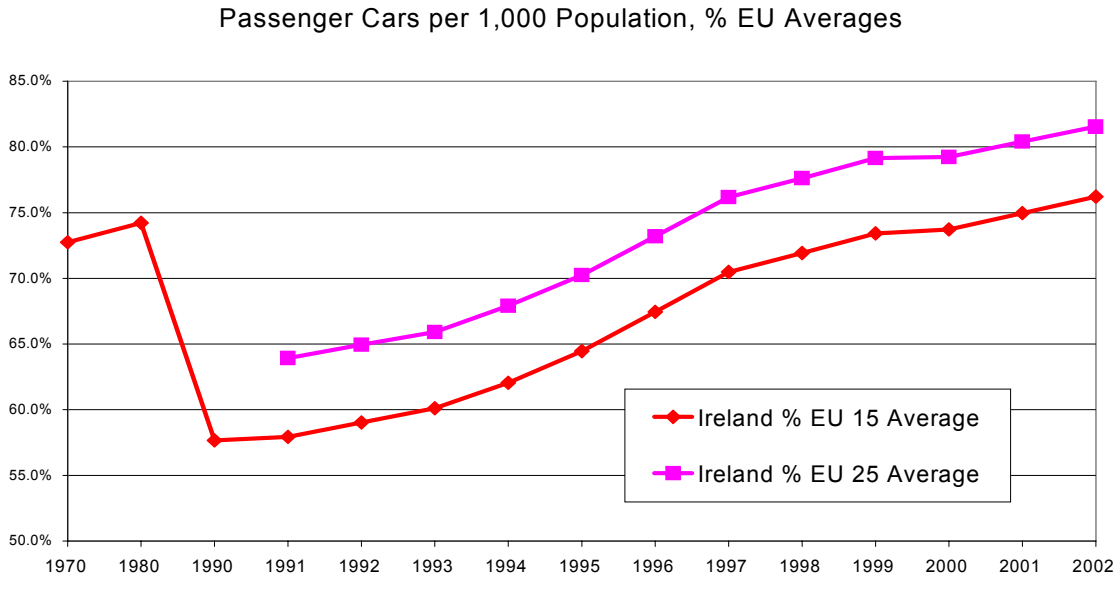
Figure 15:



Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

However, it is surprising to note that Ireland still has some way to go in terms of car ownership relative to the EU average – indeed, that relatively has only recently returned to what it was back in the 1970s, (Figure 16).

Figure 16:



Source: Amárach calculations based on 'European Union Energy & Transport in Figures', 2004 Edition

Nevertheless, looking ahead, it is clear that there is still some room for further growth in Ireland's car population, when compared to the EU as a whole. For this reason, there is every expectation that Ireland's continued economic growth will translate into increased demand for car ownership and therefore continued growth in oil consumption.

Other Transport

Road haulage has been a major beneficiary of Ireland's economic growth in the past decade. Between 1995 and 2002, national road haulage volumes (in tonnes per kilometer) more than doubled, compared with an EU 15 average cumulative growth of just 19%. Over the same period, rail haulage volumes fell by 28% in Ireland, while they rose by 6% in the EU 15 countries. Clearly then, freight transport by road has contributed to the increasing consumption of oil in transportation in Ireland described earlier.

Air travel, of course, is also crucially dependent on oil. Due to Ryanair and the revolution in air travel availability from Ireland, the Irish have lead the way in air travel demand among EU 15 countries. Between 1990 and 2002, the number of passenger kilometers generated by Irish air travelers to other EU 15 countries more than doubled – whilst the volume of total EU traffic rose by 'only' 78% over the same period.

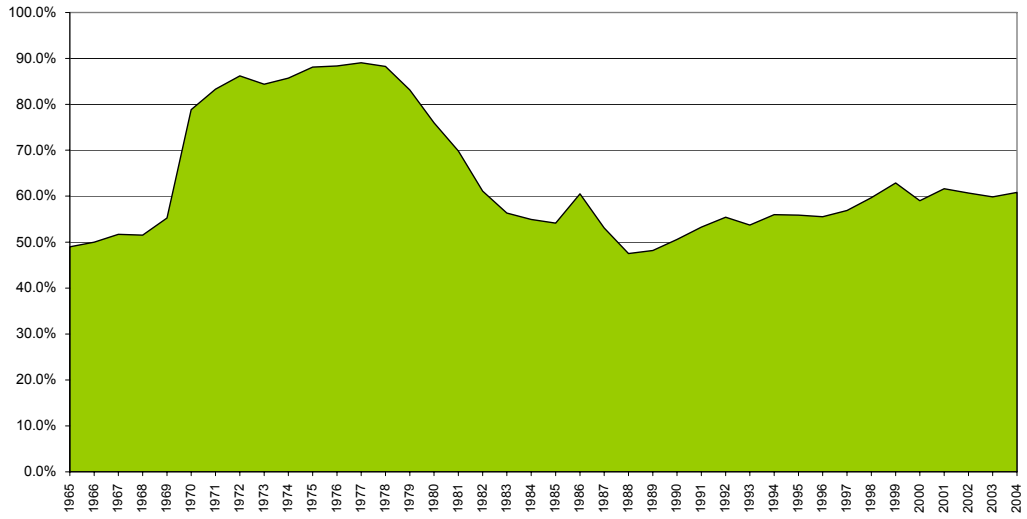
Air travel – and to a lesser degree, road freight transport – are functions of Ireland's economic success and the affluence this has given rise to. Affluence in turn leads to increasing demand for personal transportation – i.e.: cars – and to demand for holidays abroad.

Oil and Ireland's Economy

Oil is still vital to Ireland's continued economic growth, despite the growing availability of gas and renewables in recent years. Oil has been – and still is – the dominant element in Ireland's energy mix (Figure 17, measured as a percentage of total primary energy consumption in million of tonnes of oil equivalent – mtoe):

Figure 17:

Oil Share of Total Energy Used in Ireland

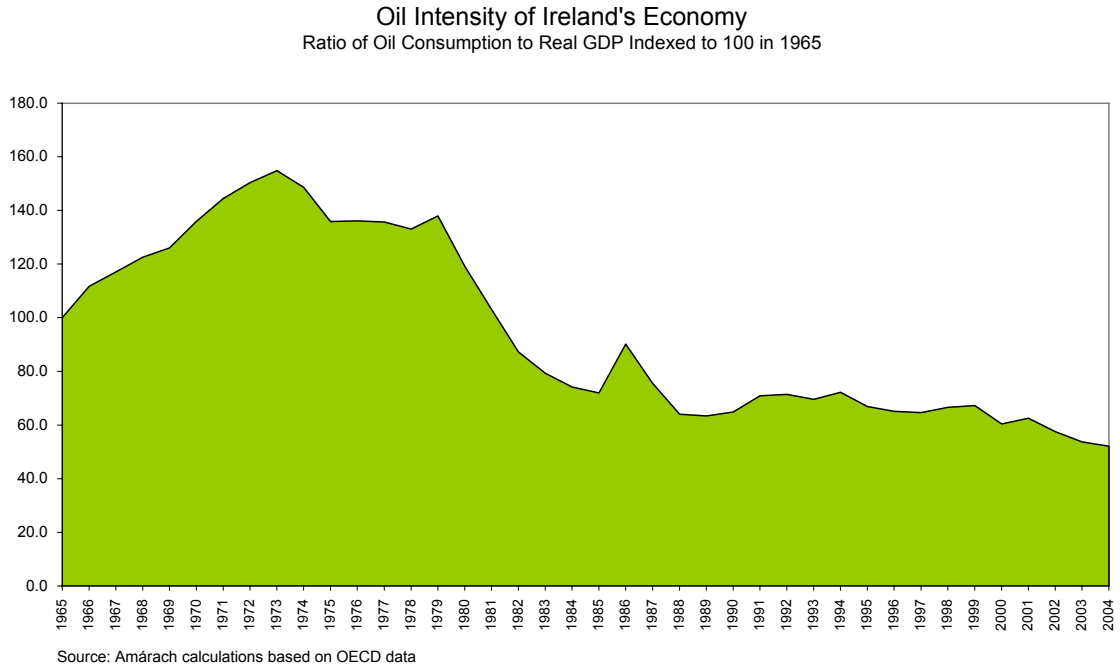


Amárach calculations based on BP Statistical Review, 2005

Nevertheless, the long run trend is for the 'oil intensity' of Ireland's economic output to decline as the economy moves away from manufacturing (which typically has a higher requirement for oil-related inputs) to services (which tend to be more reliant on electricity as a main energy input).

As Figure 18 shows, the oil intensity of Ireland's economy (measured as a ratio of oil consumption to real GDP, indexed to 1965 = 100) actually increased during the 1970s as Ireland underwent its own industrial revolution, but then fell steeply from the mid-1980s onwards. Ireland therefore needs marginally less inputs of oil to generate each marginal increase in economic output – though of course, the oil is still necessary, even if slightly less extra is required each time.

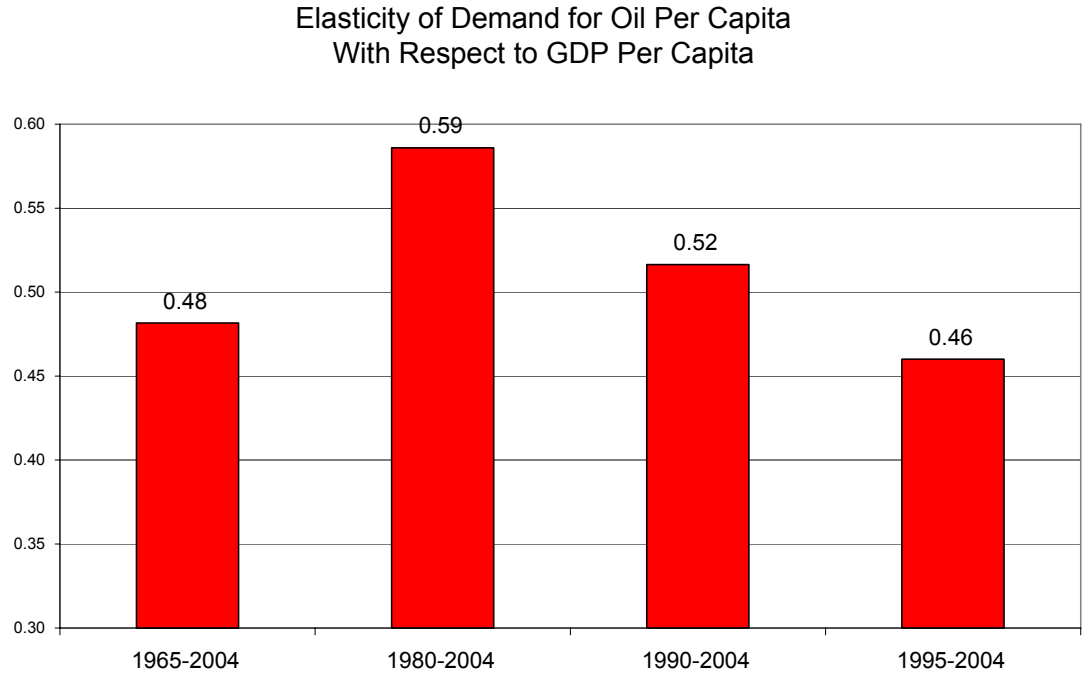
Figure 18:



The declining oil intensity of Ireland's economic output is reflected in the gradual decline in the elasticity of demand for oil charted next – with the relation weakening in recent years. Figure 19 below tells us that, since 1995 for example, every 1 percentage point increase in real GDP per capita has lead to an increase in oil consumption of 0.46 percentage points. So if GDP per capita rises by 10% in real terms, then – other things being equal – oil demand will rise by 4.6%.

This in turn means that the long run outlook for oil consumption in Ireland is for further strong growth against a background of continued economic prosperity.

Figure 19:



Source: Amárach calculations based on BP and CSO historical data

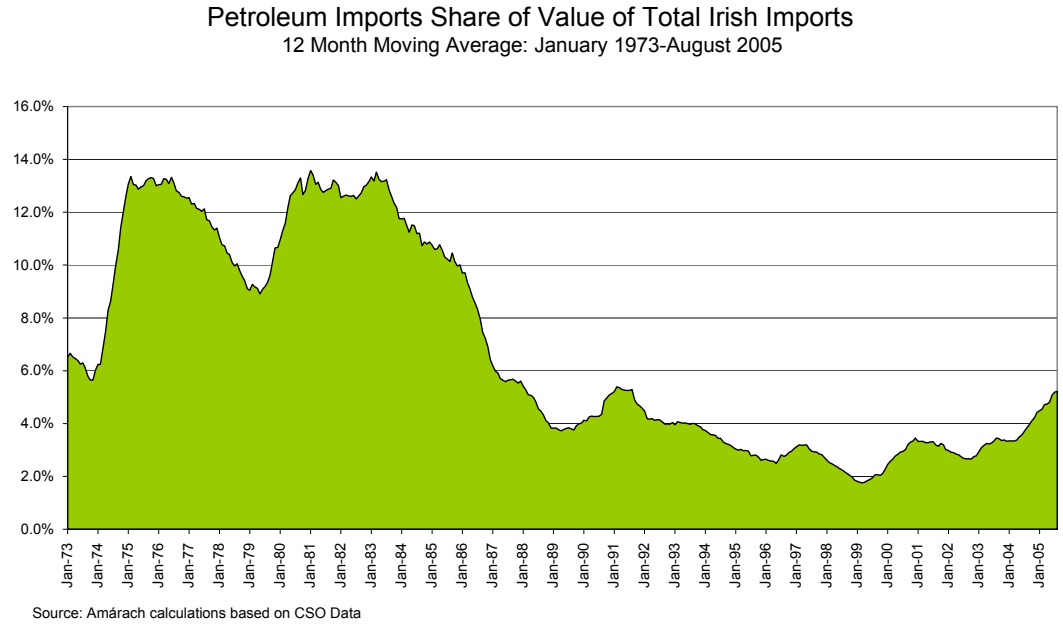
It is crucially important, however, to note that – even though the oil intensity of Ireland's economic output has declined (in line with all other developed economies) – the total requirement for oil has nevertheless increased over time. In other words, the elasticity of demand remains positive which leads us to expect that further economic growth in Ireland will lead to increasing demand for oil.

Oil Imports

Ireland has no indigenous sources of oil so all our requirements are imported, as noted earlier. This has meant that Ireland's balance of trade has – in the past – been particularly vulnerable to rising oil prices feeding through into a rising cost of oil imports.

However, with recent economic growth and oil price stability, the share of oil in the value of total Irish imports has long since declined from its peak of nearly 14% of the value of imports in the early 1980s. Figure 20 below shows the monthly share of petroleum imports on a twelve month moving average since January 1973.

Figure 20:



Note, however, that the recent rise in oil prices has led to some increase in the share of petroleum in the value of imports – back to levels last seen in 1991 following Iraq's invasion of Kuwait.

Ireland's Oil Sector

Ireland relies mainly on the importation of refined petroleum and related products, with some refining of imported crude oil at the Whitegate facility in Cork operated by Conoco Phillips (which provides up to 20% of all refined product requirements currently). Whitegate has a processing capacity of 71,000 barrels per day.

A growing share of Ireland's refined and crude oil supplies now come from the UK (previously they came almost exclusively from Norway until the sale of Whitegate by the Government in 2001).

The Government's National Oil Reserves Agency (NORA) is responsible for the management of the country's strategic oil reserve stocks (in compliance with European Union (EU), International Energy Agency (IEA) and national criteria). NORA has oil stocks stored in various locations around Ireland as well as in a number of overseas facilities. In addition, NORA has contracts in place (known in the oil industry as "stock tickets") to secure additional oil reserves at time of emergency.

Table 7 shows the latest composition and location of Ireland's strategic oil reserves:

Table 7: Number of Days of Oil Stock Held by Ireland at 1 July 2005, IEA Methodology

Number of days of oil stocks held by Ireland at 1 July 2005 IEA methodology

	In Ireland (days)	Abroad (days)	Total (days)
NORA stocks Wholly owned	31	7*	38
Ticketed (Stock tickets) **	0	24	24
Industry/Consumer Stocks ***	38	Not applicable	38
Total	69	31	100

Source: NORA, www.dcmnr.gov.ie

*These are stocks held in other EU countries under cover of Bilateral Agreements whereby the host country guarantees that it would not oppose the transfer of the oil in question to Ireland in the event of an emergency.
** Surplus (i.e. over and above operational stocks) private sector stocks which NORA rents with an option to purchase (during the period of the contract) in the event of an emergency.
*** These are operational stocks held at major ports, the Whitegate refinery and by large consumer companies such as the ESB which would be legally and physically amenable to the Minister's control in the event of an emergency under the Fuels Acts 1971 and 1982. Industry stocks that have already been delivered to filling stations etc. are not included.

Though there were high expectations for the development of an offshore oil industry in Ireland in the 1970s and 1980s, subsequent findings were discouraging. Operators spent some €2 billion in real terms between 1971 and 2003, drilling more than 140 exploration & appraisal wells. Ireland's exploration success rate has been among the lowest in the world. Historically, the chances of a commercial find have worked out at about one in 50. Though there has been success in developing commercially viable gas fields (Kinsale and, eventually, Corrib), there have been no viable oil finds – nor is there any prospect of same at present.

In all likelihood then, Ireland will continue to rely on imports to meet all our oil requirements for the foreseeable future.

An Increasing Demand

As noted earlier – every 10% increase in real GDP per capita at present translates into an increase in oil consumption of almost 5%. Even as the oil intensity of economic output continues to decline in Ireland, the reality remains that that oil intensity will never reach 'zero', in other words, further economic growth will – for the foreseeable future – always lead to some, however modest increase in oil consumption.

The ESRI's Medium Term Review 2005-2012 provides the best available long-term forecast for oil demand in Ireland. Table 8 – from the report - shows the demand for primary energy (including electricity production and importation) by fuel in tonnes of oil equivalent (TOE). The table compares two economic scenarios – one characterized by High Growth over the next ten years (with an average annual increase in GNP of 5.7% to 2010, declining to an average of 3.9% from 2010 to 2015); and one by Low Growth over the next fifteen years (an average growth rate of 3.5% to 2010, and 3.2% from 2010 to 2020):

Table 8: Ireland's Demand for Primary Energy by Fuel, 1990-2020

Demand for Primary Energy by Fuel, Thousand TOE

								Average Annual Growth Rates				
	1990	1995	2000	2005	2010	2015	2020	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020
						High Growth						
Coal	2,163	1,917	1,989	1,995	2,168	1,488		0.7	0.1	1.7	-7.2	
Oil	4,285	5,454	7,868	8,784	9,471	10,341		7.6	2.2	1.5	1.8	
Gas	1,447	1,916	3,059	3,918	5,320	6,123		9.8	5.1	6.3	2.9	
Peat	1,358	1,214	804	925	834	687		-7.9	2.9	-2.1	-3.8	
Renewables	110	132	187	294	411	489		7.2	9.4	7.0	3.5	
Electricity	59	60	73	71	153	209		4.0	-0.7	16.8	6.4	
Feedstock	430	423	384	0	0	0		-1.9	-100.0			
Total	9,852	11,116	14,364	15,987	18,358	19,338		5.3	2.2	2.8	1.0	
						Low Growth						
Coal					2,163	1,472	814				-7.4	-11.2
Oil					9,354	9,958	10,683				1.3	1.4
Gas					5,211	5,709	6,605				1.8	3.0
Peat					829	677	551				-4.0	-4.0
Renewables					411	489	568				3.5	3.0
Electricity					153	209	264				6.4	4.8
Feedstock					0	0	0					
Total					18,121	18,514	19,485				0.4	1.0

Source: ESRI Medium-Term Review 2005-2012

The ESRI's forecasts assume an average annual increase in real oil prices of 5.4% to 2010.

Though the rate of growth in demand for oil is expected to decline over the next 10-15 years under either scenario, the total amount consumed each year will nevertheless increase. It would appear then that Ireland's economic future is inextricably linked to oil for some time to come. But if the future for global oil supplies is increasingly uncertain, then this in turn implies an increasing vulnerability on Ireland's part to the supply disruptions and price shocks threatened by peak oil.

Ireland's Vulnerability

Indeed, on a number of measures, Ireland remains highly vulnerable to potential interruptions to the supply of oil imports, despite the decline in oil intensity.

Table 9 below shows three measures of 'oil vulnerability', namely:

- The sensitivity of economy to a rise in oil prices
- The dependence of the economy on imported oil rather than indigenously produced oil, and
- The share of oil in the total energy consumed by the economy.

These three measures combined create what we have called the 'Oil Vulnerability Index', with a higher index equating to greater vulnerability. The table shows that Ireland is one of the highest scoring countries listed in terms of the components of the index.

Table 9: Global Oil Vulnerability Index

	Oil Price Sensitivity (1)	Oil Import Dependence (2)	Oil Energy Dependence (3)	Oil Vulnerability Index (4)
Singapore	-1.3	0.98	0.97	3.25
Israel	-0.8	0.99	0.72	2.51
Hong Kong	-0.7	1.00	0.68	2.38
Greece	-0.7	0.98	0.62	2.30
Ireland	**-0.6**	**1.00**	**0.60**	**2.20**
Spain	-0.6	0.98	0.54	2.12
Germany	-0.6	0.95	0.40	1.95
Italy	-0.5	0.94	0.50	1.94
Sweden	-0.6	1.00	0.32	1.92
Switzerland	-0.5	0.99	0.42	1.91
Japan	-0.4	0.98	0.50	1.88
Iceland	-0.6	1.00	0.27	1.87
Finland	-0.5	0.96	0.36	1.82
Austria	-0.5	0.91	0.40	1.81
France	-0.4	0.96	0.37	1.73
New Zealand	-0.6	0.67	0.32	1.59
Netherlands	-0.1	0.91	0.48	1.49
USA	-0.4	0.54	0.39	1.33
China	-0.4	0.30	0.25	0.95
Australia	0.0	0.13	0.33	0.46

1. Impact on GDP of a 10% increase in real oil price
2. (Oil Consumption - Indigenous Oil Production)/Oil Consumption
3. Ratio of Petroleum Consumption to Total Primary Energy Consumption
4. Sum of 1-3 (using absolute value of price elasticity)

Source: World Bank, March 2005 + Amárach estimates

This simple measure – coupled with our earlier analyses of Ireland's reliance on oil for total energy, electricity and transportation relative to other EU countries – highlights just how vulnerable our economy is. In its 2003 review of Ireland, the International Energy Agency noted that:

This high rate of energy demand growth has occasionally strained the country's energy infrastructure and, while these constraints are generally being addressed, they increase concerns about the country's overall energy security. These concerns are fuelled in part by the country's lack of substantial domestic energy resources and consequent high level of imports. In 2000, only 15% of the country's energy came from indigenous sources. The country's relative isolation and lack of extensive international energy connections also exacerbate Ireland's vulnerability to supply disruptions and/or price spikes[23].

We have examined in this chapter how the economy as a whole has come to rely on oil – and the implications of this reliance for economic security and energy vulnerability. In the next chapter, we look in more detail at how different sectors of the economy – manufacturing, services and agriculture – could be affected by peak oil.

[23] Ibid.

3. The Sectoral Impact of Peak Oil

Summary of Chapter 3

Though the wider economic impact of oil price rises are well known, it is less clear just how a potential oil shock of the magnitude and duration of peak oil would actually affect different sectors of the economy.

Some useful information about the consumption of oil and other fuels at a service and industry sector level has been gathered in recent years as part of the assessment of Ireland's progress towards it Kyoto commitments. Though mainly focused on CO2 and other emissions, the information nevertheless provides us with valuable comparative information on the relative dependence of different sectors on oil.

In the case of the services sector, oil consumption has remained relatively unchanged in volume terms over the past fifteen years, and has fallen substantially as a share of total fuel usage – giving way to gas and electricity. The effects of peak oil induced price increases will directly affect a small number of service sub-sectors, e.g.: aviation and tourism. The greater effects will be those that are indirect, including a reduction in consumer demand (which affects services more than products, as the former has a higher elasticity of demand on average).

Manufacturing relies on oil both for transportation and lubrication of machinery. Some sectors – such as mining and equipment manufacturing – are more reliant on oil (as a share of total fuel requirements) than others. Electricity generation is a category within manufacturing, and not surprisingly it accounts for the dominant share of oil requirements, as explained in the previous chapter. A number of industrial sub-sectors are potentially vulnerable to a sustained increase in oil prices, including several that supply the construction industry (e.g.: quarrying and mining). As with services, the indirect effect of weakening demand will likely be of greater consequence over the medium to long term.

The residential sector primarily uses oil for space heating (approximately half of all adults have this requirement), as well of course for transportation. With regard to the former, other than using electricity or bottled gas, there are few alternatives available to households in relation to central heating.

The agricultural sector uses oil directly in relation to operating tractors and self-propelled machinery, as well as for transportation. The indirect use of oil via sub-contractors is a larger contributor to oil consumption in relation to agriculture. As with the industry analysis, it appears that oil costs nevertheless represent a relatively small part of total operating costs for agriculture. Agriculture, like services, may be more vulnerable to the indirect impact of rising costs rather than the direct effect.

The Oil Balance

A key place to start in relation to assessing the sectoral impact of peak oil is with Ireland's oil balance – showing where Ireland's oil comes from, and where it is used. As Table 10 shows, transportation and the residential sectors consume the greater part of Ireland's oil, followed by industry and agriculture.

Table 10: Oil Consumption in Ireland by Sector, SEI

Oil Balance 2004 (000 TOE)

2004 T.O.E.	Crude	Refinery Gas	Gasoline	Kerosene	JET Kero	LSFueloil	HSFueloil	LPG	Gasoil	Derv	Naphta	Total
Production		98	588	266	0	951	0	60	453	560	23	2999
From Other Sources												
Import	2959		1199	383	976	1217	16	126	865	1525		9266
Export			130	14	0	927	0	22	75	54	27	1249
Marine Bunkers						16	33		104	0		153
Stock Changes	-38	0	-75	-262	389	-35	-34	2	-180	-118	-5	-356
DOMESTIC SUPPLY		**98**	**1732**	**897**	**587**	**1260**	**17**	**162**	**1318**	**2148**	**0**	**8219**
TRANSF. SECTOR			**0**	**0**	**0**	**778**	**0**	**0**	**33**	**0**	**0**	**811**
Publ. Electr.						778			33			**811**
Autoproducers												0
CHP Plants												0
Gas Works												
ENERGY SECTOR	**0**	**98**	**0**	**0**	**0**	**18**	**0**	**6**	**8**	**0**	**0**	**130**
Oil Refineries		98				18	0	6	8			**130**
FINAL CONSUMPTION	**0**		**1732**	**897**	**587**	**465**	**17**	**155**	**1276**	**2148**	**0**	**7277**
INDUSTRY	0	0	0	121	0	333	12	66	185	0	0	**717**
TRANSPORT	0	0	1732	0	587	16	1	5	40	2148	0	**4529**
OTHER SECTORS	0		0	776	0	116	4	85	1051	0	0	**2032**
Agriculture									262			**262**
Comm. and Publ.				0	0	116	4	11	550			**681**
Residential				776				74	239			**1089**

Source: Sustainable Energy Ireland, 2005

We have already noted the predominant use of oil in transportation in Ireland. Therefore in this chapter, we focus on the use of oil in industry and services, referring briefly to the agricultural and residential sectors.

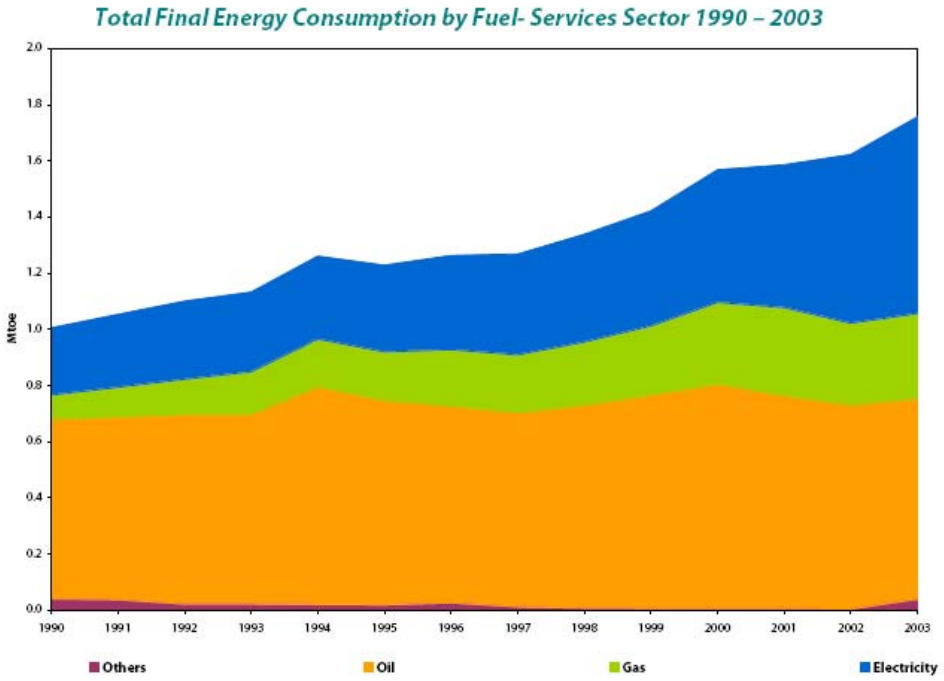
The Services Sector

It is important to bear in mind – at the risk of repetition – that Ireland will not be unique in relation to how we are affected by high and rising oil prices. This in turn means that key sectors such as financial services (and the IFSC for that matter) will not be at any particular disadvantage vis-à-vis their competitors elsewhere.

However, a key issue will be the capacity of the telecommunications infrastructure as this will undoubtedly come under massively increased demand due, for example, to increased use of video conferencing and even voip (voice over internet protocol). Here again will be an infrastructural challenge – domestic (e.g.: regions) and international (e.g.: internationally traded services).

In terms of the use of oil within the services sector, we can see from recent analyses by Sustainable Energy Ireland (Figure 21) that oil remains a key but relatively less important source of fuels for the sector:

Figure 21:



SOURCE: SEI

Furthermore, it is clear from the following tables (Tables 11 and 12) that other fuels usage has grown far more rapidly than that of oil in the past fifteen years:

Tables 11and 12:

: Final Energy Consumption in the Services Sector

ktoe	1990	1993	1996	1999	2000	2001	2002	2003
Oil	639	675	701	761	799	759	727	714
Gas	87	152	201	246	293	314	291	303
Electricity	240	285	336	411	473	510	602	702
Others	40	21	25	4	4	4	3	38
Total	1006	1133	1263	1422	1569	1587	1623	1758

SOURCE: SEI

Growth Rates and Shares of Final Energy Consumption in the Services Sector

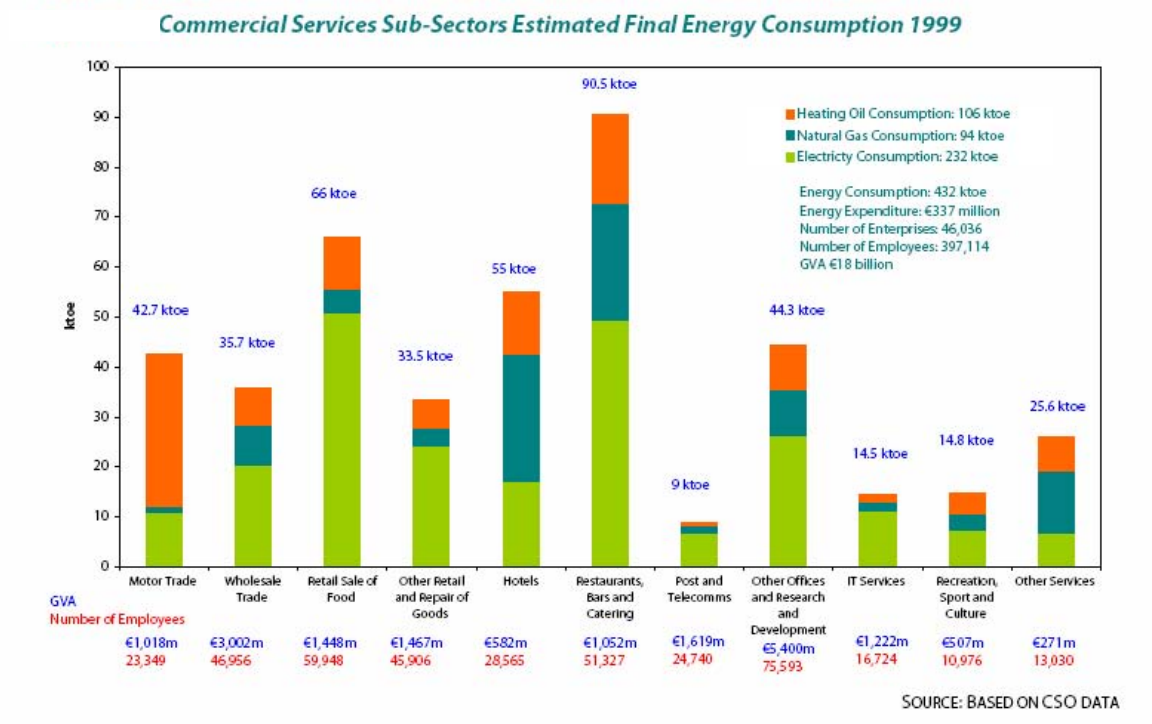
	Growth %	Average annual growth rates %					Shares %	
	1990 – '03	1990 – '03	1990 – '95	1995 – '00	2000 – '03	2003	1990	2003
Oil	11.7	0.9	2.6	1.9	-3.7	-1.8	63.5	40.6
Gas	250.4	10.1	14.9	11.0	1.2	4.3	8.6	17.3
Electricity	192	8.6	5.2	8.9	14.1	16.6	23.9	39.9
Others	-3.1	-0.2	-14.9	-25.7	*	*	4.0	2.2
Total	74.8	4.4	4.1	5.0	3.9	8.3	100	100

* Due to a reclassification 2003 data is not directly comparable with other years.

SOURCE: SEI

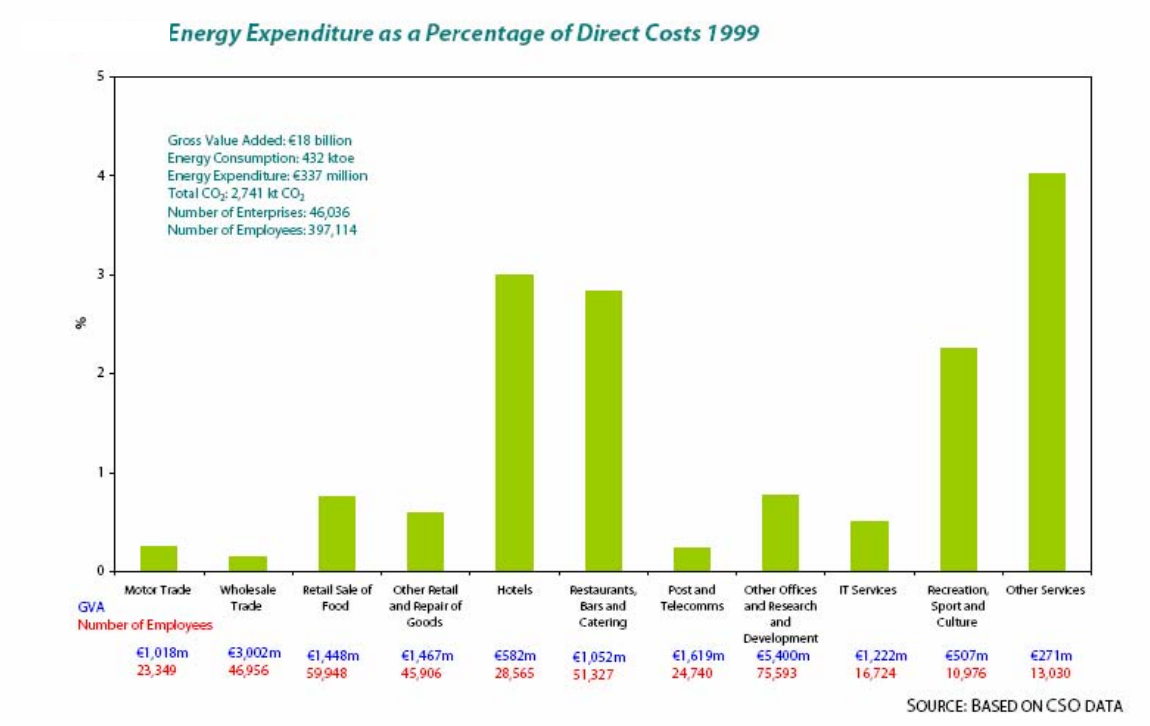
As a result, oil's share of final energy consumption in the services sector has fallen from 63.5% in 1990 to 40.6% in 2003. However, as with our discussion previously of energy intensity, a declining share does not necessarily equate to a falling absolute demand. In fact, the amount of oil used by the services sector has increased by 12% since 1990, however this compares favorably to the increase of 93% in oil consumption in the economy as a whole over the same period. As we can see in Figure 22, most of the services sector's requirements for oil relate to its use for space heating, with some sub-sectors more reliant than others on oil:

Figure 22:



With the exception of the motor trade (which has obvious requirements for oil and lubricants), no other sub-sector relies predominantly on oil to meet their total final energy requirements. Rather electricity is the predominant input, followed by gas in most instances. All of this suggests that the services sector will be less likely to experience severe direct effects as a result of peak oil induced shortages, given the potential to substitute oil use in most instances with gas and electricity (e.g.: for space heating). As Figure 23 illustrates, energy costs in general account for only a small share of costs in most services sub-sectors, and oil is in turn only a part of these already small costs:

Figure 23:



The 'Other Services' category covers a great many services – some of which are directly vulnerable to oil price increases, e.g.:

- *Aviation* – though some airlines have avoided some of the consequences of recent oil price increases through hedging, the sector as a whole has seen prices rise as a result of fuel costs. Clearly a continuation of this trend – or a marked deterioration due to further price increases – will have a negative effect on air travel due to rising fuel prices.
- *Tourism* – aside from the impact on costs of getting to Ireland, there are also direct costs arising from the costs to tourists of getting around Ireland. Car hire and even coach usage would be affected by rising oil prices – which would have an adverse effect on those regions distant from airports, though possibly a beneficial effect on cities like Dublin with more 'compact' tourist attractions.

We should not be too sanguine, however, about the consequences of peak oil for the services sector overall. In all likelihood, the indirect effects of an economic slowdown and even recession will be more severely felt than those arising from a need to change the source of energy for heating.

Impact on Services Sector: Summary

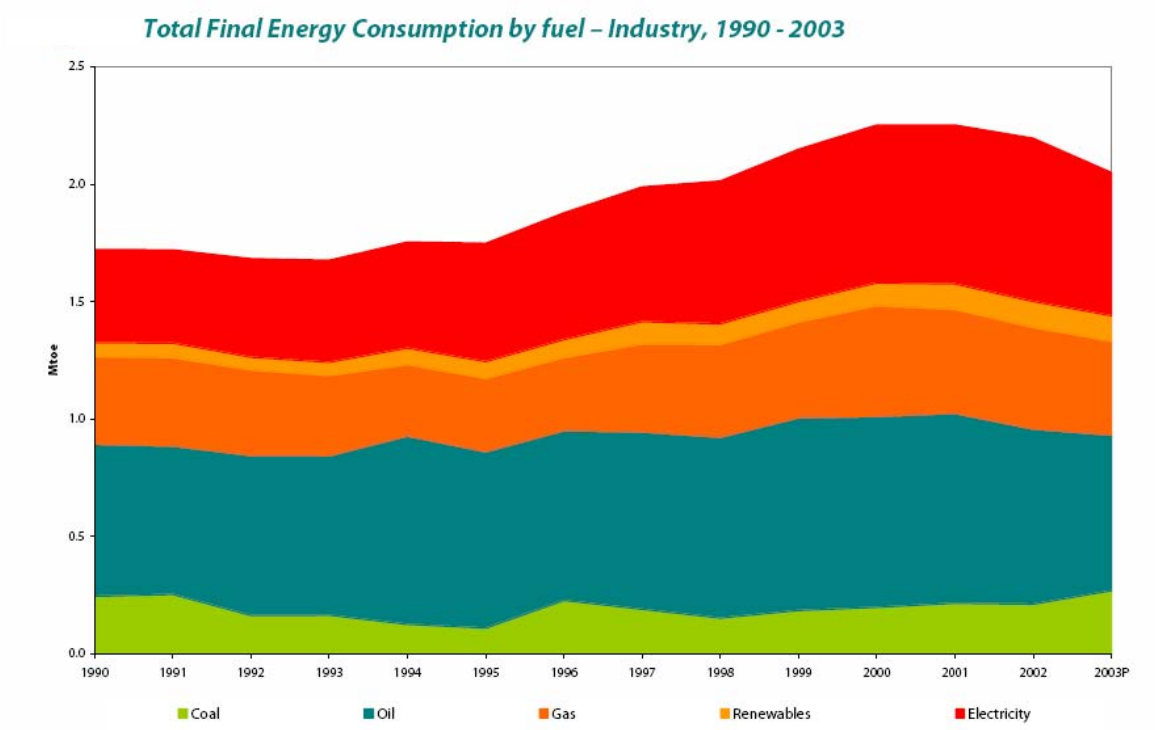
- The effects of peak oil induced price increases will directly affect a small number of service sub-sectors, e.g.: aviation and tourism.
- The greater effects will be those that are indirect, including a reduction in consumer demand (which affects services more than products, as the former has a higher elasticity of demand on average).

Industry Sector

Ireland is fortunate in not having a major petro-chemical sector, which by definition is critically dependent on oil as a raw material input. But we do have other industrial sectors – such as IT and pharmaceuticals – that are very dependent on secure, uninterrupted energy supplies (particularly electricity).

As with the services sector, oil's share of the final energy demand of industry has fallen steadily in recent years, driven partly by an increase in the share of gas and electricity, (Figure 24):

Figure 24:



Nevertheless, industry still requires oil as an energy input, though the absolute amount consumed has remained almost constant over the past fifteen years (not even experiencing the modest increase seen in the services sector). The decline of more traditional industries that would have had a higher requirement for oil (as a direct input into the manufacturing process or simply for space heating requirements) has likely lead to this constant trend.

In 2001, the Central Statistics Office captured detailed information on fuel expenditure in its Census of Industrial Production. This information enables us to take a more detailed look at how different industrial sub-sectors are likely to fare in relation to a permanent constraint on oil supplies, and the resultant price volatility.

Table 13 below shows the share of different industrial sectors (in broad NACE code categories) in total oil purchase in 2001:

Table 13: Oil Spend across Industry Sector in Ireland, 2001

		% of Total Oil Spend	Total Oil €000	*Gas oil*	*Heavy fuel oil*	*Petrol*	*Autodiesel*	*LPG (for vehicles)*	*Other*
10 - 14	Mining and quarrying	6.6%	€27,457	€8,624	€2,738	€88	€15,359	€203	€445
15 - 16	Manufacture of food products; beverages and tobacco	16.5%	€68,220	€8,265	€30,337	€7,510	€19,023	€2,185	€900
17 - 18	Manufacture of textiles and textile products	1.1%	€4,469	€1,333	€2,594	€249	€271	€22	€0
20	Manufacture of wood and wood products	0.5%	€1,886	€150	€610	€336	€318	€472	€0
21 - 22	Manufacture of pulp, paper and paper products; publishing and printing	0.9%	€3,592	€60	€1,360	€260	€1,738	€3	€171
24	Manufacture of chemicals, chemical products and man-made fibres	1.0%	€4,287	€1,209	€514	€2,290	€274	€0	€0
25	Manufacture of rubber and plastic products	4.1%	€16,855	€2,957	€10,153	€1,043	€2,003	€405	€294
26	Manufacture of other non-metallic mineral products	0.5%	€2,131	€1,320	€202	€244	€309	€54	€2
27 - 28	Manufacture of basic metals and fabricated metal products	6.0%	€24,735	€4,754	€5,026	€455	€13,799	€701	€0
29	Manufacture of machinery and equipment n.e.c.	10.8%	€44,801	€721	€42,235	€81	€1,764	€0	€0
30 - 33	Manufacture of electrical and optical equipment	0.6%	€2,641	€840	€826	€279	€478	€132	€86
34 - 35	Manufacture of transport equipment	2.9%	€11,816	€8,685	€1,188	€1,655	€162	€0	€126
36 - 37, 23	Manufacturing n.e.c.	0.3%	€1,405	€298	€261	€211	€283	€352	€0
40	Electricity, gas and water supply	48.2%	€199,094	€7,903	€190,213	€34	€916	€28	€0
	All Industries	100.0%	€413,388	€47,120	€288,257	€14,734	€56,698	€4,555	€2,024
	Transportable goods industries	51.8%	€214,294	€39,217	€98,044	€14,700	€55,782	€4,527	€2,024
	Manufacturing industries	45.2%	€186,837	€30,593	€95,306	€14,612	€40,423	€4,324	€1,579

Source: Amárach calculations based on Census of Industrial Production, CSO, 2001

Electricity generation accounts for the largest single share of total oil consumed. However other sectors that drive oil demand by industry include the food and beverage sector and the machinery manufacturing sector. Table 14 shows the share of oil in total fuel consumption, its share of total non-labour costs and oil spend per employee:

Table 14: Share of Oil in Total Fuel Consumption

		Oil Share of Total Fuel	Oil Share of All Non-Labour Purchases	Oil Spend per Employee
10 - 14	Mining and quarrying	41.7%	3.6%	€4,940
15 - 16	Manufacture of food products; beverages and tobacco	31.4%	0.5%	€1,343
17 - 18	Manufacture of textiles and textile products	24.1%	0.7%	€490
20	Manufacture of wood and wood products	10.1%	0.3%	€312
21 - 22	Manufacture of pulp, paper and paper products; publishing and printing	15.4%	0.1%	€153
24	Manufacture of chemicals, chemical products and man-made fibres	13.9%	0.0%	€177
25	Manufacture of rubber and plastic products	14.2%	2.2%	€1,762
26	Manufacture of other non-metallic mineral products	9.0%	0.2%	€200
27 - 28	Manufacture of basic metals and fabricated metal products	26.4%	2.2%	€1,605
29	Manufacture of machinery and equipment n.e.c.	61.1%	3.8%	€3,189
30 - 33	Manufacture of electrical and optical equipment	12.9%	0.0%	€41
34 - 35	Manufacture of transport equipment	13.0%	1.8%	€1,437
36 - 37, 23	Manufacturing n.e.c.	12.2%	0.1%	€125
40	Electricity, gas and water supply	26.4%	11.9%	€19,858
	All Industries	26.5%	0.6%	€1,565
	Transportable goods industries	26.6%	0.3%	€843
	Manufacturing industries	25.2%	0.3%	€752

Source: Amárach calculations based on Census of Industrial Production, CSO, 2001

The mining and quarrying sector has a high dependency on oil as a share of its total fuel requirements, and is second only to the electricity generation sector in spend per employee. Overall, however, oil's share of total non-labour costs for industry is relatively small – at just 0.6% of the total.

In terms of anticipating the potential impact of peak oil at an industry sector level, particularly with regard to oil expenditure per employee, the most vulnerable sectors – excluding power generation – appear to be mining/quarrying and machinery manufacturing.

Ireland's Emerging Sectors

A number of sectors play a key part in Ireland's economic and trade performance. These include the pharmaceuticals and computer hardware and software manufacturing sectors. These correspond approximately to the NACE categories 24 and 30-33 in the previous two tables.

Our analysis of these sectors in the context of all industrial categories shows that they have a below average level of vulnerability in relation to the direct consumption of oil. This is especially encouraging given the contribution of these sectors to the economy.

Other, emerging sectors such as digital media and web hosting services will tend to follow the pattern of the services sector as a whole and the computer manufacturing sector in particular. In other words, we would expect to see low direct usage of oil as an input, though higher indirect exposure (e.g.: via the price of plastics – derived from oil – used to manufacture equipment such as computers

Nevertheless, emerging sectors will only be indirectly at risk from peak oil – and the very high gross value added per employee of these categories will mean that transportation costs, even by road freight, will not impinge severely on total sales costs.

Looking ahead to the likely consequence of a higher price of oil (and threatened scarcity), we may see a reinforcement of the current spatial distribution of industry in terms of its bias towards the Dublin and Cork hinterlands, stalling any potential developments outside these areas. This would be mainly due to rising transportation costs, and in particular, access to ports for exported manufactures.

Indeed, we are likely to see the emergence of 'energy parks' as opposed to business parks, where the focus will be on providing secure, onsite electricity generation (with grid backup) to support energy-intensive industrial and service activities. This will appeal both to those industries with a higher requirement for electricity inputs, as well as to those using oil but looking to substitute the same with greater electricity usage.

Impact on Industrial Sector: Summary

- A number of industrial sub-sectors are potentially vulnerable to a sustained increase in oil prices, including several that supply the construction industry (e.g.: quarrying and mining).
- As with services, the indirect effect of weakening demand will likely be of greater consequence over the medium to long term.

Residential Sector

In marked contrast to the services and industrial sectors, the residential sector has seen a marked growth in the share of oil in final energy consumption – more than doubling its share in the past fifteen years according to a recent study by Sustainable Energy Ireland summarised in Table 15 below[24]:

Table 15:

Growth Rates and Shares of Final Energy Consumption in the Residential Sector

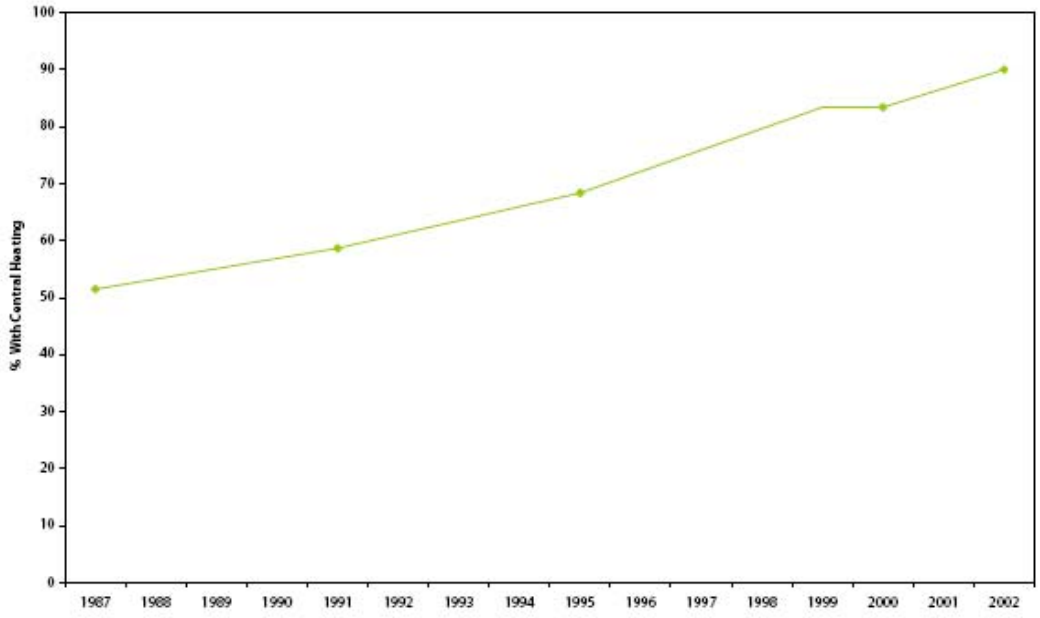
	Growth %	Average Annual Growth Rates %		Shares[16] %	
	1990 – '04	1990 – '04	2004	1990	2004
Oil	211.7	8.5	5.6	15.9	*37.7*
Gas	405.7	12	10	5.4	*20.6*
Electricity	77.6	4.2	5.4	16.2	*21.9*
Coal	-56.5	-5.8	-9.2	27.4	*9.1*
Peat	-69	-8	0	26	*6.1*
Briquettes	-42.2	-3.8	-4.1	7.1	*3.1*
Renewables	2.2	0.2	0	1.9	*1.5*
Total	31.7	19	3.2		

SOURCE: SEI

A key driver in domestic oil consumption has been the growth in penetration of central heating in Irish households – from 25% in 1974 to 90% in 2002 as shown in Figure 25:

Figure 25:

Penetration of Central Heating - Selected Years



Note that the trend is interpolated linearly for years where data are not available. *Source: CSO and ESRI*

Oil has become a more important source of central heating fuel in recent decades – rising from 12% in 1987 to 38% in 2002, (Figure 25). Some 42% of all households with central heating now rely on oil as their fuel source. This is expected to decline slowly as the mains gas grid is

24

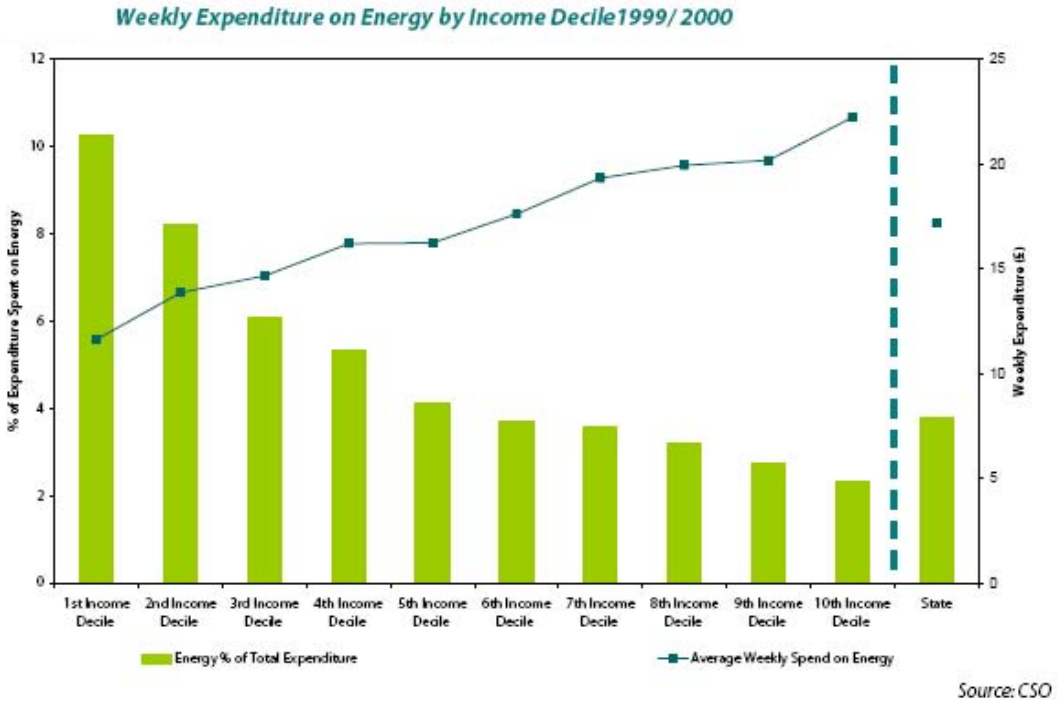
Energy Consumption and CO2 Emissions in the Residential Sector 1990 – 2004, SEI, 2005

extended to other cities and towns – but it does illustrate a marked vulnerability on the part of Irish households to interruptions in oil supplies.

Moreover, it is important to note that lower income households spend proportionately more on energy (including oil, gas, solid fuel and electricity) than wealthier households. On average in 1999/2000, energy expenditure accounted for just 4% of total household weekly expenditure.

However, this share stood at 10% for the lowest income decile of households, falling to little over 2% for the top decile, highlighted in Figure 26 below:

Figure 26:



Average household size tends to be larger for users of oil-fired central hearting. Therefore rising oil prices have and will impact on the majority of adults in Ireland, simply because of their use of oil for heating purposes. In reality, such households have relatively few options in relation to other fuels for running central heating systems. Many of those using oil do not have access to the mains gas grid which mainly links the major urban conurbations. In the context of future rises in oil prices there will be a switch away from oil to biomass, limited perhaps by the relatively few suppliers of biomass fuelled central heating systems at present and the toxic emissions that result from the burning of biomass in homes.

An even greater challenge, however, will be the relatively poor level of insulation and energy efficiency in residential buildings in Ireland. This will only exacerbate the substantial threat of a rise in fuel poverty among those who cannot afford the capital cost of switching away from oil – or the running cost of the alternatives.

Agricultural Sector

A key challenge for the agricultural sector will be the knock-on impact of rising oil prices on gas prices and therefore on artificial fertiliser prices (as gas is a key input into fertiliser manufacture). A related challenge will be the reliance on oil and petrol for the running of the business of farms (tractors etc). In the event of a severe and prolonged shortage of oil, it is likely that farmers will be given priority access to any rationed supplies, simply because of their energy requirements.

Though there is considerable information on agricultural input costs and prices, there is surprisingly little specific information on the use of oil in the agricultural sector. The Teagasc National Farm Survey in 2001 did, however, examine in detail the energy use of Irish farms[25].

In 2001, Teagasc estimate that Irish farmers purchased 258,000 tonnes of fuel oil, at a cost of €140 million. This was for use mainly in the engines of tractors and other self-propelled machines. Farmers also spent an additional €126 million on road vehicle fuels (mainly petrol), of which some €46 million (50,000 tonnes equivalent) was attributed to farming operations. These figures exclude the fuel use of contractors – which combined with those employed directly in farm operations brings the total fuel use up to some 400,000 tonnes – at a cost in 2001 of €220-€240 million.

The type of farming undertaken also has a strong influence on fuel requirements. Teagasc estimate that energy use per hectare is as high as 130 litres of fuel equivalent in the case of arable crop operations – falling to 80 litres per hectare for forage operations.

As with the industry analysis, it appears that oil costs nevertheless represent a relatively small part of total operating costs for agriculture. Agriculture, like services, may be more vulnerable to the indirect impact of rising costs rather than the direct effect.

[25] An estimate of fuel use and related emissions on Irish farms, B. Rice & G. Quinlan, Tegasc

4. Scenarios for the Mitigation of Peak Oil

Summary of Chapter 4

Ireland is especially vulnerable to the consequences of a peak oil induced shock to the world economy. Ireland is no different from many other oil importing countries in its reliance on overseas suppliers to meet its requirements, though its limited crude oil refining capabilities mean that most imports have to be refined before delivery to Ireland.

The impact of peak oil on Ireland is thus best examined through scenarios – using different assumptions about the timing of peak oil and the responsiveness (or otherwise) of policy makers. These show a very diverse set of outcomes, and point to the benefits of early, preparatory initiatives by government, businesses and consumers.

The timing of mitigation strategies is critical – on a global scale, it is likely that it will take 20 years before the onset of peak oil to put in place adequate measures, practices and technologies to fully offset the consequences of a permanent oil supply shortfall. Leaving the onset of mitigation strategies until peak oil is imminent or has occurred will inevitably lead to a gap in energy availability relative to the requirements of a growing economy and population.

Though oil prices are important in signaling changes in the supply and demand of oil, the use of oil futures prices to inform decisions is of limited value as they are invariably anchored to current/spot prices rather than to anticipated future developments.

A key issue arising from this analysis is the extent to which we can rely on others (in particular, the United States) to solve the threatened impact of peak oil for us, such as through technology innovation.

How will Peak Oil affect Ireland?

In this chapter we examine the options open to Ireland to mitigate the consequences of peak oil, and at three global scenarios in relation to how rapidly mitigation is introduced. For the purpose of this chapter, we have assumed that peak oil will inevitably happen, but that the timing remains unclear.

Firstly, however, it is important to address the question as to whether it is necessary to prepare for peak oil, even if it is 'inevitable'? After all, Ireland has experienced the consequences of oil crises and shortages in the past, and our economy has subsequently survived and thrived. The question might reasonably be asked whether – in light of past experience – the onset of peak oil is really going to be any different to past crises?

Ireland has recently experienced the consequences of just such an unforeseen increase in oil prices, exacerbated by Hurricane Katrina and its impact on US oil refining capacity. Crude oil prices – even when denominated in euro – have more than doubled in just over two years. Yet with the oil intensity of our economy at an all time low, it would appear that the impact of rising oil prices on the inflation rate in Ireland and the growth of the economy has been modest and short lived. This could be interpreted to suggest that we have little to fear from further price increases induced by peak oil.

Such a conclusion, however, would be misleading for a number of reasons. The differences between peak oil and previous oil shocks are significant:

No alternative supplies – in previous oil shocks, restrictions on supplies from OPEC countries lead to surging demand, and subsequently production, in non-OPEC countries, albeit a number of years later. In the event of peak oil, it is unlikely that neither OPEC nor non-OPEC suppliers would be able to make up for the short fall in supply.

Physical shortages – in previous oil shocks, oil remained available in adequate quantities, even if panic buying lead to long queues and occasional shortages in petrol stations etc. In the event of peak oil, the amount of oil required to meet prevailing needs for transportation, heating etc will exceed the amount then available in most oil importing, developed countries.

Structural not cyclical – Ireland's economy recovered from previous oil shocks simply because they came to an end, supplies were restored and prices fell back; in turn allowing business to continue more or less as usual. With the onset of peak oil, the economic impact will be structural rather than cyclical, with all the major actors in the economy required to adjust to a permanent reduction in oil availability.

Given these differences, it is clear that peak oil will demand a different response than that given to previous oil shocks. A recent exercise by Feasta, which was part funded by the Environmental Protection Agency, examined a number of different scenarios for Ireland in terms of responding to peak oil[26]. The exercise – which involved a combination of systems dynamic modeling and scenarios-generation workshops – arrived at four different scenarios for Ireland in the context of peak oil. The scenarios are summarized below:

Energy Scenarios for Ireland

Scenario: Business as Usual
Peak oil does not occur until after 2030 – and until such time there is an adequate supply of oil to meet the world's needs, and those of Irish businesses and consumers. However, Ireland is lulled into a false sense of security and fails to diversify into renewables and other non-fossil fuel supplies until it is too late. The resultant upward spiral in the economy's energy costs drives down incomes, output and economic growth – leading to a prolonged economic depression.

Scenario: Enlightened Transition
Again it is assumed that peak oil does not occur until after 2030 – but in this scenario, government, businesses and consumers prepare for the transition from 2005 onwards. Security of energy supply is ranked more important than low energy costs, and every effort is made to develop new sources of energy (renewables, distributed generation), and to reduce consumption (by adopting radical energy efficiency standards for buildings, cars and manufacturers). With the onset of peak oil, Ireland becomes a favoured location for energy-intensive manufacturers and other businesses due to the high level of energy security. This surge in inward investment helps offset the inevitable consequences of rising oil and transportation costs on the economy and trade.

Scenario: Fair Shares
Peak oil arrives sooner than expected – in 2007. An international approach is taken to addressing the new shortages, ensuring that the developing world has fair access to limited resources (through a process of new emission permits). Ireland adopts radical policies on energy efficiency, and all transport investment is re-directed exclusively into electrified bus and rail services. The economy nevertheless suffers as rising energy costs impact on consumer incomes and business profits. A difficult process of adjustment leads eventually to a 'back to the future' world of farmers using horses rather than tractors, and ships using sail wings rather than diesel to facilitate trade.

Scenario: Localisation
As with the previous scenario, peak oil arrives in 2007. The world's central banks treat it as another inflation inducing oil shock – and raise interest rates to curb the impact.
Economic recession sets in Ireland, and capital spending – public and private – collapses in the wake of price volatility and collapsing world demand. The following years and decades experience a 'zig-zag' process of falling oil prices due to recession, giving way to a revival in growth which sparks another price spike – and further recession. Some sectors continue to thrive – including those based on the internet and e-commerce – though most of the interactions

[26] Full details available at www.energyscenariosireland.com

will be local, regional and national rather than global. Nevertheless, the process of adjustment is slow and dis-organised: it is only with the emergence of new community responses to the permanent nature of the crisis that a different pattern of sustainable economic development sets in.

Source: energyscenariosireland.com

These scenarios – and other analyses of the impact of peak oil in a global context – highlight the importance of preparing for peak oil, and the benefits of preparing well in advance. We turn now to examine the issue of mitigation options for Ireland designed to either respond to the onset of peak oil in the short term, or to prepare for its eventual onset in the long term.

Ireland's Energy Options

Ireland is no different from many other oil importing countries in its reliance on overseas suppliers to meet its requirements, though its limited crude oil refining capabilities mean that most imports have to be refined before delivery to Ireland. Thus the challenges we will face from the onset of peak oil will likely be the same as other oil importers with little or no indigenous oil resources of their own.

A key point to make about peak oil is that it is not an *energy crisis* so much as a *liquid fuels crisis*. In other words, the onset of peak oil will not have any immediate consequences for gas supplies (though gas prices will likely go up) nor electricity supplies (to the extent that electricity is or can be generated from fuels other than oil). But it will be a liquid fuels crisis, which will have immediate consequences for the main categories of oil usage, in particular transportation.

There are a number of short term initiatives that can be undertaken to reduce the usage of oil in transportation – mainly relating to changes in commuting and working patterns. In the longer term, however, there are only two options in relation to reducing oil consumption for transportation purposes, namely:

Replace the existing stock of cars with more fuel-efficient cars, including hybrids and others that do not run on petroleum related fuels (e.g.: bio-fuels, hydrogen fuel cells).
Provide alternative modes of transport – particularly public transport – that run on electricity rather than petroleum related fuels (e.g.: electrified trams, trains and buses).

Neither option is likely to yield significant benefits in the form of reduced oil demand for transportation in less than five years – with the main benefits arising after 5-10 years as older cars are replaced and new public transport infrastructure comes on stream. Oil, of course, is also used for other forms of transportation i.e.: air travel and shipping. Neither of these applications is likely to lend themselves to any viable substitution measures for the foreseeable future (and again they are subject to the same fleet replacement challenge as with cars though over a much longer time scale).

Where oil is used for other purposes (e.g.: power and heat generation as well as providing petro-chemicals for industrial processes), then other fuels may be substituted, e.g.: gas; however the time and capacity for this to have a significant impact is likely to be measured on a decade timescale. Nevertheless, there will remain a core of uses and requirements where substitution is simply not viable, for example in the agri-sector where food production and transportation requires the use of diesel-fueled vehicles in the main.

In time, the electrification of transportation will likely be the main route to mitigating the social, spatial and economic impact of peak oil on businesses and consumers. But this in turn highlights the importance of the time horizon we adopt in analyzing peak oil and potential mitigating strategies. Given the structural changes in the pattern of economic activity that peak oil will induce, it is essential to assess the strategies for mitigating its more adverse consequences over an appropriate scale of time – up to 20 years and more.

In the analyses that follow, we explore three stylized scenarios for the world's response to the threat of peak oil, assuming a response at the onset of peak oil; 10 years before the onset; and 20 years before the onset of peak oil.

Mitigation Scenarios

The following analysis builds on the original study of mitigation strategies for the US Department of Energy (DoE) published in February 2005, namely: 'Peaking of World Oil Production: Impacts, Mitigation & Risk Management', by Robert L. Hirsch, SAIC, Project Leader, Roger Bezdek, MISI and Robert Wendling, MISI. Hereafter referred to as the Hirsch Report.

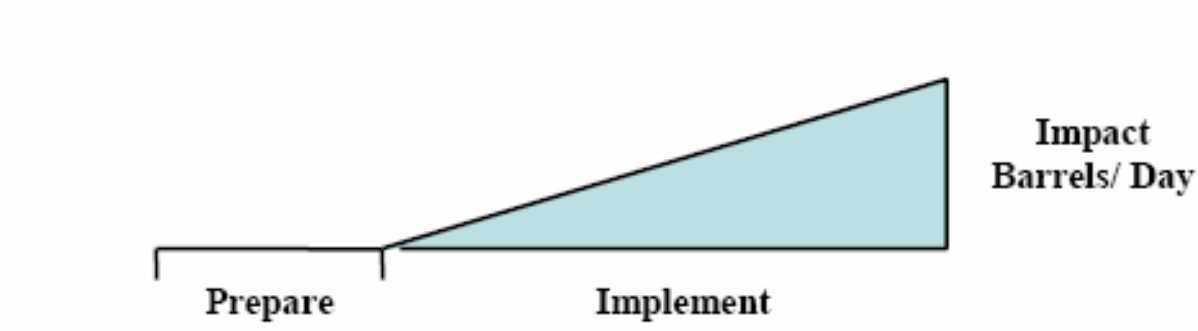
The report modeled a number of different mitigation scenarios in relation to the timing of peak oil and the degree to which mitigation is initiated or not prior to its onset.

The model chosen in the Hirsch Report to illustrate the possible effects of likely mitigation actions involves the use of "delayed wedges" to approximate the scale and pace of each action. The use of wedges was effectively utilized in a recent paper by Pacala and Socolow.[27]

The wedges are composed of two parts. The first is the preparation time needed prior to tangible market penetration. In the case of efficient transportation, this time is required to redesign vehicles and retool factories to produce more efficient vehicles. In the case of the production of substitute fuels, the delay is associated with planning and construction of relevant facilities.

After the preparation phase, the wedges then approximate the penetration of mitigation effects into the marketplace. This might be the growing sales of more fuel-efficient vehicles or the growing production of substitute fuels. The wedge pattern is shown in Figure 27, where the horizontal axis is time and the vertical axis is market impact, measured in barrels per day of savings or production. The figure is bounded on the right side for illustrative purposes only. It is assumed that the wedges continue to expand for a few decades, which simplifies illustration but is increasingly less realistic over time because markets will adjust and impact rates will change.

Figure 27: Delayed wedge approximation for various mitigation options



The criteria used in the Hirsch Report for selecting candidates for energy saving and substitute oil production wedges were as follows:

1. The option must produce liquid fuels that can, as produced or as refined, substitute for liquid fuels currently in widespread use, e.g. gasoline, jet fuel, diesel, etc. The end products will thus be compatible with existing distribution systems and end-use equipment.

[27] Pacala, S., Socolow, R. "*Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*." Science. August 13, 2004.

2. The option must be capable of liquid fuels savings or production on a massive scale – ultimately millions to tens of millions of barrels per day worldwide.

3. The option must include technology that is commercial or near commercial, which at a minimum requires that the process has been demonstrated at commercial scale. For production technologies, this means that at least one plant has operated at greater than 10,000 bpd for at least two years, and product prices from the process are less than $50/barrel in 2004 dollars. For fuels efficiency technologies, the technology must have at least entered the commercial market by 2004.

4. Substitute fuel production technologies must be inherently energy efficient, which we assume to mean that greater than 50 percent of process energy input is contained in the clean liquid fuels product.[28]

5. The option must be environmentally clean by existing standards.

6. Substitute fuel feedstocks must also be considered, e.g. heavy oil/tar sands and gas-to-liquids.

7. Energy sources or energy efficiency technologies that produce or save electricity are not of interest in this context because commercial processes to convert electricity to clean hydrocarbon fuels do not currently exist.

The combination of technologies, processes, and feedstocks that meet these criteria are as follows:

1. Fuel efficient transportation,
2. Heavy oil/Oil sands,
3. Coal liquefaction,
4. Enhanced oil recovery,
5. Gas-to-liquids.

In the end-use category, a dramatic increase in the efficiency of petroleum-based fuel equipment is one attractive option. New hybrid engine technology has been phasing into the automobile and truck markets. In a period of national oil emergency, hybrid technology could be massively implemented for new vehicle applications. Hybrid technologies offer fuel economy improvements of 40 percent or more for automobiles and light-medium trucks – no other engine technologies offer such large, near-term fuel economy benefits. Though diesel substitution for petrol could also deliver fuel efficiency benefits, it is assumed that the supply of diesel is similarly constrained to that of petrol and therefore the hybrid rollout will be more important.

The fuels production options that the DoE study chose are heavy oil/tar sands, coal liquefaction, improved oil recovery, and gas-to-liquids. The rationale was as follows:

1. Enhanced Oil Recovery is applicable worldwide.

2. Heavy oil / Oil sands are currently commercial in Canada and Venezuela.

3. Coal liquefaction is a well-developed, near-commercial technology.

4. Gas-To-Liquids is commercially applicable where natural gas is remote from markets.

The study excluded a number of options for various reasons. While the U.S. has a huge resource of shale oil that could be processed into substitute liquid fuels, the technology to accomplish that task is not now ready for deployment. Because various shale oil processing

[28] The choice of a minimum is subjective. A minimum of 50 percent seems reasonable, but a higher rate is clearly more desirable.

prototypes were developed in years past and because shale oil processing is likely to be economically attractive, a concerted effort to develop shale oil technology could well lead to shale oil becoming a contributor in those scenarios where mitigation begins some years before peaking.

Biomass options capable of producing liquid fuels were also excluded. Ethanol from biomass is currently utilized in the transportation market, not because it is commercially competitive, but because it is mandated and highly subsidized. Biodiesel fuel is a subject of considerable current interest but it too is not yet commercially viable. Again, a major R & D effort might change the biomass outlook, if initiated in the near future.

Over 45% of world oil consumption is for non-transportation uses. Fuel switching away from non-transportation uses of liquid fuels is likely to occur; mimicking shifts that have already taken place in the U.S. The time frame for such shifts is uncertain. For significant world scale impact, alternate large energy facilities would have to be constructed to provide the substitute energy, and that facility construction would require the kind of decade-scale time periods required for oil peaking mitigation.

Nuclear power, wind and photovoltaics produce electric power, which is not a near-term substitute fuel in transportation equipment that requires liquid fuels. In the many-decade future after oil peaking, it is conceivable that a massive shift from liquid fuels to electricity might occur in some applications (e.g.: hydrogen powered fuel cells in cars). However, consideration of such changes would be speculative at this time.

It is possible that technology innovations resulting from aggressive future research may well change the outlook for various technologies in the future. The Hirsch Report chose not to add a wedge for undefined technologies that might result from accelerated research, because such a wedge would be purely speculative. No matter what the new technology(s), implementation delay times and contribution growth rates will inherently be of the same order of magnitude of the technologies that we have considered, because of the inherent scale of all physical mitigation.

It is not possible to predict with certainty when world conventional oil peaking will occur or how rapidly production will decline after the peak. To develop the scenarios in the Hirsch Report, the U.S. Lower 48 production pattern was used as a surrogate for the world. This assumption is justified on the basis that Lower 48 oil production represents what really happened in a large, complex oil province over the course of decades of modern oil production development.

For the study, the vertical axis was pegged at a peak world oil production of 100 million barrels per day (MM bpd), which is 16 MM bpd above the current 84 million bpd world production. If peaking were to occur soon, 100 MM bpd might be high by 20 percent. If peaking were to occur at 125 MM bpd at some future date, the 100 MM bpd assumption would be low by 20 percent. Since the estimates in the wedges are rough under any conditions, a 100 MM bpd peak represents a credible assumption for this kind of analysis. The selection of 100 MM bpd is not intended as a prediction of magnitude or timing; its use is for illustration purposes only.

As noted, the three scenarios are benchmarked to the unknown date of peaking:

Scenario I: Mitigation begins at the time of peaking;
Scenario II: Mitigation starts 10 years before peaking;
Scenario III: Mitigation starts 20 years before peaking.

These mitigation choices are then mapped onto the assumed world oil peaking pattern as shown in figures 28, 29 and 30:

Figure 28: Mitigation crash programs started at the time of world oil peaking: A significant supply shortfall occurs over the forecast period

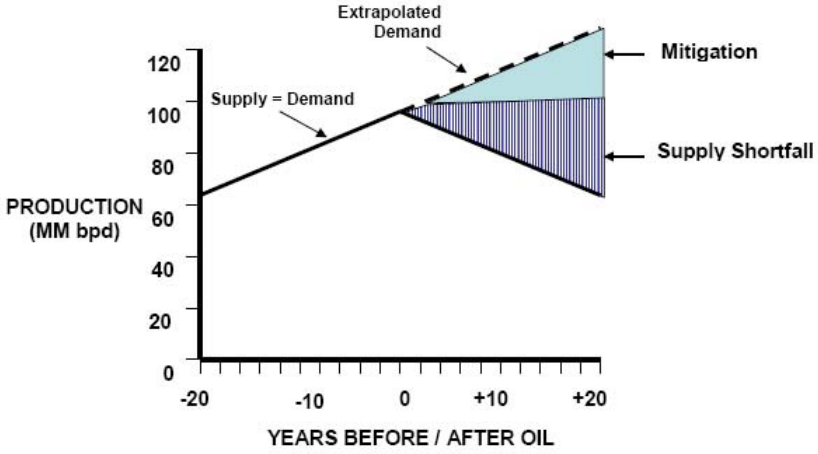


Figure 29: Mitigation crash programs started 10 years before world oil peaking: A moderate supply shortfall occurs after roughly 10 years.

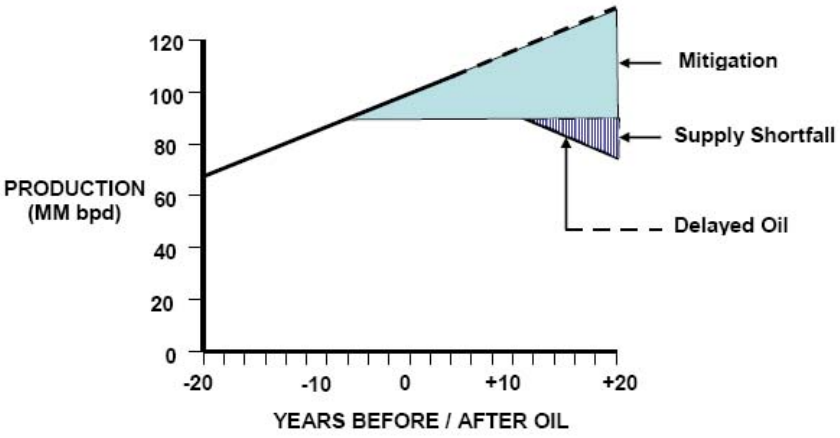
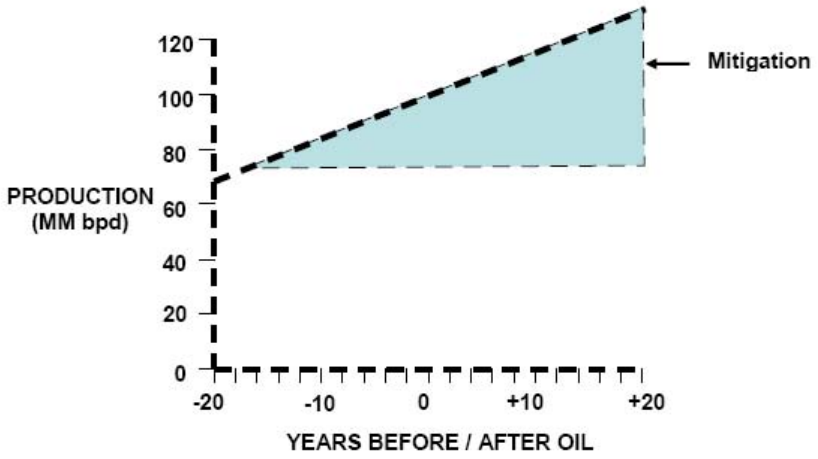


Figure 30: Mitigation crash programs started 20 years before world oil peaking: No supply shortfall occurs during the forecast period.



The Hirsch Report exercise was conducted bottom–up; the report estimated reasonable potential contributions from each viable option, summed them, and then applied them to an assumed world oil peaking pattern.

While the option contribution estimates are clearly approximate, in total they probably represent a realistic portrayal of what might be achieved with an array of physical mitigation options. Together, implementation of all of the specified options would provide 15-20 million barrels per impact, ten years after simultaneous initiation. Roughly 90 percent would result from substitute liquid fuel production and roughly ten percent would come from transportation fuel efficiency improvements. In other words, it is possible to avoid most of the adverse consequences of peak oil if a) the peak does not occur for some twenty years in the future, and b) all appropriate mitigating strategies are put in place twenty years before the onset of the peak. Both conditions have to be satisfied in order for there to be no significant adverse economic consequences from peak oil.

As the Hirsch Report notes, the results are congruent with the fundamentals of the problem:

- Waiting until world oil production peaks before taking crash program action leaves the world with a significant liquid fuel deficit for more than two decades.
- Initiating a mitigation crash program 10 years before world oil peaking helps considerably but still leaves a liquid fuels shortfall roughly a decade after the time that oil would have peaked.
- Initiating a mitigation crash program 20 years before peaking appears to offer the possibility of avoiding a world liquid fuels shortfall for the forecast period.

The obvious conclusion from this analysis is that with adequate, timely mitigation, the costs of peaking can be minimized. If mitigation were to be too little, too late, world supply/demand balance will be achieved through massive demand destruction (shortages), which would translate to significant economic hardship, as discussed earlier.

Furthermore, the report notes that it is possible that peaking may not occur for several decades, but it is also possible that peaking may occur in the near future. Policy makers are thus faced with a daunting risk management problem:

- On the one hand, mitigation initiated soon would be premature if peaking is still several decades away.
- On the other hand, if peaking is imminent, failure to initiate mitigation quickly will have significant economic and social costs to Ireland and the wider world economy were they to wait as well.

A key point to note is that the two risks are asymmetric:

1. Mitigation actions initiated prematurely would amount to a poor use of resources and would ultimately retard the growth of the economy.
2. Mitigation actions that are initiated too late would reduce our room for manoeuvre, leaving us exposed to the full, adverse economic impact of a permanent, growing liquid fuel shortage.

The Role of the Market

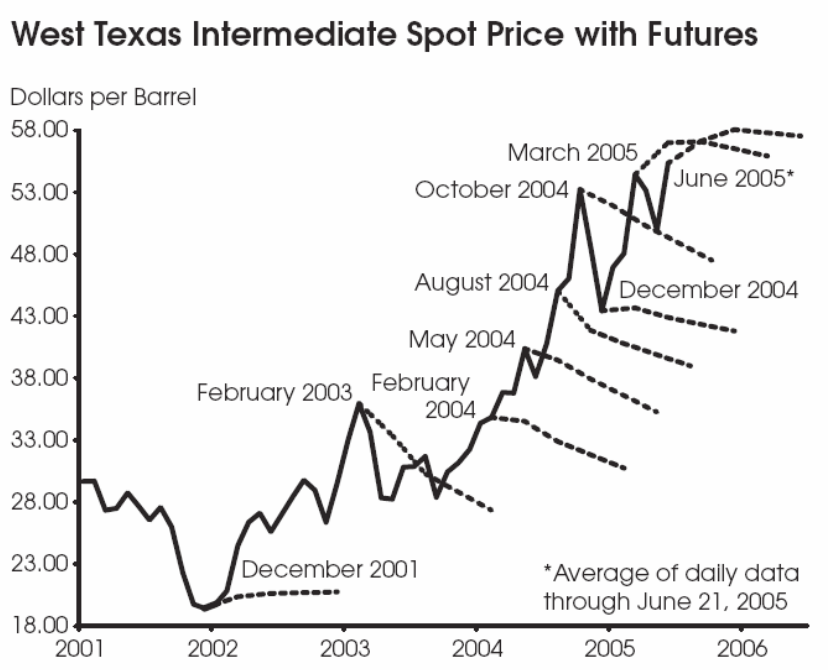
A major criticism of the peak oil analysis that informs this report – and of mitigation policies such as those set out in the Hirsch report – is that oil price signals to businesses and consumers will likely result in most of the changes required anyway (reduced demand, more efficient usage, switching to other fuel sources), so a 'hands on' approach by government and other agencies is

not necessary. For example, economists such as James Hamilton[29] have pointed to the potential for the oil futures market to provide all the information that oil users need about the future direction of oil prices over the long term – and right now, oil futures 6-7 years out show no 'peak-induced spike' or any other such signs of an imminent shortage.

Certainly we would agree that the market can and should be used to provide as much information about price, demand and supply as possible to all the users of oil. But there are obvious limits to the part the market can play specifically in relation to oil – not least the simple observation that most of the oil reserves in the world are owned and operated by nationalized oil companies (NOCs), while the international oil companies (IOCs) such as ExxonMobil, Shell and BP only account for less than a quarter of total reserves. Therefore political and other considerations may play a significant, if not dominant part in the pricing and investment behaviour of the NOCs as any economic and business considerations.

Moreover, the role of the oil futures market in forecasting oil prices is not particularly helpful. The analysis by Michael Pakko for the Federal Reserve Bank of St. Louis[30] shows that futures prices for oil (shown by the dashed line in figure 34) were persistently lower than spot prices (the solid line) throughout the run up in oil prices during 2004, demonstrated in Figure 31 below:

Figure 31: Oil Futures and Spot Prices; 2001-2006



There is a marked tendency for futures prices to usually lie below the spot prices – a phenomenon known as 'backwardation'. Essentially, oil producers enjoy a 'convenience yield' by knowing they already have their future oil requirements 'in the ground', so they can discount the production and storage costs associated from accessing the oil now (the spot price) from the price of that future oil. So the future price is almost always lower than the spot price for that reason.

Furthermore, less than 1% of futures contracts actually result in the oil changing hands (EFP or 'exchange for physical' as this is known), as most users of futures (buyers and sellers) liquidate their positions long before the contracted delivery date.

[29] See his analysis of the Hirsch report at:
http://www.econbrowser.com/archives/2005/08/limitations_of.html from August 2005
[30] Future Oil, Michael R. Pakko. National Economic Trends, Federal Reserve Bank of St Louis, July 2005

These considerations suggest then that the market futures pricing mechanism will provide only limited forewarning of peak oil.

Implications of Mitigation Options for Ireland

For Ireland, a key issue arising from this analysis is the extent to which we can rely on others (in particular, the United States) to solve the threatened impact of peak oil for us (e.g.: through technology innovation and substantial efforts to reduce their own demand for oil – currently a quarter of the world's total). Secondly, there is the issue of timing – the analyses presented in Chapter 1 do not suggest that we, or the world, has twenty years to get our energy house in order: even if we start right away. Nevertheless, it is important to focus on what we can do ourselves in Ireland, both in the short term and medium term to respond to peak oil – regardless of its timing.

Short Term Measures

The OECD also highlighted how oil consumption in the transport sector has continued to increase over the past few decades, reflecting a long-term price elasticity of between -0.6 and -0.8[31]. A number of market changes in the sector have however affected the economizing impact on consumption. The slow replacement rate of vehicle fleets, increasing ownership levels, greater distances traveled, and shifts towards heavier cars with larger sized engines that also include energy consuming components such as air conditioning are an example of these market changes. Nevertheless, significant short term reductions in oil consumption can be achieved through the adoption of radical policies in relation to car usage which may contribute to the interim period during which longer term mitigation strategies are put in place (note that in all three scenarios reported above, there is no impact on oil replacement for the first three years because of the time lag associated with, for example, capital intensive initiatives requiring planning etc.)

The IEA's recently completed study, 'Saving Oil in a Hurry'[32], took a quantitative assessment of potential oil savings to be made and costs of oil demand restraint measures if supply was disrupted. Consideration of a number of options were put forward in order to test the responsiveness or 'consensus view' of individual measures to an oil emergency, (Table 16). These included increases in public transport usage, carpooling, telecommuting, driving bans/restrictions, speed limit reductions and changes to work schedules. A summary of these measures is shown below in table 16.

[31] Graham & Glaister, "The demand for automobile fuel: a survey of elasticities," Journal of Transport Elasticities, 2002.
[32] Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport, International Energy Agency, 2004

Table 16: Summary of IEA's Oil Saving Measures

Potential Oil Savings	Individual Measures
Very Large	**Car Pooling** - let cars with 3 or more passengers use bus lanes
	Odd/Even Driving Ban - drivers can access city centre on alternate days using odd/even number plates restrictions
Large including	**Speed Limits** - reduce maximum speed limit on all roads, motorways, to 90kph/55mph
	Free Public Transport - on working days
	Telecommuting - encourage businesses to support staff to work from home some or all of the time
	Compressed Work Week - work four 10 hour days rather than five 8 hour days
	One in Ten Driving Ban - ban all cars from entering city centre one working day in ten (i.e: once a fortnight)
	Eco-Driving - information campaigns to encourage drivers to drive more efficiently, e.g.: keep tyres inflated to right level, avoid excessive accelerating etc

Source: 'Saving Oil in a Hurry', International Energy Agency, 2005

In August/September 2005, Amárach surveyed a nationally representative sample of 621 employees in Ireland who usually use their car to commute to work. If we scale this up to the total adult population, we find that more than 1 million employees usually commute to work by car[33]. A further 180,000 employees usually travel as passengers in a car – with someone else driving. Thus some 7 in 10 employees are dependent on cars as their usual form of transport to get to and from work.

The survey tells us that for those who drive to work themselves:

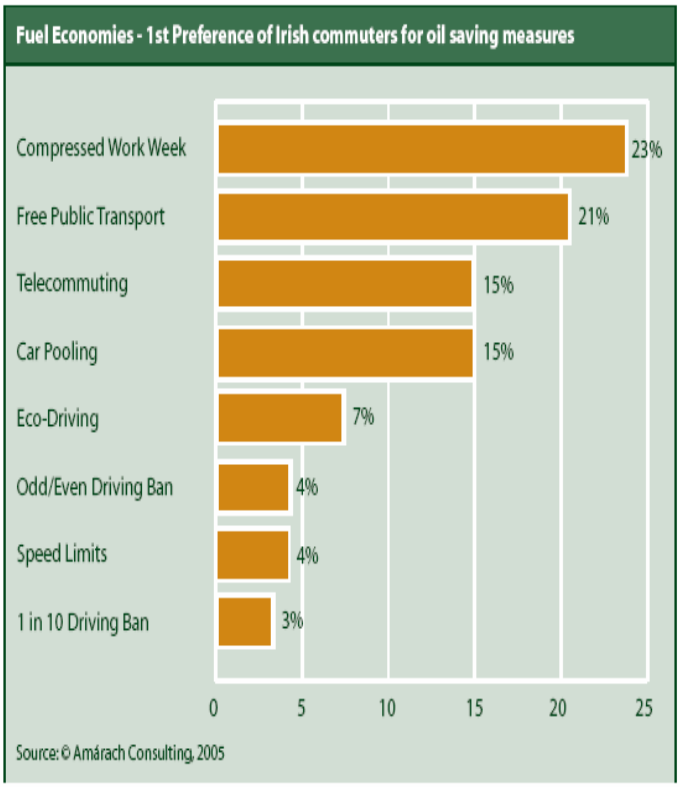
- The typical commuter uses his or her car 5 days a week.
- The average journey time to work by car is 34 minutes.
- The average home to work travel distance is 14 miles.
- The typical car-based commuter currently spends €122 per month on fuel.

That's an annualised total of over €1.5 billion on petrol or diesel - mostly to get to and from work. The use of oil for road transportation is now the single largest source of oil consumption in the Irish economy (56% according to the IEA).

Given the high levels of car usage, primarily for commuting purposes, one would expect a higher level of resistance to these measures designed to move us out of the car. However, the results show (Figure 32 below) that Irish drivers are prepared to more flexible about their car usage, though not equally so. The most favoured options included compressing the working week (23%) and free public transport (21%).

[33] Ireland in a Jam, Amárach Consulting, 2005

Figure 32: Amárach Survey Results, 'Ireland in a Jam,' September 2005



Irish consumers and commuters will be willing to make short-term sacrifices in response to an oil emergency – at least according to our own research. This should support those charged with managing the immediate response to the difficulties that will arise from peaking oil.

But such short-term measures are only viable as the main response in the event of a short-lived oil shortage. A longer-term problem – such as that arising from peak oil – will require longer-term measures, particularly at the level of government energy and related policies.

Medium to Long Term Measures

Transportation will remain the main driver of demand for oil in Ireland (and the world) for many decades to come. We noted at the start of this chapter that the electrification of the mass transit system would ultimately be the key to mitigating many of the adverse effects of peak oil. However, Ireland is currently experiencing serious constraints with regard to meeting its current needs for electricity, let alone supporting the widespread use of electric transit systems such as the Luas.[34]

Thus any move towards building and operating new, electrified tram, train and bus networks in Ireland's cities would necessitate a significant increase in electricity generation capacity. Yet, as we have noted previously, Ireland is already vulnerable to fuel supply difficulties in relation to electricity generation. Therefore putting in place a transportation strategy to mitigate peak oil will require implementing an electricity generation strategy that is markedly different to that envisaged in current assessments of generation adequacy for example.

Renewables will play an important role in expanding our generation capacity, as well as in meeting our Kyoto and common EU targets. However, the scale of future electricity demand arising from the electrification of large parts of the public transportation system will likely require a much higher level of generation than currently envisaged. Ensuring that a much larger

[34] Generation Adequacy Report 2006-2012, EirGrid, November 2005

generation capacity is in place will require substantial investment in new generating capacity – ideally using a far more diverse mix of fuels than at present (including renewables such as wind and biomass).

It is unlikely that additional renewable electricity generation will be sufficient to meet the substantially higher requirement we anticipate. An East-West interconnector between Ireland and Wales or England will provide access to the UK electricity grid and will certainly help fill any 'gap' between indigenous generation capacity and future requirements. However, such an interconnector will provide 'security of connection' not 'security of supply'. As the Ukraine discovered at the start of 2006, its gas pipe connection with Russia did not provide a secure supply of gas. Similarly, an electricity interconnector to the UK grid does not necessarily guarantee a supply of electricity, especially if the UK's own requirements for electricity are constrained by uncertainties over gas supplies etc and generators there decide to meet the needs of domestic customers first.

There has been a growing debate about the future of nuclear energy in the UK in light of their own concerns about energy security (including the consequences of peak oil). That debate has important consequences for Ireland. For the foreseeable future, Ireland will not be an attractive location in which to build a nuclear power station. Aside from the generally hostile attitude of the Irish electorate to nuclear energy, the economically feasible scale of a nuclear power station would exceed the capacity of the Irish market to absorb its output (alongside that of the existing generators) – for now.

Yet Ireland will require a far higher level of electricity in order to progress towards a less oil-dependent future. An 'interim' solution – for the next 10-20 years or so – would be to lease the use of a nuclear power station in the UK that it is scheduled for closure in the near future. In other words, a contract could be put in place with the UK's Nuclear Decommissioning Authority to keep one of its power stations open for an additional 10-20 years beyond the current decommissioning schedule, supplying the output directly to Ireland via an interconnector. One candidate power station for such an arrangement is the Wylfa power station in Anglesey, North Wales, due to cease power generation in 2010. Such an arrangement would provide security of supply to Ireland as well as security of connection.

The interconnector could remain in place after 2020 or 2025 (when the power station would finally close) – perhaps even providing a supply of electricity from Ireland to the UK if Ireland's indigenous generation capacity has developed further in the mean time (possibly including that from an Irish nuclear power station, should one be economically feasible by then).

Though the approach outlined above will undoubtedly be fraught with its own difficulties, it will have the vital benefit of buying Ireland some time during a period that will likely see the world coping with the onset of peak oil.

We turn now in the next chapter to examine the long-term policy implications of peak oil for Ireland.

5. The Policy Implications of Peak Oil

Introduction

In preparation for this study, Amárach – with Dr. Robert Hirsch – facilitated two workshops in Dublin in November 2005. The workshops were designed to bring together a mix of policy makers, representatives of NGOs, and others specializing in energy policy issues. The list of participants in the workshop is given in the appendix to this report. The workshops served to introduce participants to the peak oil issue, to address the challenge of mitigation options, and to initiate a valuable discussion on policy responses across the full range of government departments.

Prior to the workshops, a number of in-depth expert interviews were held with oil and energy specialists in Ireland and internationally to provide additional information on policy issues and options.

In the following commentary, we set out the policy implications arising from the workshop discussion under different policy headings. At the end of each policy section we set out our recommendations for policies in response to the challenges of peak oil. The reader should note that these are the recommendations of Amárach Consulting and Dr. Robert Hirsch, and do not necessarily reflect the views or consensus of the workshop participants.

Energy Policy

We set out below some of the issues and ideas raised in relation to energy policy in the workshops and in-depth expert interviews conducted by Amárach.

Security of Supply

When assessing the Ireland's approach towards it strategic reserve, it is worthwhile to first consider China's government policy to build a strategic reserve, aimed at bolstering their energy security as consumption soars and domestic output stagnates. Ten million barrels of storage capacity is due as the first phase of a strategic petroleum reserve (SPR) of 150 million barrels planned for completion in three to five years.

Further supporting this point is the earmarking of three other sites for strategic stocks along their eastern seaboard, aiming to build a total of 16.2 million cubic meters (101.9 million barrels) of reserves, equivalent to 20 days of consumption. This would augment the commercial stocks of the country's major refiners and importers, who typically hold 10 to 30 days worth of supplies. Given the level of current oil prices it is unclear when China will begin to undertake stockpiling activities; yet this is of lesser importance. The key point from this is their willingness to take proactive measures to address security of supply concerns and their recognition of urgency surrounding this action. Though increasing this reserve would, in essence, be only of temporary value, the role strategic reserves growth can play in mitigating against an emergency supply shock is still a worthwhile consideration. A major concern must be the timing at which a decision takes place to increase reserves; undoubtedly too long a delay will ultimately mean the purchase of reserves at a high market price, given the demand is also likely to rise. In this sense, it will be necessary to carefully monitor market prices and demand in relation to the decision to build the country's strategic reserves.

- Ireland has limited oil storage facilities on the island of Ireland, and relies on overseas storage for a large share of its strategic reserves – one option, therefore would be to expand the domestic storage capabilities contracted by NORA to both extend the strategic reserve and to provide enhanced security of access to oil in the event of short term disruptions (as well as providing additional fuel for electricity generation if required – though this depends on the type of oil in storage).

- As NORA does not currently own or operate any storage facilities directly, such an expansion would necessitate either a change in NORA's modus operandi and/or a possible PPP type joint initiative with commercial builders and operators of such facilities.

- Ireland's oil requirements are comparatively small in an international context. In the event of a global shortage, the Irish government could consider contracting with NOCs (e.g.: national oil companies such as Saudi Aramco) in oil producing countries that continue to have a surplus of production relative to their domestic requirements.

- A number of unilateral agreements of this nature could be put in place as options to be managed by NORA, and established as binding treaties between Ireland and the supplying countries: these could also include an element of barter (e.g.: in relation to beef and dairy products) that could be attractive to some suppliers.

- Additional support for the production of bio-fuels by Irish farmers could also provide a modest volume of alternative fuel supplies, for use even in supporting agricultural output itself in the event of actual oil shortages.

- Examples to follow include that of Germany, which has set a target to increase the share of biofuels (including biodiesel and bioethanol) to 5.75% of fuel consumption by 2010 – mitigating, to some extent, the likely impact of peak oil.

- Given the limited nature of Ireland's oil sector, consideration could be given to encouraging the oil majors to locate their head office type functions and possibly even their research and development operations in Ireland to 'kick start' the sector here, and to derive a degree of security from their presence and potential contribution to the economy.

- Such an initiative could be driven partially be tax incentives (and tax treaties with relevant countries) as well as by Government commitments to energy R&D initiatives involving Ireland's third level institutions and the oil majors.

Electricity

- Oil remains a significant fuel for use in electricity generation in Ireland, but the most obvious alternative is gas, which itself is subject to an increasing level of uncertainty about its future supply – therefore encouraging the use of non-fossil fuels will provide the most secure alternative to oil (and gas) in meeting future generation requirements.

- Ireland has some potential to increase the use of renewable energy sources such as wind for electricity generation, though the capacity of the grid to import and distribute the variable output of wind generation will require significant development.

- Ireland has little experience of 'distributed generation' (e.g.: combined heat and power usage in homes), which has the potential to 'take the strain' off the main electricity generation capacity, by encouraging homes and communities to provide more of their own electricity requirements – and even to resell these back to the grid when not required: such distributed generation would likely work with renewables such as wind and biomass, and to a lesser extent gas and peat, though each of these options hold their own limitations

- An all-Ireland electricity market will have only marginal impact on the security of supply given the broadly similar exposure of Northern Ireland's generators to fossil fuels to that of those in the Republic of Ireland.

- Global supplies of coal are considered adequate for the foreseeable future – therefore the continued operation of Moneypoint (Ireland's only coal fired power station) will

provide an important element of diversity of supply: indeed the development of new coal fueled power stations could also be an option for the future, coupled with advanced scrubbing and CO2 sequestration technologies (using, for example, the Kinsale gas fields for storage).

- Likewise, the use of peat for electricity generation – whilst not ideal from an environmental perspective – does nevertheless provide additional diversity of supply (and a domestic source at that), which could be considered as part of a wider assessment of responses to peak oil.

- Other potential sources of electricity generation – e.g.: biogenic waste (such as gas from landfills) and incinerators – can also form an important part of a diversification strategy in relation to electricity generation.

- Plans are already underway to develop one and possibly two additional East-West electricity interconnectors with the UK – these could provide a significant degree of energy security, subject to the UK resolving its own security of fuel supplies problems (note, however, that an East-West interconnector is not expected to be operational before 2010 at the earliest).

- Another option for Ireland to secure its long run energy security – especially in relation to electricity generation – will be to develop the use of nuclear energy, though this is explicitly not part of Ireland's policy preferences at present. The revived interest in developing an enhanced nuclear electricity sector in the UK will provide an important context for Ireland's electricity options in the next 5-20 years.

Energy Efficiency

- Though some initiatives have been made to adopt higher energy efficiency standards in Ireland, the most important initiative in relation to total energy usage will be that of the Energy Performance Building Directive (EPBD) due to begin implementation in January 2006 – this will provide a basis for assessing and improving energy usage in commercial and residential buildings that will result in a more efficient use of electricity energy in particular (though also of oil for space heating where used as central heating fuel).

- Ireland could adopt a proactive approach to the Directive, seeking to place Ireland at the leading edge of energy efficiency practices, and supporting the development of businesses that can provide the deliver the same practices in other markets.

Fuel Poverty

- Users of oil for central heating have few options at present – policies to encourage the uptake of biomass fuelled central heating systems, upgrading of insulation standards and other measures to minimize the exposure of electricity prices to fossil-fuel price increases will mitigate to some extent the consequences for residential users of oil.

Environmental Obligations

- The short-term onset of peak oil would likely lead to the abandonment of the current Kyoto targets and emissions trading requirements – however, a delay in its onset would likely see the adoption of lower CO2 emission targets by Ireland, which in turn would lead to investments and policies that would coincidently support preparations for peak oil.

- It has been observed that the current emissions trading regime effectively discriminates against renewable energy[35], therefore this should ideally be renegotiated.

- Given the direct and indirect impact of rising oil prices on business and consumer costs (and every expectation of further rises), it seems unlikely that a carbon tax will be necessary in order to encourage the switching away from 'carbon-intensive' fuels such as oil, gas and coal.

Energy R&D

- The recent review of energy research, development and demonstration by the Department has highlighted the need for an Energy Research Co-Coordinating Council – providing a focused and sustained emphasis on energy R&D that has not been the case for several decades.

- We would recommend that the Council prioritizes a more detailed sectoral assessment of oil vulnerability across, industry, services and agriculture – in co-ordination with the Central Statistics Office – to ensure that appropriately detailed information is captured as part of the CSO's ongoing surveys.

- In addition, we would recommend that the Council prioritize 'energy diversification' R, D &D for example in relation to hybrid technologies as well as the use of bio-fuels and bio-mass (e.g.: in relation to central heating in homes currently using oil).

- The Council should also identify opportunities to attract oil majors to invest in joint energy R&D initiatives with Ireland's third level institutions (e.g.: along the lines of ExxonMobil's contribution of $100 million to Stanford University to develop new low carbon technologies).

Energy Policy Management

- The scale and complexity of the energy agenda might be considered to be such that it would be inappropriate to house all the responsibility for the agenda under one ministerial department or office.

- On the other hand, the experience of transport policy has shown how a focused approach – bringing together previously diverse departments and functions – can provide the kind of holistic analysis and policy making that is more likely to succeed.

- The scale of the challenge posed by peak oil is one that warrants adoption as part of the social partnership process, given the economy and society wide nature of its impact.

- The creation of a junior ministerial role with specific responsibility for energy would provide the necessary focus for the next 5-10 years to oversee the early stages of adjustment to the prospect of Peak Oil.

[35] Aspects of Irish Energy Policy, The Economic & Social Research Institute, September 2005

Energy Policy Recommendations

Amárach recommends the following in relation to energy policies designed to mitigate the impact of peak oil in the next 10-20 years:

- Negotiate long-term contingency supply contracts that provide an agreed volume of oil for Ireland's economy in the event of a global shortage, priced at premium as necessary to guarantee delivery.
- Support the development of non-fossil fuel electricity generation, with back up generation capacity in reserve, through a combination of renewables and nuclear power.
- The latter is best developed jointly with the UK, and we would recommend 'leasing' a nuclear power station due for de-commissioning by the UK in the next 5 years with the requirement that it remains in operation for another 10-20 years, giving Ireland security of generation, and coupled with an interconnector between the power station (linked also to the rest of the UK grid) and Ireland.
- Fast track the adoption of the Energy Performance Building Directive to maximize the energy savings benefits in terms of electricity and oil for space heating.
- The energy policy agenda should be managed with the same degree of focus and integration as that of transport.
- Energy policy should be championed as part of the social partnership process, supported, for example, by the National Economic & Social Council (NESC).
- A junior ministerial role should be created with a specific brief for energy to coordinate the adjustment process.
- Energy R&D policy should support a strategy of energy diversification – both in relation to electricity generation and transportation – as well as potential joint initiatives with the oil majors.

Transport Policy

Next we set out some of the issues and ideas raised in relation to transport policy:

Public Transport

- Ireland already provides tax relief in relation to hybrid cars – a more radical adoption of this approach could lead to a faster increase in hybrid usage (and therefore fuel efficiency benefits) than will otherwise be the case.

- The recent Transport 21 programme of capital spending on transport over the next 10 years will play a key part in preparing Ireland for the transition to a 'post-oil' world – its strong emphasis on public transportation infrastructure (accounting for €16 billion of the total spend of €34 billion) will be central to this preparation.

- An opportunity exists to 'fast track' those elements of Transport 21 relating to public transportation that are currently envisaged as part of medium-term and long-term priorities rather than for immediate implementation.

- The use of congestion charges and other measures to discourage private car usage and encourage public transport usage, will likely have a significant effect on usage, though whether they will add further to the effect of rising fuel costs anyway is open to debate.

Spatial Development

- Though not technically a transport issue, the current pattern of spatial planning mitigates against the development of an efficient and effective public transport system.

- The development of regional hubs and spokes will play a key part in enabling urban communities in particular to respond to the challenges of peak oil – and those communities that are adequately resourced in terms of public transport infrastructure will have greater choice in relation to how they respond.

- Consideration should be given to maintaining, extending or introducing tax relieves in relation to city-centre residential developments (in cities/towns with large daily inflows of commuters) that help re-direct property development away from a pattern of extensive sub-urbanisation.

Transport Policy Recommendations

Amárach recommends the following in relation to transport policies designed to mitigate the impact of peak oil in the next 10-20 years:

- Adopt more radical tax incentives to encourage hybrid car purchases (along the lines of the 'scrappage scheme') sufficient to facilitate their widespread adoption as replacement cars, phasing out the incentives as new public transport facilities come on stream.
- Accelerate, where possible, those elements of the Transport 21 investment programme relating to public transportation – even if it delays some of the road related initiatives.
- Only use congestion charges and other incentives to discourage private car usage as adequate public transport facilities come on stream.
- Require large scale, green field property developments to include a 'planning gain' requirement in relation to providing public transport infrastructure and services.
- Focus residential property development tax incentives exclusively on city-centers with large daily inflows of commuters.

Telecommunications Policy

Telecommunications is likely to be a key beneficiary of responses to peak oil, with important implications for policy:

- One likely response to peak oil and its impact on business costs will be to encourage more people to work from home – in turn placing considerable demand on both the fixed line and mobile telephone networks (for data as well as voice traffic).

- Ireland currently has a comparatively low level of broadband access, and mobile data networks of equivalent capacity are still only being rolled out – therefore a key issue will be the access of knowledge workers in particular to the higher bandwidth communications networks they will require in order to work from home or other non-office locations.

- Key sectors of the economy – such as internationally traded services, e.g.: financial services – will be crucially dependent on the telecommunications network, so its capacity to continue meeting their needs, along with a large number of 'distributed' users will be key to maintaining confidence in Ireland as a location from which to trade.

Telecommunications Policy Recommendations

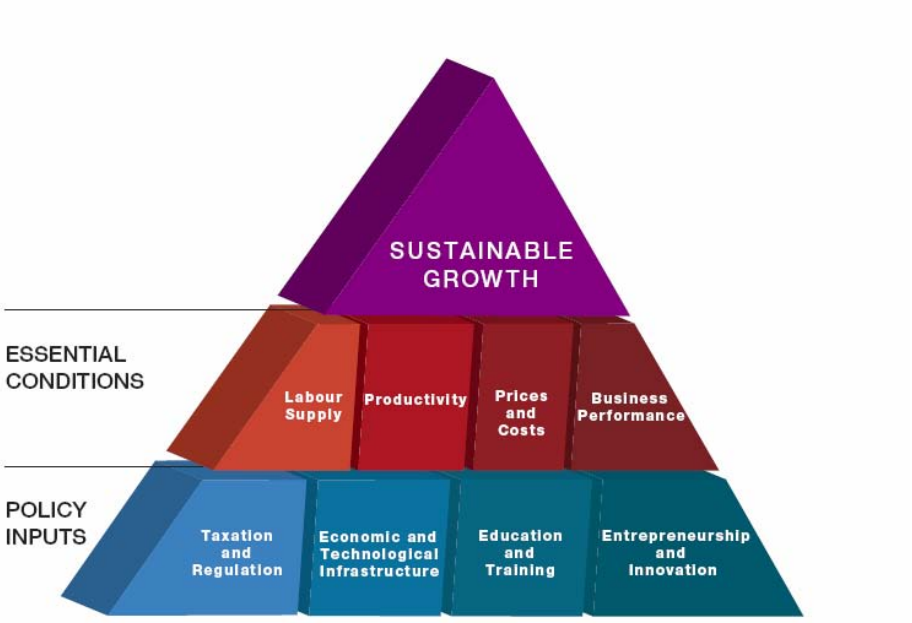
Amárach recommends the following in relation to telecommunications policies designed to mitigate the impact of peak oil in the next 10-20 years:

- Support employers to encourage staff to adopt teleworking practices – on a limited basis to begin with – through tax relief and the absence of BIK charges for the provision of computers, software and telecommunications services to staff.
- The main network providers – eircom, Vodafone and O2 – should be supported to develop more pervasive and more robust networks on a nationwide basis, sufficient to meet a rapid increase in traffic in the event of a short term adjustment to peak oil.

Competitiveness Strategy

Though not specifically a policy category, we nevertheless have examined the implications of peak oil for Ireland's competitiveness and related strategies. The National Competitiveness Council's 'Competitiveness Pyramid' highlights the importance of economic and technological infrastructure as a fundamental element in the 'pyramid'.

Figure 36: Competitiveness Pyramid, NCC, Annual Report, 2005



The recent NCC report on The Competitiveness Challenge 2005[36] references peak oil as a particular threat in the context of Ireland's energy infrastructure:

> More generally, there are growing concerns at global and national level about the security of energy supply (physical interruption in oil supply), increasing global demand and the risk of the current oil price shock deteriorating further. Some commentators believe that the level of oil supplies have peaked in 2003; others believe that it will not happen until 2030 (depending on definition used). *p.45*

[36] The Competitiveness Challenge 2005, National Competitiveness Council, Forfás, 2005

The report notes the already damaging consequences of rising electricity costs in Ireland, and concerns about the inadequate availability of generation capacity in the next few years. Clearly, in the advent of peak oil, then the current run up in electricity prices would be but a rehearsal for a far more serious jump in prices. Moreover, it would exacerbate existing concerns about generation adequacy.

Competitiveness Strategy Recommendations

Amárach recommends the following in relation to competitiveness designed to mitigate the impact of peak oil in the next 10-20 years:

- Set clear, public domain goals for delivering security of electricity supply in the next five years via diversification of fuels in use, adding generation capacity quickly through interconnectors, and supporting those operators who can provide a reliable and competitively priced supply of electricity to business users.

- In adopting such goals in relation to energy security, then Ireland should be positioned as an emerging 'post oil' economy and an ideal location for inward investment and international trade in need of security of energy supply.

Contingency Planning

An over-arching policy requirement arising from this assessment of policy options is the need to communicate clearly the context for the changes that will be required. As suggested in the workshop, the message is that of 'securing the energy supply for future generations'. This long term, inter-generational perspective is vital to ensure that the discussion of energy choices and options – not all of them necessarily palatable to the majority of people – will at least be conducted with an appropriate timescale in mind.

We live today with the consequences of decisions made about energy in Ireland many decades ago. The decisions made in the coming years – in response to the threat of peak oil and to other energy challenges – will also have consequences many decades into the future. Though it is sometimes difficult for businesses and policy makers to take a very long-term view of the issues that they face, that is nevertheless the requirement in regard to the peak oil challenge.

We believe that Ireland can meet that challenge – and that by responding to it earlier than others we will not only minimize the potential damage from peak oil, but we may even position ourselves to compete more successfully in the post oil world economy. Securing the energy supply for future generations demands nothing less.

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Appendix 1

Names & Background Details of Individuals Consulted during Research Process

	Interviewee	Background Details
1.	Jack Zagar	Independent petroleum reservoir engineering consultant
2.	Jonathan Cooney	Carried out assessment of Irish Energy Policy in 2004
3.	Colin Campbell	Irish Oil Expert
4.	Jerry Gilbert	MD; Barrelmore Ltd
5.	Michael Lynch (U.S)	Economist
6.	Neil O'Carroll	Conoco-Phillips Ireland
7.	Jim Fitzgerald	Campus Oil Ltd
8.	Martin Regan	Energy Options
9.	Richard Douthwaite	Economist/Author
10.	Jimmy Quinn	Irish Road Haulage Association
11.	Brendan Halligan	Institute of European Affairs
12.	Martin Howley	Energy Policy Statistical Support Unit
13.	David Horgan	Petrel Resources PLC
14.	Frank Bergin	Shell Ireland
15.	Michael O'Mealoid	Department of Transport

Appendix 2

Names & Background Details of Individuals in Attendance at Amárach / Forfás Workshop (3rd November 2005)

	Attendee	Background Details
1	Bob Hirsch	Project Consultant
2	Andrew McDowell/	Forfas
3	Eoin Gahen	Forfas
4	Jay Stuart	EcoCo.
5	Mary Austin	DCMNR
6	Morgan Bazilion	Sustainable Energy Ireland
7	Jim Fitzgerald	Campus Oil
8	John Reihill	Tedcastles
9	Michael Forde	IPIA
10	David Horgan	Petrel Resources
11	Micheal Fitzgibbon	Forfas
12	Elizabeth Muldowney	Sustainable Energy Ireland
13	Shane Quinlan	Forfas
14	Gerard O'Neill	Amárach Consulting
15	Iain Leopold	Amárach Consulting

Appendix 3

Names & Background Details of Individuals in Attendance at Amárach / Forfás Workshop (8th November 2005)

	Attendee	Background Details
1	Mr. Andrew McDowell	Forfás
2	Mr. Bob Hanna	DCMNR
3	Ms. Mary Austin	DCMNR
4	Mr. Seamus O Morain	Assistant Secretary – Department of Trade, Enterprise & Employment
5	Dr. Michelle Kearney	Forfás
6	Mr. Tom O'Mahony	Dept. of the Environment, Heritage & Local Government
7	Ms. Edel O'Dea Kenny	Department of Transport
8	Mr. Tom Sneyd	Department of Transport
9	Mr. David Hedigan	Policy & Planning - Enterprise Ireland
10	Mr. Michael Fitzgibbon	S&T Division - Forfás
11	Mr. Brendan Halligan	Chairperson - Institute of European Affairs
12	Dr. Carol Gibbons	Chief Science Advisor's Office
13	Mr. Paul Byrne	Department of Finance
14	Mr. John Callinan	Department of Taoiseach
15	John Burke	Assistant Principal
16	Morgan Bazilion	Sustainable Energy Ireland