Envisioning a Sustainable Ireland from an Energy Availability Perspective

A report to the
Environmental Protection Agency

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Executive Summary

Tightening restrictions on the use of fossil fuels to limit climate change combined with the depletion of the sources of the most cheaply-produced oil will have far-reaching effects on the Irish economy and society. Energy prices can be expected to rise substantially in relation to those of labour. As a result, technologies will evolve which lower business and household costs by saving energy. This will be done either by using more labour or by increasing the intensity with which energy is used as capital. For example, a householder may invest energy as capital by installing more insulation in order to avoid using so much energy as income to heat his home every year. Similarly, a firm may invest energy as capital by holding greater stocks of components, tying up the energy embodied in them, in order to reduce the income energy used by frequent deliveries. In other words, higher energy costs can, perversely, increase the demand for energy for use as capital investment.

Renewable energy projects are generally more capital energy intensive than their fossil energy alternatives and another way in which higher energy costs can increase the demand for energy for capital purposes is by making the development of renewable energy sources more profitable. The pace at which renewable sources can be expanded therefore depends on the energy supply. This is a crucial consideration because if the pace is inadequate and this country's total fossil and renewable energy contracts more rapidly than the efficiency with which it uses energy increases, overall economic growth will stop and the economy will shrink.

While some sectors of the economy may expand when the total supply of energy is diminishing, the contribution their growth makes to national income will be outweighed by the sectors in decline. The sectors most likely to grow in an economy which is contracting because its energy supply is shrinking include renewable energy production, agriculture (the production of biofuels), home improvements, repair and maintenance and some types of manufacturing. Those most likely to experience reduced sales will include construction, retail, the motor trade, road freight transport, tourism and airlines.

The strongest conclusion from this study is that, as energy supplies are going to be increasingly tight and thus increasingly costly in future, the sooner investments of energy capital are made in saving energy and in the transition to renewable energy, the more substantial those investments can be and, as a result, the smaller will be the extent to which the economy contracts as the imported energy supply tightens. Foregoing economic growth now for the sake of achieving greater energy self-sufficiency will enable the country to maintain higher incomes in future.

A second important conclusion which is linked to the first is that no attempt should be made to keep energy prices low whatever the motive for doing so. Maintaining international competitiveness or reducing fuel poverty are not adequate resasons for preventing the market signalling to companies and consumers to produce more renewable energy and to reduce their fossil energy use. Other ways need to be found to meet any commercial and social objectives which impede the move to an energy-self-sufficient economy.

Renewable energy sources are, for the most part, relatively small and dispersed. ***Developing renewables efficiently means that the pattern of energy production and distribution has to change.*** The centralised generation of electricity will give way to distributed generation and, if fuel is burned as part of the generation process, it will become very important that the low-grade heat finds a good use. This will affect the location of manufacturing companies both within Ireland and around the world. Firms for whom energy is an important component of their costs will locate in communities which can guarantee them secure supplies of electricity and process heat at fixed prices. A recognition of this will obviously affect Ireland's inward investment strategy.

Another factor which will affect spatial planning and investment policy is that ***renewable sources of liquid fuels like biodiesel and bioethanol will not be able to make up for the increasingly restricted supply of oil***. The transport sector will be profoundly affected and the higher energy modes like air- and road-freight will become much more costly in comparison with rail and water. One way firms will attempt to reduce their distribution costs is by manufacturing a smaller quantity of a wider range of products in a greater number of plants. This will lead to much more local production for local use.

The third factor which will work to ensure that economic activity becomes more widely dispersed is that although biomass is going to replace oil as a source of many chemicals, it is too bulky to be transported far. Accordingly, just as co-operative creameries were set up in almost every parish a century ago to concentrate milk into butter or cheese, ***small biorefineries which concentrate their area's vegetable matter into valuable, transportable substances will be established throughout the country*** over the next 25 years.

Because industrial agriculture is energy-intensive, the cost of food will become much higher in relation to people's earnings. While this will enable farms to afford to employ more workers and become more labour-intensive, it will also mean that, together with the increased cost of energy, non-farmers will have less money left over for discretionary spending. The shopping-as-a-pastime economy will end. ***Trade unions will be unable to preserve their members' living standards.*** As there will be more jobs in rural areas and the cost of energy and food is likely to be lower there, the flow of people from rural to urban is likely to be reversed.

The major threat to the Irish economy identified by the study comes not from higher energy prices themselves but from the European Central Bank's reaction to them. In a market economy, higher real prices are needed to allocate inadequate energy supplies to the most profitable uses and to encourage energy saving and the development of new energy sources. Because different amounts of energy are embodied in everything we buy, the price of everything needs to change by a different amount. There is no standard percentage that can be applied. An inflation is required to make this differential adjustment relatively painless in comparison with the distress that would be caused if an attempt was made to maintain price stability while bringing the changes about.Such an exercise would require low energy-use firms to reduce their prices, even though their energy costs had risen, by enough to allow high-energy use ones to put their prices up.This painful course seems to be the one the ECB is following. Certainly, by increasing interest rates to slow inflation, it is attempting to maintain the value of the euro despite the fact that the cost of one of the two factors of production, energy, has gone up and is likely to stay up, *in euro terms*. The only way that the value of the euro can be maintained in this situation is if the price of

labour is forced down *in euro terms*, so that the fall balances the rise. Such a policy threatens to create an economic disaster.

Another important conclusion is that is that, when a vital commodity such as fossil energy gets scarce, its distribution can no longer be left to a completely uncontrolled market but has to be rationed .***The scenario developed for this study in which energy rationing was introduced enabled much higher and more stable living standards to be maintained in Ireland than the one in which the market was left to itself.*** This was because all the scarcity rents accrue to the energy producing countries unless rationing is introduced internationally and this threatens the world economy. Moreover, unless rationing is introduced internally, the distribution of energy can become very polarised and cause a social disaster.

Contents

The report was compiled by Richard Douthwaite (project leader), Phoebe Bright and Nicola Creighton from Feasta and by Larry Staudt and Ray Byrne from the Centre for Renewable Energy, Dundalk Institute of Technology.

Illustration 1: In historical terms, the rise and fall of oil as an energy source is merely a blip.

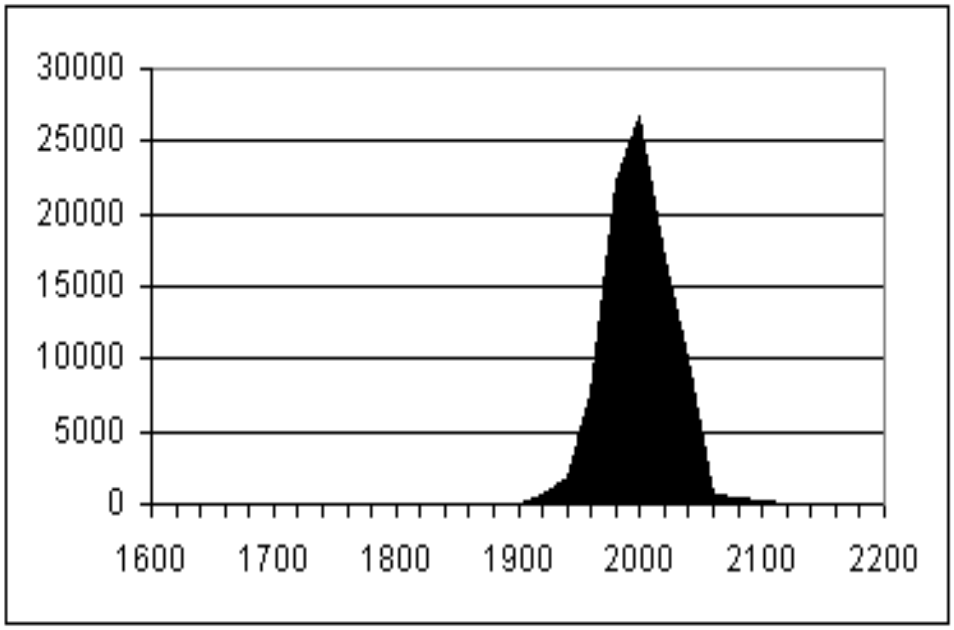
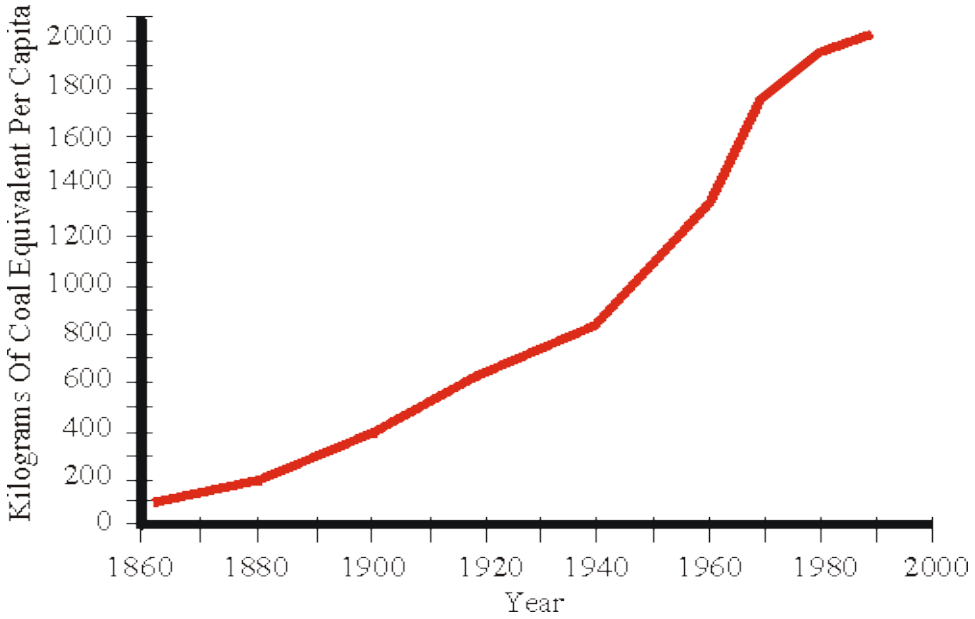


Illustration 2: The use of energy per head of the world's population is reaching a peak.



Chapter 1

Introduction, Conclusions and Recommendations

Two factors will make fossil energy supplies scarce and expensive in future. One is that in February 2007, the EU set itself the target of cutting its greenhouse gas emissions by 20% below their 1990 level by 2020, and said that it would reduce by30% if other industrialised nations would undertake to do so too. These emissions reductions will be achieved by using the Emissions Trading System and the price of emissions permits, and thus the total cost of using energy, can be expected to rise substantially. The other factor is that the total amount of energy available to the world economy from oil and gas production will almost certainly peak within the next twenty-five years and perhaps within the next five. After the peak, competition among the nations of the world for the falling supply will increase the cost of these fuels.

Regardless of which of the two factors becomes the more important price driver, this more costly energy will have profound implications for the Irish economy and society. The development path the country has taken over the past fifty years has been based on achieving higher labour productivity and thus higher incomes through the increased use of fossil fuel which, itself, became progressively cheaper in relation to labour during much of the period. The enforced reversal of the trend towards using increasing amounts of energy to boost ouput will leave no aspect of life unchanged. However, very little thinking about the nature and extent of the changes has been carried out. Instead, in common with almost every other country, the Irish government and the private sector are making investments on the assumption that the 'business as usual' approach - that is, the use of technologies and systems that require increases in energy consumption - will turn out to be as economically advantageous as it has in the past. However, if the assumption turns out to be incorrect and an increased energy supply is not available at a reasonable cost, a lot of the investments being made now or planned for the next few years will turn out to be completely unsuited for the fossil- world in which they will have to generate a return.

Feasta, the Foundation for the Economics of Sustainability, is a Dublin-based international network of researchers concerned with the systemic changes required to achieve a stable, sustainable world. In December 2004, the EPA, wishing to improve the chances of Irish organisations making better energy-related investment decisions, commissioned it to guide and inform a collective process to envision Ireland's energy future. Feasta's brief was to get decision-makers to explore how large increases in energy prices in relation to those of the other factor of production, labour, might affect their own operations and thus the future shape of the Irish economy. Its researchers then used ECCO, a computer model of the resource flows in the Irish economy, to feed the changes the decisionmakers forecast for their sectors through the other sectors to assess what the knock-on effects might be and thus the overall effect on the economy.

Feasta realised that the circumstances in which the higher relative price of energy was reached were bound to have a major bearing on its effect. For example, if the price rose gradually and steadily and energy-users anticipated such a trend and allowed for it in their plans, the outcome was likely

to be very different from that produced by a sharp, unexpected rise for which no-one was prepared. Accordingly, it was not enough for the project's interviewers to ask their subjects about how their organisations would react to higher energy prices – they also had to explain how those higher prices were achieved and the economic climate in which their investment and choice of technology decisions were being taken. The project therefore developed four scenarios to explain to interviewees how energy prices and economic conditions might evolve.

Project Methodology

The first step in carrying out the project was to agree the extent of the relative price rise we would ask our interviewees to consider. When we first submitted our research proposal to the EPA in May 2004, oil was within the $20 - $32 range that it had traded since 1999 and we thought we would be pushing the limits of our credibility if the project examined the effects of its price increasing by a factor of ten over the next twenty-five years. We nevertheless decided that our study would do so because the price of energy in relation to wages had fallen to a tenth of their 1920 level by 1970 and there seemed to be no reason why such a fall should not be reversed by, 2030. Today, mid 2007, oil is 2.5 times the dollar price it was when we took this decision. In other words, the price that would have represented a tenfold rise when we started planning the project now only amounts to a fourfold rise from the current level.

The second step was to develop the scenarios which would enable our sample of decisionmakers to understand the background and the circumstances in which their investment and technology choices were being made. We decided that there were two key determinants of the way energy prices might move. One was how soon the peak in the world's oil output was reached, because after that date the growing scarcity would have a major effect on prices. The other was the attitude taken by the Irish government and the international community. Would the government react pro-actively to warnings of an peak in oil production and create the circumstances in which investors were enabled to invest in the development of renewable energy sources with the minimum of risk? Or would it be re-active, and say that investment decisions should be determined purely by market forces? These two determinants gave us four scenarios, one pair in which oil peak occurred almost immediately, the other pair in which it occurred after about 25 years. In one scenario in each pair, the government (and the international community) was pro-active, in the other reactive. The four scenarios were:

Business as Usual in which oil peak occurs around 2030 and the government adopts a reactive stance to that happening, regarding 2030 as a long way off and oil peak as something which the market can respond to nearer the time. Meanwhile, it maintains its goal of achieving maximum economic growth.

Enlightened Transition in which oil peak occurs around 2030 but the government adopts a proactive posture, arguing that it has taken over fifty years to build up to Ireland's present level of fossil energy dependency so that 25 years is not too long to change all the country's energy intensive systems and bring its energy demand down to something approaching its 1945 level. This government does not believe that the market will signal the arrival of oil peak in sufficient time to

make such radical changes. Its attitude is that all available resources should be devoted to reducing energy use and switching to renewable energy sources rather than the attainment of further economic growth.

Enforced Localisation, in which oil peak occurs now and a re-active government and international community rely on the market to allocate the increasingly scarce resource among competing buyers. As a result, oil prices rise steeply, causing an inflation and taking spending power out of the economy and diverting it to the oil producing countries. The world's central banks step in to control the inflation by putting up interest rates. This removes more purchasing power. The resulting slack demand causes investment projects to be cancelled. Unemployment increases, a depression starts and the reduced demand for oil brings its price back down. The low prices remove all incentive to switch to renewable energy use. The Irish economy, and the global one, remain depressed for a decade or more before a recovery begins. However, the increased energy demand soon sends oil prices soaring, inflation sets in and the cycle repeats itself. During the troughs of each cycle, only local low-energy production and distribution systems enable the increasing numbers of not-formally-employed people to survive.

Fair Shares, in which oil peak occurs now but a pro-active government and the international community decide that the available supply needs to be rationed so that the prices paid to producers are controlled. The world's central banks allow a controlled inflation so that the effects of the higher oil prices can be passed through to consumers and reflected in a new relative price structure. However, as every citizen gets a tradable energy allowance, they get an income when they sell their allowance which protects them from the worst effects of the inflation.

It will be noted that there is no mention of any response to the threat of climate change in any of the scenarios. We took a conscious decision to leave possible responses to the threat out because we felt that their inclusion would not make a significant difference to the scenarios themselves or the way they worked out. The only difference we could see was that the need to respond to climate change was likely to make it more likely that governments and the global community took a pro-active course.

The scenarios were presented to decisionmakers at one or other of two one-day seminars, both in Dublin, at which we explained the grounds for believing that energy supplies might be restricted in future and that this would mean that they became much more costly. The four scenarios were then explained. After that, we divided the participants into groups of six, each with a facilitator, and invited them to think through the consequences of each scenario by imagining that they were journalists on a trade magazine for a particular sector of the economy in the year 2015, trying to interest their editor, the facilitator, in a story dealing with changes that they expected to have happened under that scenario at that time. The approach was deliberately informal so that the various possibilities could be considered more easily.

The headlines of the articles proposed were posted on a website, www.energyscenariosireland.com we set up for the project as a way of allowing more people to inform themselves about the possibilities and to comment on them. The website stimulated a lot of online discussion and won an honourable mention in an international competition (see www.beyondpeak.com/scenarios/ireland1.html).

About sixty decisionmakers attended one or other of the seminars. Their names are listed in an appendix. They were chosen as representatives of the most important companies and organisations in their sectors and invited to come individually. However, some of those we hoped would attend displayed extreme reluctance to consider how their businesses might be affected if energy prices rose massively in real terms. For example, despite persistent efforts, it proved impossible to get anyone to attend from either Ryanair or Aer Lingus.

After the seminars, we had further discussions with some of those who attended and did a great deal of desk research to gather further information about some of the suggestions the participants had made. This enabled us to write the sectoral reports presented in Appendix 2 and summarised in Chapter 5. After each sectoral study was completed it was sent out for suggestions and comment to seminar participants or others we had interviewed in the course of the study. The reactions we received from this group of reviewers have been incorporated in almost every case. The sectoral studies were then used as the basis of a final run of ECCO, our model of energy and material flows in the Irish economy, and the results of this are presented in Chapter 6.

Corporate and governmental people are not the only ones who will have to respond to higher energy prices. Every member of the public will have to do so too and in two other meetings, one in Galway, the other in Waterford, we got consumers to think about how they would react to a radically different energy future. *The End of Suburbia*, a film which deals with the consequences of a decline in oil production, was shown at each meeting. Afterwards, we used a series of slides to explain to the audience that they should expect the 90% fall in the real price of energy since 1920 to be partially reversed and that this would make everything they bought more expensive in relation to the amount they earned. We gave them a form listing hypothetical energy-cost related price increases for the major categories of consumer goods and services and the proportion of their income that their purchases of these made up. How would they try to balance their budgets in the new price regime? A total of 87 forms were completed and the results of their analysis are given in Chapter 7. They show that ordinary people (if people prepared to attend the showing of a film on peak oil can be considered ordinary) are confident they will adapt to whatever comes.

Besides the seminars and the two meetings with consumers, we spoke about the project at several conferences and had face-to-face meetings with people from key organisations like the Construction Industry Federation, the Irish Road Haulage Federation and the Irish Farmers'Association. A full list the people to whom we spoke and the events at which we made presentations in the course of the study can be found in the appendices. Feedback from these presentations has also been incorporated into this report.

General Conclusions

1.The amount of fossil energy available to each person on the planet is reaching a peak and will shortly begin to fall, either as a result of resource depletion or restrictions to combat climate change.

2.As a result, while some sectors of the Irish economy will still grow, most will decline and average incomes will shrink in terms of what they can buy. Higher food and fuel costs will reduce discretionary spending unless rents and property prices fall enough to compensate.

3.To survive in what may be a shrinking market, Irish businesses should now pay more attention to minimising their energy costs than to cutting their wages bill. This could mean re-skilling their workforces, paying them more and using less capital equipment. It could also mean using longer-life buildings and machinery and holding larger stocks – in other words, increasing their use of capital.

4.Families should seek to cut their energy costs as, for the most part, they will be unable to negotiate higher incomes to pay for their energy purchases.

5.The cost of some modes of transport will rise significantly, making decisions about where and on what scale to produce, and where to live in relation to one's work, vital for financial health.

6.The throw-away economy will not survive rises in the price of energy and raw materials and that, from now on, more goods will be bought on the basis of their long-life and repairability

7.The control and possession of energy will displace the control and possession of money as the source of political and economy power. Countries or communities able to offer secure energy supplies at fixed prices will have a big competitive advantage.

8.For the foreseeable future, energy is unlikely to be as cheap as it is today in terms of the number of seconds of work it takes to purchase a kilowatt-hour. As a result, now is the cheapest time to invest in energy conservation measures and in the development of renewable energy sources *provided that the technology adopted is mature.*

9.No efforts should be made to keep energy cheap. That gives the wrong signals. Price stability and predictability is more important.

10.The sooner investments of energy capital are made in saving energy and in the transition to renewable energy, the more substantial those investments can be and, as a result, the smaller will be the extent to which the economy contracts as the imported energy supply tightens. Foregoing economic growth now for the sake of achieving greater energy self-sufficiency will enable the country to maintain higher incomes in future.

Recommendations

1. The main national goal, the generation of economic growth, should be abandoned in favour of maximising the rate at which renewable energy sources are developed and energy use is reduced.
2. Once it has become clear that the peak in oil production has been reached, the distribution of what will become an increasingly scarce resource cannot be left entirely to the market as that would lead to a widening gap betwen rich and poor. Some form of energy or emissions rationing should be introduced internationally, as discussed in our Fair Shares scenario.
3. Research should be commissioned in renewable energy areas in which Ireland could acquire a first-mover advantage for its energy producers or equipment manufacturers in the way Denmark did for its farm equipment makers who moved into wnd turbine production and went on to gain 60% of the world market. Suitable research areas include:
    - tidal flow, wave, and deepwater offshore wind,
    - second generation biomass refining processes such as the Biofine process being studied at the University of Limerick,
    - electricity storage technologies including compressed air, flow batteries and flywheels
    - distributed generation
    - sequestering carbon in agricultural soils
    - producing,cleaning and compressing biogas for motor vehicle use
    - the development of smart heating systems and appliances that can be programmed to operate well on intermittant electricity supplies.

Chapter 2

The Future Availability of Fossil Energy

Three factors will determine the availability of fossil energy in Ireland in future; These are

1. The strength of the Irish economy. This will determine the purchasing power available for fuel imports and also for the purchase of emissions permits.
2. The availability of oil and gas in relation to global demand. This will set their price.
3. The restrictions placed on the use of fossil fuels in response to the climate crisis.

It is impossible to predict the strength of either the Irish or the global economy as both depend on too many variables. The discussion in this chapter will therefore concentrate on the availability of oil and gas and the development of policies to limit climate change.

A. The availability of oil

There are two schools of thought about future supplies of oil. One school is dominated by economists who regard oil as just another commodity and who believe that the supply of a commodity will increase if its price rises because the higher price means that more resources can be profitably devoted to its production. If sufficient investments (around $3 trillion) are made, these economists say, world oil production will increase for at least another 25 years. "We might be running low on $20 oil, but for $60 we have adequate oil supplies for decades to come" says Professor Kenneth Rogoff of Harvard and a former chief economist at the IMF[3].

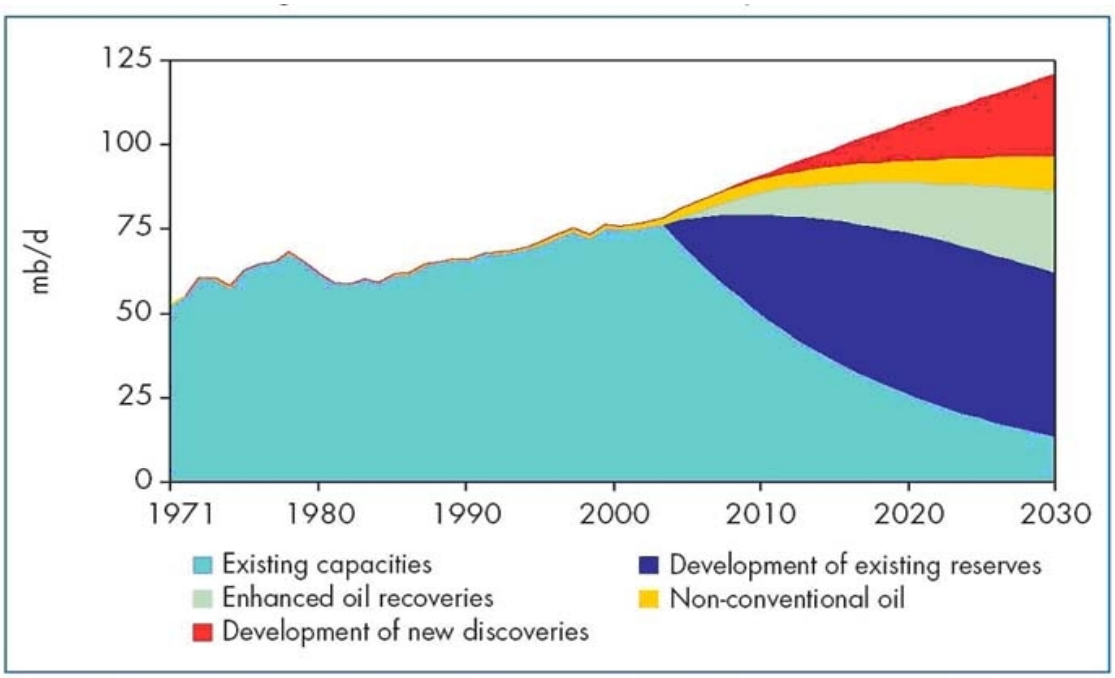
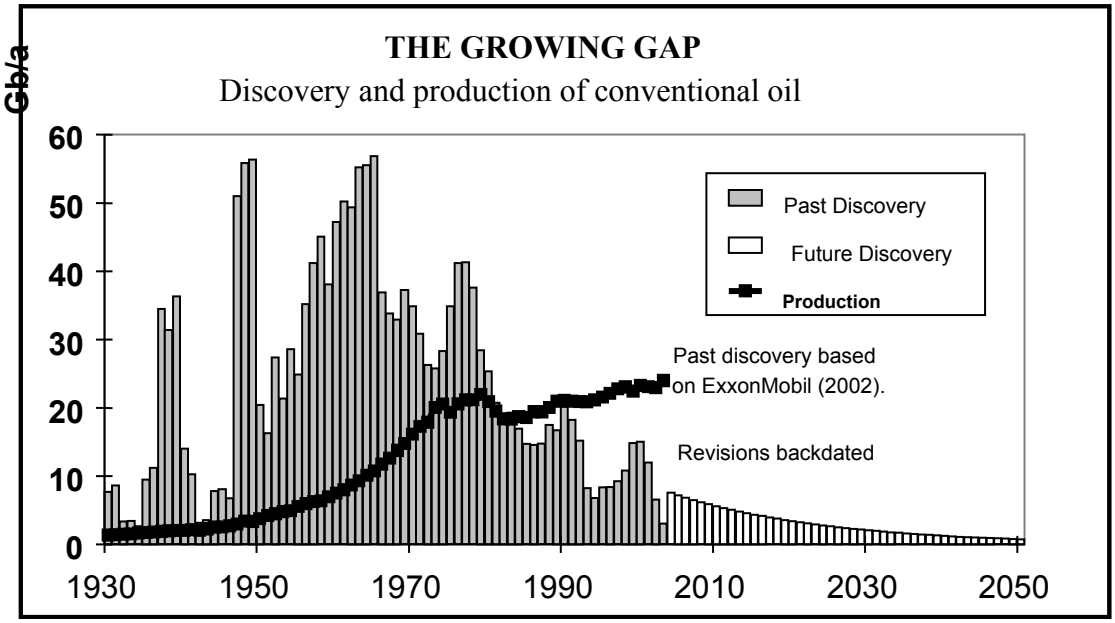


Illustration 3: Where the International Energy Agency thinks the world's oil will come from in future. The IEA emphasises that it will take massive investments to enable output to continue to climb and that high prices will be needed to attract capital on the required scale.

This view is expressed most clearly by the International Energy Agency. Illustration 3, is taken from the IEA's *World Energy Output 2004* and shows that the IEA expects most of the increase in production to come from developments to existing oil fields. These developments involve finding that there is more oil in the fields than is currently known to be the case – the dark blue area – and developing technologies which enable a greater proportion of the oil in a field to be extracted than is possible at present, the light blue zone. Very little reliance is placed on new oil discoveries, the red area.

Illustration 4: Oil is currently being found at perhaps a quarter of the rate at which it is being used. The vertical axis is in giga-barrels.



This is because far less oil is being discovered each year at present than is being produced, as shown in Illustration 4. In 2004, the world produced 30.5 billion barrels of oil but discovered only 7.5 billion barrels to replace it. "It is true that the big firms are struggling to replace reserves" writes *The Economist*, (20.04.06) . "But that does not mean the world is running out of oil, just that they do not have access to the vast deposits of cheap and easy oil left in Russia and members of OPEC".

In fact, no-one is saying that the world is running out of oil. All people are questioning is whether supplies will be able to keep up with rising global demand. There is still a lot of oil in the ground but, despite what the economists say, oil is not a commodity like any other. It is a source of energy and, if it takes more energy to extract and refine it than the oil itself delivers, that process will never be profitable, no matter how high the price rises. As increasingly difficult oil sources have to be tapped, the net energy gain – the energy return on energy invested (EROEI) ratio - declines. At some point, throwing more resources – that is to say, energy – into the effort to produce from a well becomes pointless. When the lost output from the wells being closed exceeds the increase from wells being drilled or improved, world oil output will begin to fall.

Oilmen know this and more and more of them are saying that the economists are wrong to project a rising oil output for the next 25 years. "My view is that "easy" oil has probably passed its peak" Jeroen van der Veer, the Chief Executive of Royal Dutch Shell said in January 2006. By "easy" oil he meant oil requiring little investment in complex rigs and infrastructure (and thus little energy use) to extract.

For oil prices to stay constant, enough new oil production to come on-line each year to cover both the growth in world demand of at least 2 million barrels a day each year and the decline in production from existing fields of over 4 million barrels a day each year. “That’s like a whole new Saudi Arabia every couple of years,” Sadad al-Husseini, the retired head of exploration and production at the Saudi national oil company, Aramco, said in August 2005. “It’s not sustainable.”

The increasing difficulty in producing oil led to a direct attack on the IEA projections by Christophe de Margerie, head of exploration for the French oil company Total in April 2006 in an interview[1] with *The Times* of London. The IEA predicts in its *World Energy Outlook* graph (Illustration 4) that the global supply of crude oil will reach 121 million barrels per day by 2030. “Numbers like 120 million barrels per day will never be reached, never,” de Margerie said. The world was mistakenly focusing on oil reserves when the problem was the capacity to produce oil. The IEA had failed to consider the speed at which new projects could be brought on stream. The resources were simply not available. “Take Qatar. How many projects can you have at the same time? You have more than 100,000 people working on sites. It’s a big city of contractors. Now they have the problem of having to build a new power plant to supply a city of contractors.”

Chris Skrebowski, the editor of the *Petroleum Review* takes this further[4]. He says that during 2006, 40% of the world’s oil was being produced by countries including the US, Britain, Norway and Venezuela, whose output was already declining year by year and a further 10% was coming from countries such as Mexico, whose output was about to begin to fall. The growing shortfall from these countries, plus the increases required to meet the rising global demand, could only be met from fields in the Middle East and Russia, but he did not think this could happen. “There are not enough large-scale projects in the development pipeline right now to offset declining production in mature oil fields and to meet global demand growth beyond 2007” he says.

The IEA has recently started admitting that there are short- and medium-term problems. “The world is facing strong crude and product prices until around 2010,” its Executive Director, Claude Mandil, said[2] in May 2006. "Probably, we will have to live for the next four or five years with very tight capacities, tight markets and strong prices," In November 2006 he repeated his warning in even stronger terms saying that the world's current oil supply and climate situation "may mean skyrocketing prices or more frequent blackouts; can mean more supply disruptions, more meteorological catastrophes – or all these at the same time".

Many experts expect that total world oil production will begin to fall before 2010. Table 1 is a summary of the various predictions that have been made.

Table 1. Projections for the peak in world oil production

Date	Expert	Background & Source
2006-2007	Bakhitari, A.M.S.	Iranian oil executive: Ref. 1
2007-2009	Simmons, M.R.	Investment banker: Ref 2.
Before 2009	Deffeyes, K.S.	Oil company geologist (ret.): Ref. 4
Before 2010	Goodstein, D.	Vice Provost, Cal Tech: Ref. 5
Around 2010	Campbell, C.J.	Oil company geologist (ret.): Ref. 6
2010-2012	Skrebowski, C.	Editor, Petroleum Review. Ref. 3
After 2010	World Energy Council	Non-Government Org: Ref. 7
2010-2020	Laherrere, J.	Oil company geologist (ret.): Ref 8.
2016	Energy Information Agency	US govt. dept. Ref. 9.
After 2020	Cambridge Energy Research	US energy consultants: Ref. 10
2025 or later	Shell	Major oil company: Ref.11
No peak	Lynch, M.C.	Energy economist: Ref. 12

1. Bakhtiari, A.M.S. "World Oil Production Capacity Model Suggests Output Peak by 2006-07." *Oil and Gas Journal*, April 26, 2004.
2. Simmons, M.R. Association for the Study of Peak Oil (ASPO) workshop. May 26, 2003.

3. Skrebowski, Chris, http://www.odac-info.org/bulletin/documents/cs_cera_letter.htm, December 2006

4. Deffeyes, K.S. *Hubbert's Peak-The Impending World Oil Shortage*. Princeton University Press. 2003.

5. Goodstein, D. *Out of Gas – The End of the Age of Oil*. W.W. Norton. 2004
6. Campbell, C.J. "Industry Urged to Watch for Regular Oil Production Peaks, Depletion Signals." *Oil and Gas Journal* July 14, 2003.
7. *Drivers of the Energy Scene*. World Energy Council. 2003.
8. Laherrere, J. Seminar Center of Energy Conversion. Zurich. May 7, 2003
9. DOE EIA. "Long Term World Oil Supply." April 18, 2000.
10. Jackson, P. et al. "Triple Witching Hour for Oil Arrives Early in 2004 – But, As Yet, No Real Witches." *CERA Alert*. April 7, 2004.
11. Davis, G. "Meeting Future Energy Needs." *The Bridge*. National Academies Press. Summer 2003.
12. Lynch, M.C. "Petroleum Resources Pessimism Debunked in Hubbert Model and Hubbert Modellers' Assessment." *Oil and Gas Journal,* July 14, 2003.

Three broad oil supply/oil price outcomes must therefore be considered:

- The oil men are right and oil output in 2006 turns out to be close to the peak in world production and deliveries begin to fall within the next few years. Prices therefore go very high as users compete to secure supplies.
- The economists are right and world oil output continues to increase over the next 25 years. However, the oil is much more expensive in real terms than in the 1990s because of the need to attract huge amounts of capital and to exploit increasingly difficult sources.
- High oil prices arising from either (1) or (2) push the world into a depression. The demand for oil drops and so does its price.

1. The oilmen are right.

In this case, the world's production of oil is likely to fall at between 4% and 6% a year, as shown in Illustration 5. There are limited prospects for replacing oil with natural gas because supplies of that, too, are expected to peak in the near future. Illustration 6 shows projections for global gas supplies and Illustration 7 shows the total amount of energy that can be expected to be available from the two fuels together. Under the oilmen's scenario, this decline can be expected to begin within the next ten years. Coal production will be increased in an attempt to compensate but the energy return on energy invested is poor, particularly if the flue gases are scrubbed to remove sulphur dioxide and especially so if the carbon dioxide is sequestered. Some coal will be turned into liquid fuels for transport using variants of the SASOL process. This, again, involves energy use, energy loss and expense. In any case, the world's production of coal may be nearing a peak itself. A re-assessment of the world's coal reserves[5] published in April 2007 shows that these are much lower than previously thought and that "Global coal production [will] peak around 2025 at 30 percent above present production in the best case."

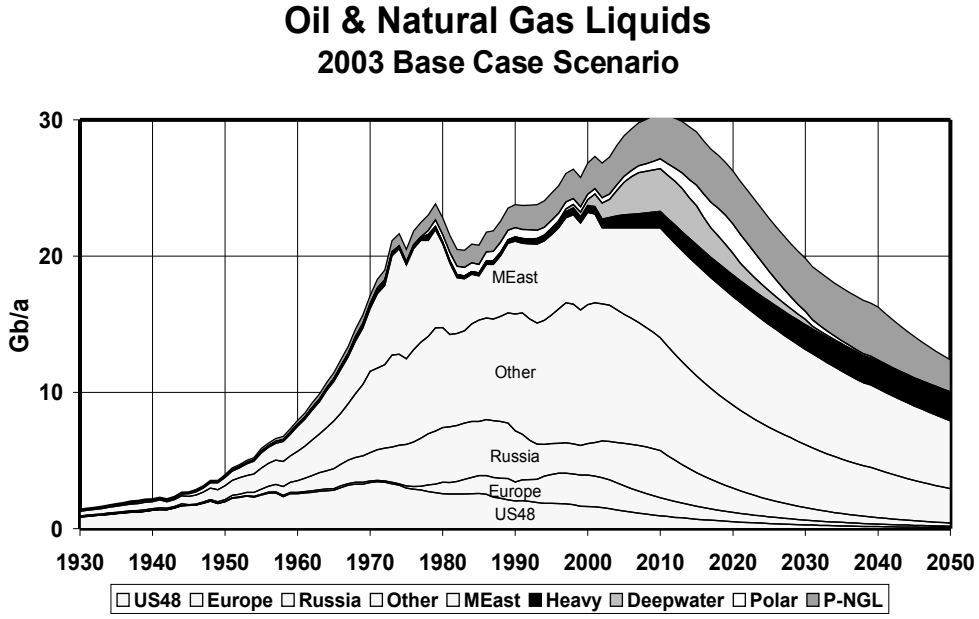


Illustration 5: The Association for the Study of Peak Oil expects the world's production of oil to peak within the next few years and then decline quite rapidly

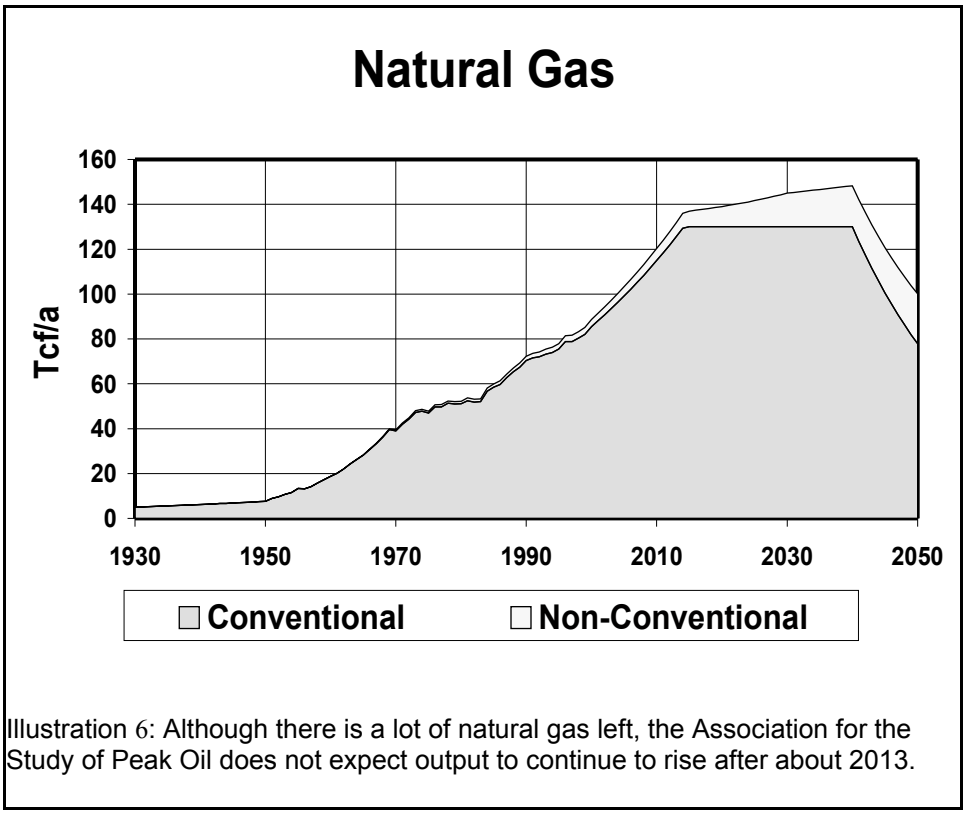


Illustration 6: Although there is a lot of natural gas left, the Association for the Study of Peak Oil does not expect output to continue to rise after about 2013.

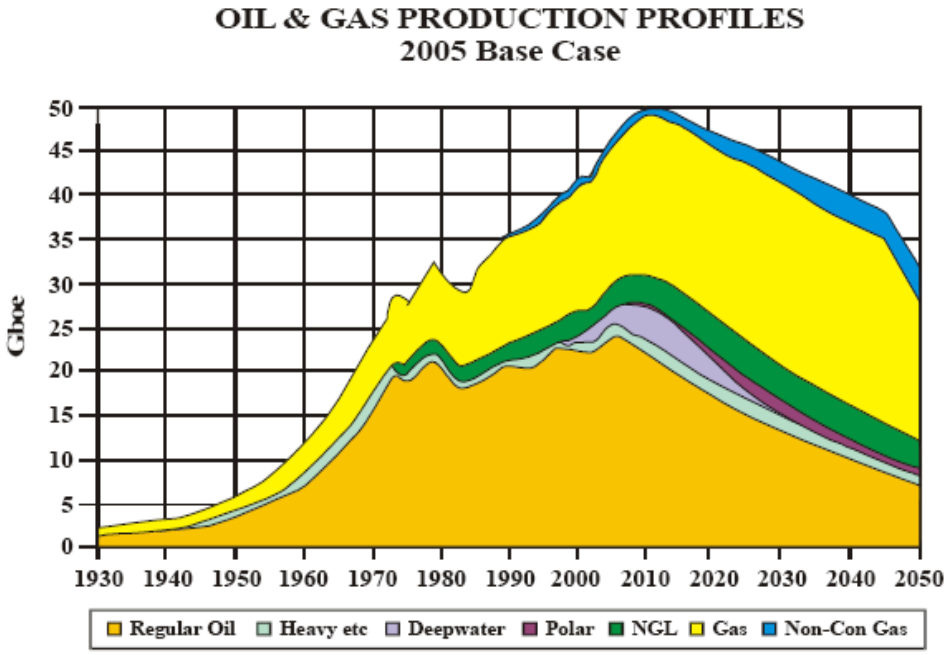


Illustration 7: The total amount of energy that the world will be able to get from oil and natural gas could start to fall within 5-10 years.

It therefore seems highly unlikely that alternative energy sources can be developed rapidly enough to replace oil and gas if supplies decline as quickly as expected by the Association for the Study of Peak Oil. The strength of the world economy and availability of the alternative fuels is likely to determine how high oil prices rise.

2. The economists are right.

Two possibilities arise here: one is that oil output rises at the 1.6% per annum forecast by the IEA, rising from 77 million barrels a day in 2002 to 121 million in 2030, and that this matches the growth in global demand and that, consequently, the rate at which prices increase is modest. The other possibility is that the 1.6% rate is inadequate to meet global demand and that oil prices go very high and world growth slows down.

In either case, Ireland would be able to secure all the oil it needed – the only thing which differs between the two possibilities is the price at which oil would be available. However, because of the EU's efforts to limit climate change with its Emissions Trading System, Ireland would also have to obtain the emissions permits to use the oil and it would be competing with other EU countries for these. It might turn out that, if the oil price was low, the emissions permit price would be high and *vice versa,* so that there could be little difference between the two cases – the effective fossil fuel price would be high whatever happened. This would be a good outcome because it would preserve the incentive for the development of non-fossil energy sources.

3. High oil prices push the world economy into a recession

This is probably the most likely outcome to emerge. It would not be the oil prices themselves which caused the recession but the efforts of the world's central banks to limit the inflation that the higher energy costs are already causing. The current head of the Federal Reserve has written a paper[3] which projects that for every $10 a barrel rise, the US growth rate falls by 0.4% for about four months. This drop happens because consumers who are spending more for oil have less to spend on other things. After that, however, the economy recovers rapidly as firms invest in new opportunities such as supplying equipment for renewable energy projects and consumers invest in improving the energy-efficiency of their homes. After 18 months the higher energy prices actually boost the US growth rate by 0.1%, an effect which lasts for another year and a half. If these assumptions are right, it would take a very big, sudden increase in energy prices to send the US and the world economy into a recession.

The inflation which causes the central banks to act could be due, at least in part, by the boost that higher energy prices give to an economy. Counter-intuitively, the investments in energy-saving projects and renewable energy systems made in response to higher energy prices could actually increase energy demand. This is because investment projects of any sort are more energy-intensive, because of the energy required to make and install the equipment they require, than, say, typical consumer expenditure such as a meal in a restaurant. In other words, higher energy prices can increase the demand for energy.

This means that a positive feed-back loop could develop, with increased energy prices leading to increased energy-related investment, leading to a further increase in energy prices… and so on. The world's central banks obviously need to moderate this effect but, if in doing so, they use too heavy a hand when raising interest rates, they could increase the amount that consumers have to pay on their mortgages and other borrowings at the same time that the higher energy prices are forcing them to cut their expenditure in other areas. This would reduce consumer demand and, if the drop was significant, so many firms might cancel investment projects that a downward recessionary spiral developed, lessening the demand for oil and bringing its price down. High and widespread unemployment would then develop which could persist for several years since every nation would be affected and no one of them would be able to act as the 'engine of global growth'. The continuing low fossil energy prices during this period, coupled with the lack of confidence and low energy demand would destroy the incentive to invest in renewable energy and energy saving projects. The overall effect would be that the world continued to deplete its fossil fuel reserves without building renewable systems to replace them. We feel that there is such a serious risk of this happening that we made it the basis of the Enforced Localisation scenario described in the next chapter.

Latest views on the timing of oil peak

Writing in the November/December 2006 issue of the *OPEC Bulletin*, Dr Shokri Ghanem, Chairman of the People's Committee, the National Oil Corporation (NOC) of Libya summed up the views on oil peak as follows: "While some of the more pessimistic oil specialists are declaring that peak oil has already been passed, or at best is here now, others believe it is not going to arrive before 2010. Some optimists give the world a little more breathing space — that is to say up to 2020, and perhaps even up to 2030. However, all in all, most would appear to agree that peak oil output is not very far away. It could take place sometime within the next decade or so, which in fact means that there is not much time left for a world economy driven largely by oil."

The oil industry banker Matthew Simmons believes that the world will only know for sure when the peak has happened by looking “in the rear-view mirror” some time after it has taken place. Commenting in October 2006 after the release of figures showing that the world supply of crude oil had declined to 83.98 million barrels per day in the second quarter of 2006 after hitting 84.35 million bpd in the fourth quarter of 2005. Simmons said: "If you basically have another six to ten months of that decline lasting, then I think for certain we would look back and say, 'Guess what? We actually reached a sustainable peak in crude oil production in December 2005.'"

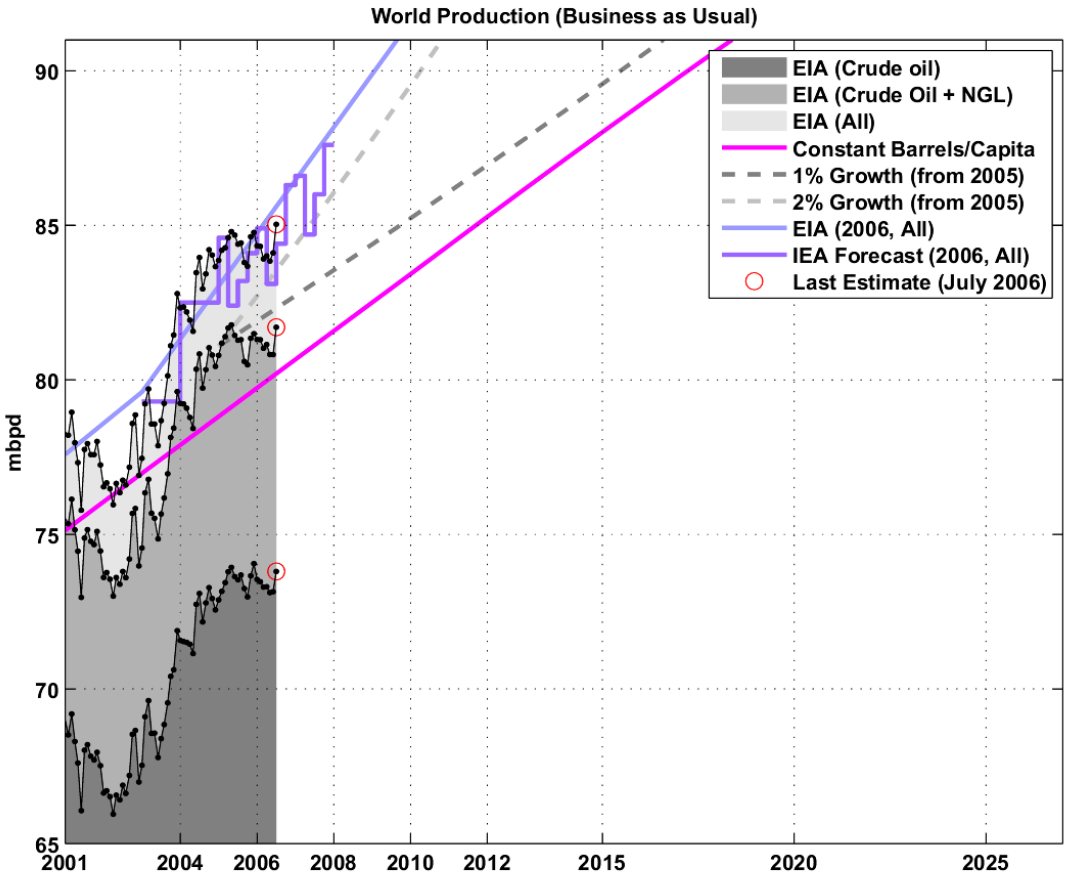


Illustration 8: World production of crude oil is represented by the darker grey area above. The lighter grey area is the contribution made to the global oil supply by natural gas liquids, the light oil produced as a bi-product of natural gas production. It will be seen that world oil production reached a peak sometime early in 2005 and has since been on a plateau despite the very high prices. Production is certainly not increasing at the rate required to keep up with the expansion of the world's population (the constant barrels per capita line) nor the forecasts made by the International Energy Agency and the US government's Energy Information Agency. Source: http://www.theoildrum.com/story/2006/10/3/104458/751

What is definite is that one peak has already occurred. This is the peak in the world production of light, sweet oil, the type found in the North Sea and elsewhere which is the best oil for petrol production. As its output is already in decline, the debate has now switched to when the peak in heavy sour oil might happen. Sour oil is the high sulphur type found in the Middle East which needs special refining capacity to get the sulphur out.

Illustration 8 shows how total world production of all types of oil has run recently. At present, sweet and sour oil make up the bulk of this production. The graph makes it clear that, while output is not yet falling, it is certainly not increasing. Could the resulting plateau be the peak itself and the prelude to an imminent decline? Only the rear-view mirror will enable us to tell. However, the graph does show that it will be very difficult for the oil industry to increase production enough for world oil consumption to expand at even 1% a year from its 2005 level , a rate indicated by the shallower hatched grey line. If oil production does not increase, world economic growth will be constrained.

The effects of the peaks in the supply of oil and gas

The timing of the peak in world oil production is crucial because it will mark a major change in the way the world economy operates. There is a very close connection between the rate of increase in world oil use and the total world production of all goods and services as Illustration 9 shows. Accordingly, unless other sources of energy can be found to replace oil and gas or the efficiency with which the two fuels are used can be increased more rapidly than their output declines, or a combination of the two, world output will decline once the joint oil-and-gas peak is passed.

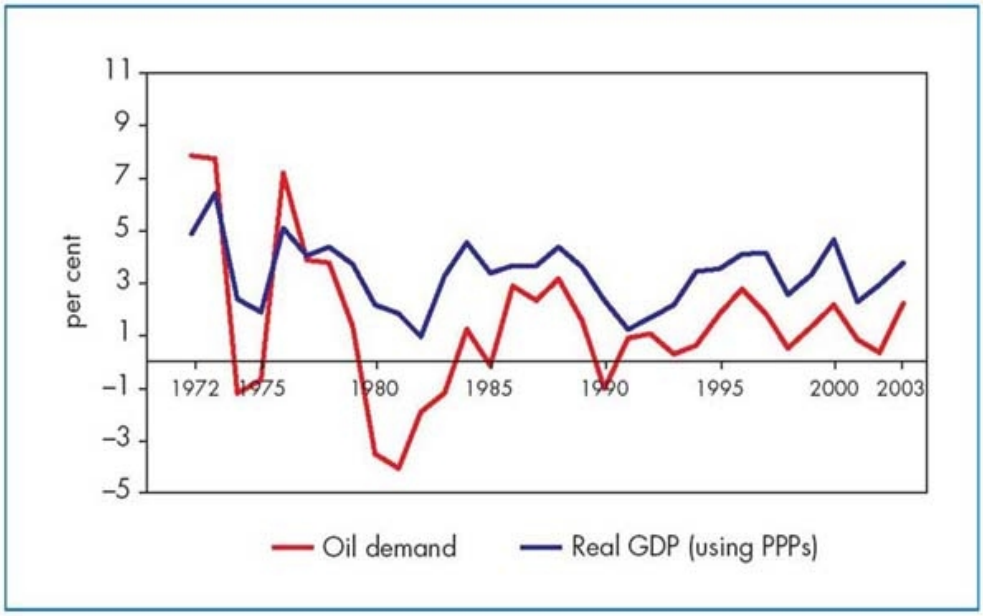


Illustration 9: The close relationship between oil use and world output. Source: International Energy Agency, *World Energy Outlook*, 2004

Illustration 7 indicated that a 10% fall in the amount of energy available from oil and gas can be expected within 15 or 16 years of the combined peak being reached. It is by no means impossible that, spurred by higher prices, gains in the efficiency with which those two fuels are used will be enough to cancel out this decline. However, will any extra efficiency gains, together with whatever increases we can expect in the supply of nuclear, coal and renewable energy, be enough to keep the global economy growing at the pace it did in, say the 1990s, a period in which the amount of energy delivered to the world economy by oil and gas together rose by 20%? In our view, the answer is "no" and the rate at which the world economy will grow will fall.

We also have to ask what types of energy the substitutes will provide. As we show in Appendix 2, 50% of the world's oil is used for transport, and 81% of that is used by road vehicles. We also show that renewable biomass sources of ethanol and diesel will not be adequate to replace more than a fraction of the fossil vehicle fuels now being used. Because petrol and diesel have such a high energy density, and are therefore very convenient, and because no substitutes are in sight for aviation fuel, we can expect the price of vehicle fuels to rise in relation to other forms of energy such as electricity which can be produced from a wider range of sources. This will also affect the rate of growth as a lot of recent growth has been generated by reaping the economies of scale by producing large amounts using specialist equipment in a few locations and then distributing the output around the world. In short, we expect the rise in transport costs, particularly by air and road, to cancel out many economies of scale and for industrial production to become more localised and labour-intensive.

As well as the distribution of industry, the distribution of the incomes generated by the global economy will also change, with far greater amounts going to energy producers unless some type of rationing system is put into place as envisaged in the Fair Shares scenario and described in a Feasta publication, *Emissions Rationing and the Oil Price Crisis*[6]. In any case, the real value of the average wage is likely to fall because any increases in income from the limited amount of growth which it might be possible to generate from the restricted energy supply are likely to be outweighed by the price rises caused by the higher energy costs. As energy prices rise, increasing amounts of purchasing power will flow out of Ireland to the sources of our fossil fuel supplies, lessening the amount that people here can invest or spend.

In order to limit this flow, it is not inconceivable that the governments of fuel importing countries will set up what would be equivalent to a buyers' cartel, to negotiate with the sellers' cartel, OPEC, for supplies. The buyers' cartel would agree a price and a quantity each year with the suppliers, and then share out the amount it had purchased amongst its members. We have proposed a way of doing that in our Fair Shares scenario. Such an arrangement would stabilise the world economy and could thus be advantageous to both buyers and sellers. After all, it is not in OPEC's interests for oil and gas prices to rise so high on a temporary basis that the world economy went into a depression, since a depression would mean that its prices and net income fell to very low levels, possibly for several years.

Higher energy prices will also re-adjust the balance between the value of human and mechanical labour. A strong person can produce 75 watts per hour[4], which gives 3 kWh in a 40-hour working week. At present electrical costs of 13 cents/kWh, a week of hard human labour would therefore be worth about 45 cents, or about one cent per hour. A litre of petrol has an energy content of 8.9 kWh, and is therefore equivalent to three weeks' manual work. The conclusion from this is that someone with access to fossil energy will be able to boost their productivity to such an extent that they will always be able to out-compete someone relying on their labour alone. As a result, the person using energy will be able to afford to buy further energy supplies whereas the poorer person will not. As a result, the distribution of energy around the world will become even more polarised than it is at present, and with it the distribution of wealth. A rationing system to share the available fossil fuel would offer the possibility of avoiding the backlash that such a polarisation would create.

B. Actions to combat climate change

An effective global system of controlling greenhouse gas emissions to limit climate change would, inescapably, be a form of energy rationing as it would determine who got the right to burn a set amount of carbon fuel. In the international negotiations that have taken place so far under the auspices of the UNFCCC, the poorer nations of the world have made it clear that they will not accept any climate treaty that does not give them access to a greater share of the world's fossil fuel usage than they have at present. Consequently, if there is to be a post-Kyoto climate treaty at all, the emissions rights allocated under it will have to move closer to equality per head of each country's population than is the case today. This will tend to prevent an increased polarisation of energy use although the emissions rights granted under the treaty are almost certain to be tradable. This will allow high-energy countries to buy the right to use more fossil fuels from countries which use very little. Phase 3 of the EU Emissions Trading System will be linked to this international system. This will not necessarily limit the amount of fossil energy consumed in Ireland but it will increase its price because of the necessity to buy emissions rights.

It is not yet clear how rapid a rate of global emissions reduction will be mandated by any post-Kyoto treaty. If the rate of reduction is greater than the rate of resource-depletion-dictated decline in the output of gas and oil, the emissions permits will be the scarce resource and their price will rise to whatever amount is necessary to balance supply and demand. On the other hand, if the supply of oil and gas contracts more rapidly than the rate at which emissions are cut, the oil and gas producers will see their prices increase to bring demand into balance with the supply. The market value of the permits would be low in such a situation, their only function being to control the use of coal.

Regardless of whether the remaining oil is rationed in some way or not, as the world moves further down the oil and gas production curve, the volume of production that will be possible globally is almost certain to fall as the fossil energy subsidy humanity has been enjoying is gradually taken away. In short, the era of rapid economic growth will end. For most of the past 1,000 years, Irish growth was very slow, closer to 10% a century than 10% a year. Only technological change can prevent Ireland returning to a similar low-income, slow growth situation.

Chapter 3

Using scenarios to explore responses to restricted fossil energy supplies

Scenario planning is a technique for exploring the future by creating several plausible but challenging alternative futures rather than making a single prediction. It has been used by commercial companies since the 1970s after Shell was the only oil company prepared for the oil shocks of that decade as a result of its use. We adopted scenario planning for this study because:

- **A prediction is (almost) never right.** The unexpected always happens and the assumptions, conscious and unconscious, that we can apply today may not apply tomorrow. For example, at the end of the last century, London could see no solution to the ever increasing amounts of horse manure on the roads when along came the motor car, This highlights the difficulty with using forecasts: they simply carry forward current trends, problems and constraints on the assumption that they will still apply in the future.

- **Scenarios are versatile.** Scenarios can be used not only to prepare plans for the future, but to check existing plans for robustness. Will a plan work in more than one scenario or will if fail if any of the underlying assumptions change? If we can develop flexible plans that will work with multiple scenarios, then, when the unexpected does happen, there is a better chance that the plan can be adapted to the new circumstances.

- **It is difficult to get consensus for a prediction.** You can either agree or disagree with other people's predictions - and the tendency is to disagree. Scenario planning is about building plausible futures, a much less contentious task because we only need to agree that a scenario is possible to be able to use it. We don't even have to agree that it is likely.

- **Good scenarios challenge one's thinking and stimulate discussion.** The human species has spent most of its history telling stories rather than looking at graphs and spreadsheets. As a result, the implications of a rich story about the future can be more easily understood by most people. It is surprising how much information a scenario can convey in a few words. For example, the following classified advertisement can tell us a lot about what 2016 might be like under a particular scenario:

> *For Sale: 4x4 with axle suitable for conversion to wind turbine.*

This can be interpreted as:

> *Increases in the price of transport fuel have meant that vehicles with high fuel consumption are no longer in demand and it is becoming difficult to sell these vehicles. However, with increasing prices of home electricity, there is a boom in DIY windmills. A component of these windmills is the back axle of a car.*

The process of developing an internally consistent scenario forces one to *think about the impact of change, not just on one industry, but on the whole economy*. There is a tendency at present for each industry to think that it will change by adopting new energy sources, new production methods etc. - but that its customers and suppliers will continue just as they are. This, of course, is not the case. Change in one area stimulates change in others and so an iterative thought process is required to explore the impact of the initial change and the changes brought about by those changes and so on.

For example, in our interviews we found that the road transport industry hopes that biofuels will allow it to continue operating as usual, though with higher prices. But at the same time, its customers, looking at the increased delivery charges, can be expected to start to keep larger stocks so that they can take fewer deliveries. They will also turn to cheaper methods of delivery, such as transport by ship, again taking few larger deliveries to compensate for longer lead times. This means the road hauliers will need fewer but larger trucks to operate most efficiently and will make shorter journeys with more goods going by sea and rail. A business opportunity will be created for warehouse expansion as more goods will be stored. This is not necessarily the way the future will pan out but it shows the knock-on effect of change. Good scenarios present vivid pictures of what the future might be like. Each future should be plausible, very different from the others, and describe a world quite different from today. It should also make one feel a little uncomfortable.

How our scenarios were developed

In a scenario planning process, it is customary to choose two key areas of uncertainty related to the area of study and to look at the extreme cases of each. This produces four scenarios. Accordingly, our four scenarios were chosen because they represent the extremes of key uncertainties in relation to Irish energy prices. Timing was one key uncertainty. While it is certain the oil and gas production will peak at some time, there is disagreement about when. In 2005, when these scenarios were written, the government, on the advice of the International Energy Agency (IEA) was working on the basis of a peak in 2030, while oil geologists, such as Colin Campbell were predicting 2007-2010. While the timing of the peak is still contentious, it now seems unlikely that oil and gas prices can remain stable and low for the foreseeable future.

The other key uncertainty was the way the Irish government and the international community would respond to the knowledge that the supply of oil was going to peak some time in the future or had already done so. Would they be proactive or reactive? For example, if a government accepted the IEA position that it had until 2030 to prepare for oil peak, would its attitude be proactive "It's taken over a century for us to reach our present level of dependence on oil, so a quarter century doesn't seem very much time to get that dependence drastically reduced, particularly as gas supplies are going to be tight, too, and the use of coal needs to be restricted for climate reasons. Moreover, as the power stations, transport infrastructure and buildings we are planning now will still be in use when the shortages begin to bite, we need to make the right choices as a government and to give households and businesses an appropriate combination of incentives and restrictions so that they make the right choices too"? Or would it be reactive and say "Twenty-five years is a long time. Who knows what will happen then? We can't afford to distort the Irish economy on the basis of a projection like this. Some new source of energy might turn up. In any case, we'll all be long gone if

that day arrives. We can't distort competition and reduce the growth rate. We have to let things run on as they are"

If oil peak is reached in the next four or five years, would the government be proactive and say: "A scarce commodity as vital as oil cannot be left to the market to distribute. If that were to happen, the rich, the people who have boosted their productivity by using oil, would be able to buy it all up, leaving the poor with no heating, no lighting and no energy for production at all. We need to work with other countries to bring about an international agreement for sharing the oil out so that prices do not go through the roof, impoverishing millions and destroying the world economy. " Or would its reaction be: "Global central planning is not only impossible, but it's also very inefficient. We've got to leave things to the market to sort out. That might be painful, but it's the only way. "

These four cases gave us our four scenarios in each of which we took it as given that

- Demand for energy would increase other things being equal
- Ireland has limited local supplies of fossil fuels and must import an increasing proportion (90% in 2004)
- Fossil fuel supplies are finite

Our other assumptions are listed in Appendix 1.

	REACTIVE	PROACTIVE
Oil Peak 2030	**Business As Usual** Growth at all Costs Ireland continues to use current assumptions until close to peak	**Enlightened Transition** Ireland actively prepares by encouraging efficiency and ensuring energy prices increase predictably.
Oil Peak 2007	**Localisation** Market determines allocation of remaining oil and gas. Unstable economy. Back to the land.	**Fair Shares** Introduction of controlled distribution of remaining oil and gas. Economy slow but stable.

We then used the ECCO model described in the next chapter to determine the economic characteristics of each of these scenarios and to write a rich story about Ireland in 2015 for each of them. The stories include details of what government policies would be in place, what we would be eating, watching, driving, where we would be living, what we would be working at, and what we would be buying and selling. Details of the scenarios are given in Appendix 1.

Chapter 4

The Use of the ECCO model to Assess the Scenarios

The ECCO (Evaluation of Capital Creation Options) model is a computer programme that models the energy flows in and out of a country to determine how well renewable energy can meet a country's future energy needs. ECCO provides a broad-brush sketch of the entire economy which allows us to not only to calculate the direct impacts of renewables on the electricity-generating sector, but also the synergies that may exist between renewable generation of electricity and other technologies and economic activities. ECCO uses energy analysis theory as one of its main tools and many of the variables in the model are expressed in energy terms.

ECCO does not describe the state of the economy at a single point in time but the unfolding of events in the economy over a period of decades as a result of policy choices (or scenario) that are put into the model. It is most suited to describing long-term economic patterns over decades as it has limited ability to explain short-term fluctuations over periods less than five years.

Money is not used as the numeraire in the model as its value changes over time and it cannot account for voluntary or unpaid activities. The unit of energy the Joule, on the other hand, is fixed in value regardless of time, place and any variation in currency value or economic state. However changes in the price of energy in relation to the price of labour do have an impact on the way the various sectors of the economy use energy and ECCO tracks these energy flows. ECCO models have been developed to varying degrees of detail for economies around the world including UK, EU, Australia and New Zealand. Details are given in Appendix 3.

The Irish ECCO model

Irish ECCO is a pilot model developed over a period of approximately six months. We aimed to replicate the broad growth patterns of the Irish economy over the period 1990-2002 (or as recently as official time-series allowed), and then simulate them out to 2050. This was successfully achieved, although inevitably some areas are developed in relatively little detail as the Appendix explains. The model divides the economy into a number of broad sectors, following the sectoral divisions provided by the main data sources we used to calibrate it. The sectors are:

1. Agriculture, Forestry & Fishing
2. Mining, including gas and peat extraction
3. Industry & Manufacturing
4. Utilities, primarily electricity generation services
5. Domestic dwellings
6. Transport
7. International Finance

The sources used for the historical data were:

a) National Accounts Data From the Central Statistics Office
b) Energy Balance Data from Sustainable Energy Ireland
c) ESB Annual Statement
d) The final report of the EU funded ALTENER report "Total Renewable Energy Resources in Ireland"

The model was initiated for the year 1990 and was run over a 10-year period against real historical data to calibrate it before extrapolating it up to 2050. It should be noted that the Irish ECCO model is still at a stage where it certain sections needs further development for finer detail. As a result, the output from the model should only be taken as a broad indication of how the economy might evolve over the coming decades under given scenarios.

Results

The model was run for four different scenarios. These were -

Business As Usual - Oil peak is not expected until 2030. The policy is to continue to maximize economic growth. The country continues importing most of its energy in the form of fossil fuels with very little investment in alternative energy sources or energy efficiency. Economic growth continues until imported energy prices make Ireland uncompetitive in relation to other European counties which have invested significantly more in domestic supplies of alternative energy.

BUSINESS AS USUAL: Oil peak occurs in 2030 but no preparation is made for this as governments believe that doing so would distort the market, slow growth and damage Ireland's competitiveness. Energy prices rise slowly until 2030 but soar after the peak is reached.			
Policy	***2010***	***2030***	***2050***
Electrical, compressed air and biofuel vehicles	5%	5%	20%
Proportion of energy efficient buildings	10%	10%	10%
Non-fossil energy sources for heat	10%	10%	10%
Passenger-km travel by other means than car	10%	10%	10%
Electricity generation from renewable energy sources	10%	10%	20%

Table 5.0 The BAU scenario goes into rapid decline after 2030 as energy prices soar, taking purchasing power out of the economy. Investment stops. By 2050, far fewer vehicles are being run, which explains why more of them are powered by Irish energy sources, and only half the amount of electricity is being generated, which accounts for the doubling in the amount coming from renewable sources. If the assumptions are changed for the post 2030 period to make them seem more reasonable, BAU ceases to be BAU and moves closer to Fair Shares.

Enlightened Transition- This is the ideal case. Ireland recognises that oil peak will occur in the next 25 years. It also realises that imported energy will become very expensive once the peak occurs and that the country's future economic sustainability depends on minimizing the amount of foreign exchange required to pay for imported fuel. It therefore immediately sets about developing Irish energy sources at the short term expense of the growth rate. It starts work in 2005 by announcing that energy prices will go higher and higher, hoping that this will enable the business sector and the general public to avoid making stranded investments (that is, investments that are totally inappropriate to a high energy cost world) and, instead, to use energy which is much cheaper than it will ever be again to prepare for an energy constrained future. Table 5.1 outlines the characteristics of the resulting economy as it develops. It represents an ideal case that is unlikely to be achieved in reality. In chapter 6 a more realistic approach called towards enlightenment is developed, a compromise between business as usual and enlightened transition.

ENLIGHTENED TRANSITION: Oil peak occurs in 2030 and long term sustainability options are chosen with a view to becoming free of fossil fuels by 2030 at the expense of short term economic growth			
Policy	***2010***	***2030***	***2050***
Electrical, compressed air and biofuel vehicles	5%	70%	100%
Proportion of energy efficient buildings	10%	40%	80%
Non-fossil energy sources for heat	10%	40%	100%
Passenger-km travel by other means than car	10%	50%	60%
Electricity generation from renewable energy sources	10%	100%	100%

Table 5.1 Enlightened Transition represents the ideal outcome – the government embarks on a determined attempt to end the national dependency on fossil fuels and finds that, despite many fears, oil peak is not reached until 2030 so that it has the time and the energy to bring the transition to renewables about.

Fair Shares- Oil peaks in 2008, but the response to the shortage of oil is immediate. Governments around the world realise that, without an international agreement to share out the limited amount of oil and gas on a non-market basis, over-high oil prices will threaten both oil-producing and oil-consuming countries with depression and financial ruin. A system called Cap and Share is put in place which adopts the position that everyone has an equal claim to be able to use the atmosphere as a dump for his or her greenhouse gas emissions and issues permits for them to do so. These permits can then be traded on the free market but the effect is to control and limit the supply of fossil fuels. In this scenario Ireland endeavours to reduce its dependence on fossil fuels in the expectation of rapidly rising real energy prices. Table 5.2 summarises the policies adopted.

FAIR SHARES: Oil peak occurs in 2008 but measures are put in place to share the available fuel internationally and prevent competition for it collapsing the world economy.			
Policy	***2010***	***2030***	***2050***
Electrical, compressed air and biofuel vehicles	5%	100%	100%
Proportion of energy efficient buildings	10%	30%	50%
Non-fossil energy sources for heat	10%	100%	100%
Passenger-km travel by other means than car	10%	50%	60%
Electricity generation from renewable energy sources	10%	100%	100%

Table 5.2 The big difference between Fair Shares and Enlightened Transition is that in the former, a much greater proportion of everything that is being produced in Ireland is having to leave the country to earn the currency to import fossil and biofuels and also emissions permits. This means that there are fewer resources available for transition to a low carbon economy. So, while there is a greater proportion of non-fossil-fuelled vehicles in 2030 under Fair Shares than Enlightened Transition, there are fewer vehicles in use. Similarly, less space heating is being done – imported fuels just cannot be afforded, even though buildings are less well insulated because the resources have not been available for the work to be carried out.

Enforced Localisation- Oil peaks by 2008 as in the Fair Shares case but the world is unprepared for the imminent oil peak and the economy continues to be dictated by market forces with no little real forward thinking about reducing the dependence on fossil fuels. Due to rapid fossil fuel price rises there is a sharp economic contraction to which there is very little time to react and move to alternative forms of energy. After the central banks react to stem the inflation caused by the higher energy prices, the world economy enters a depression and the resulting lack of demand for energy causes a drop in its price as supply is once again more than required to meet the demand. Investment in alternative energy projects stops. When after a few years, the economy picks up, the need for energy also increases and since there has been no investment in alternatives, this quickly leads to supply shortages and the cycle repeats itself. By 2015, oil prices are low, but unemployment high and business people are reluctant to invest having been stung by the instability of the previous years. Those businesses that survive are focused on delivering locally sourced products to local markets. The following policies in Table 3 are chosen in the Enforced Localisation scenario.

ENFORCED LOCALISATION: Oil peak occurs in 2008. The world economy collapses. Investment stops, oil prices fall to levels which discourage a shift to renewables.			
Policy	***2010***	***2030***	***2050***
Electrical, compressed air and biofuel vehicles	3%	20%	60%
Proportion of energy efficient buildings	5%	10%	25%
Alternative energy sources for heat	10%	20%	40%
Passenger-km travel by other means than car	15%	25%	50%
Electricity generation from renewable energy sources	10%	20%	80%

Table 5. 3 – In this scenario, high interest rates imposed by central banks to stop the inflation caused by higher energy prices collapse the economy. Investment projects stop, unemployment soars and energy prices retreat. People are forced back on their own and community resources. Eventually, a locally-based economy develops using local energy sources but in fairly crude ways. Levels of activity are generally much lower than at present.

The key comparison between the scenarios is what happens to to national output and thus to people's living standards after the oil peak occurs. The proxy for output in the ECCO model is the index of manufacturing output, which includes the output of the construction sector. This is illustrated in Figure5.1. In the pair of scenarios is which oil peak happens about now, Fair Shares enables a much higher level of output to be maintained for far longer than the free-market alternative, Enforced Localisation. Nevertheless it does show a decline starting 15-20 years after the peak occurs, as fossil energy supplies get scarcer and scarcer. This eventual decline is almost inevitable because the ECCO model assumes that technology is fixed. In fact, what would happen in that 20 years is that new, low energy technologies would be developed which would require the model to be re-set and which would yield a more promising result. The big difference between the two scenarios in which oil peak happens in 2030 is that there is very little economic growth in the Enlightened Transition scenario because a high proportion of the country's energy resources are being devoted to cutting energy use and replacing fossil energy systems with renewable energy systems rather than building new, conventional production capabilities. So the Business as Usual scenario generates much more growth for as long as the cheap oil supplies last but collapses much more precipitately as oil and other fuels become more costly.

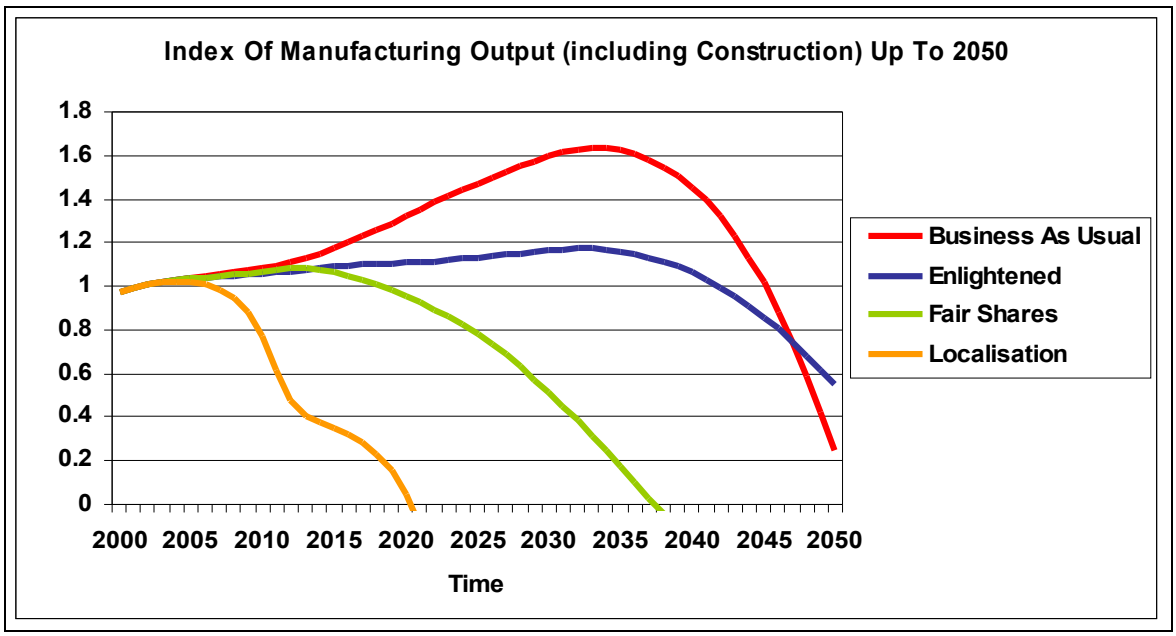


Figure 5.1: Index of Manufacturing Output

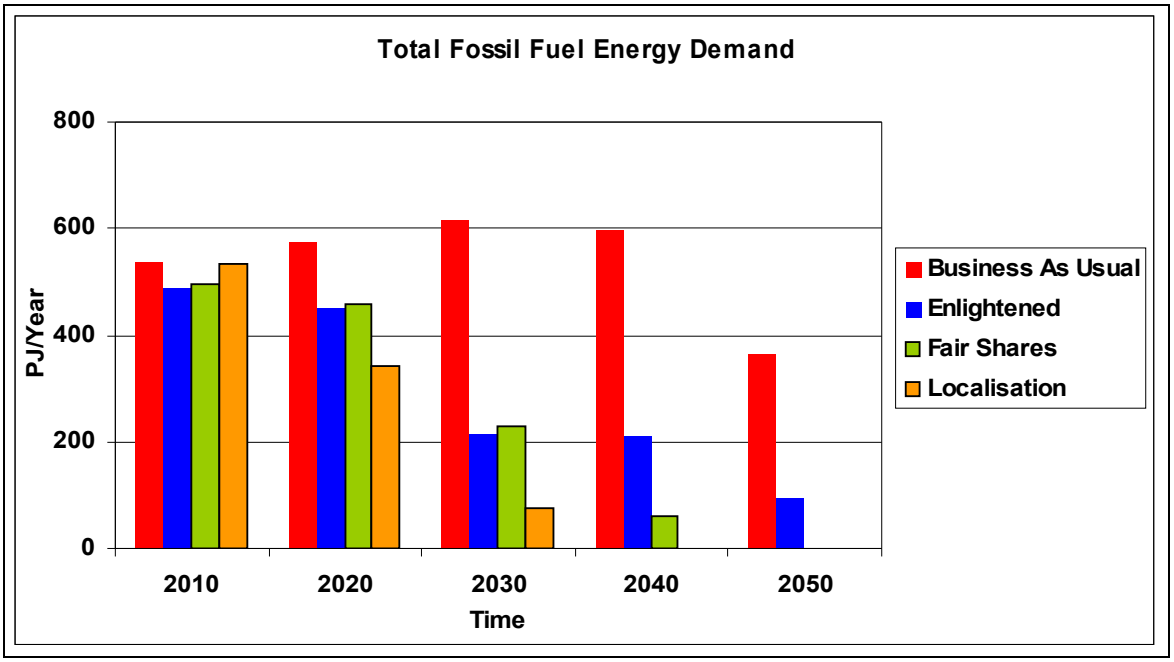


Figure 5.2: Total fossil fuel energy demand

Figure 5.2 shows that with Business As Usual fossil fuels continue to be the dominant energy source until at least 2050 although demand for them decreases after 2030 as they become increasingly costly. This causes an economic decline. In the Enlightened Transition scenario, the transition to

alternative energy and energy conservation reduces the dependence on fossil fuels to less than 20% by 2030. This keeps the economy in a healthier state when oil peak happens. The Fair Shares scenario also endeavours to become as free from fossils fuels as possible but the demand for fossil fuels falls at a lower rate than in the Enlightened Transition over the next 30 years since the economy is unprepared for the oil peak when it happens in 2008 and the energy to build the renewable energy systems is scarce and expensive. With Enforced Localisation, nothing is done proactively to move away from fossil energy. The economy declines rapidly. This results in a fall in the demand for fossil fuels. Renewable energy sources meet all the very low energy demand from the collapsed economy by 2040.

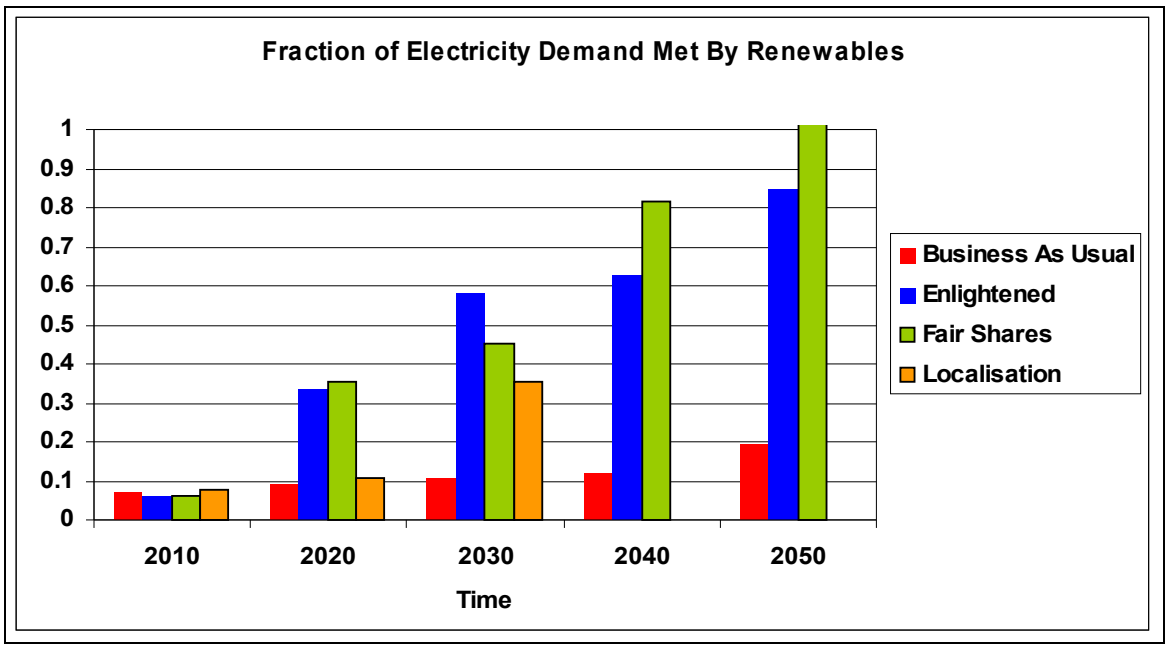


Figure 5.3: Fraction of electricity demand met by renewables

In the Business As Usual scenario in Figure 5.3 only a small fraction – up to 10% - of Ireland's electricity demand is met my renewable sources of energy up until 2040 when diminishing fossil fuels force action to be taken which then results in only 20% of our electricity demand being met by 2050. In the Enlightened Transition case 25% of electricity comes from renewables in 2010 increasing to over 80% by 2030 and up to just under 100% by 2050. Due to economic decline the demand for energy get less in the Fair Shares case and this reduced demand is met 100% from renewables by 2050. Enforced Localisation makes some attempt to generate electricity between 2030 and 2040 but is handicapped by the expansion/contraction cycles. Due to the erratic nature of the Enforced Localisation scenario the ECCO model as it stands falls down on what it can realistically calculate.

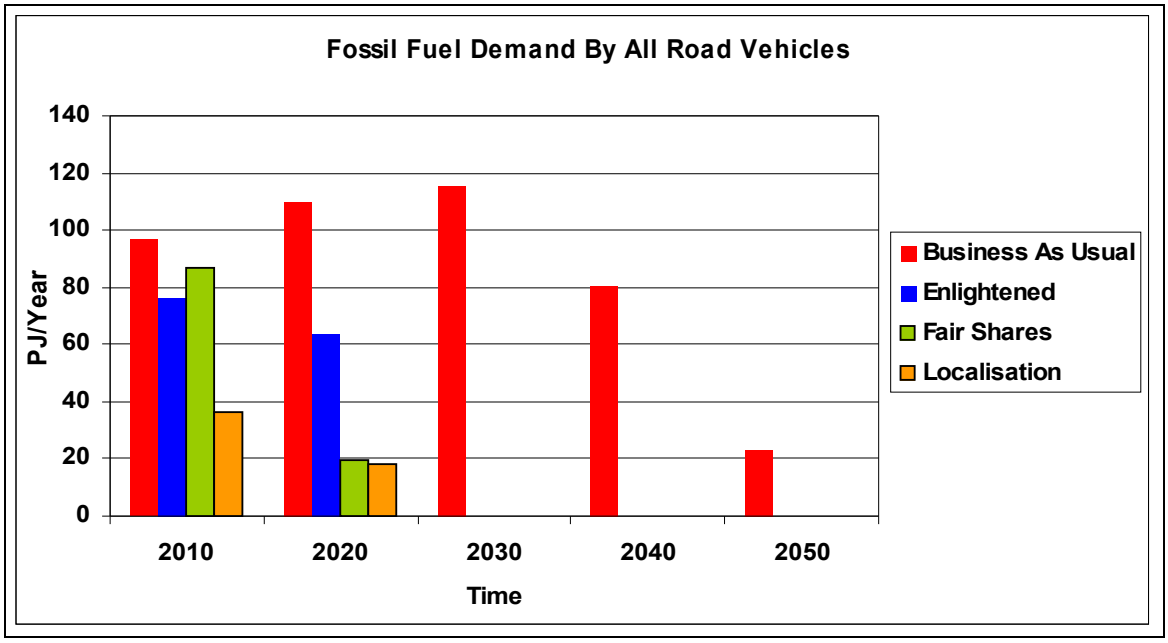


Figure 5.4: Fossil Fuel Demand by all road vehicles. Oil is the dominant transport fuel up to 2030 in Business as Usual but its use diminishes after that date due to shortages and higher prices. In the Enlightened Transition and Fair Shares cases, fossil transport fuel has been eliminated by 2030 by electric and compressed air vehicles but Fair Shares has fewer road vehicles due to the lower incomes in the economy. There is a move away from the use of private fossil fuel driven cars in Enlightened Transition and Fair Shares scenarios as more electrically powered public transport is developed and becomes a viable alternative. Despite the diminishing cyclical nature of Enforced Localisation, a few electrical vehicles appear after 2030 to meet a local road transport demand. Biofuels are not expected to meet a large portion of transport fuel demand under any scenario because of the large land areas required.

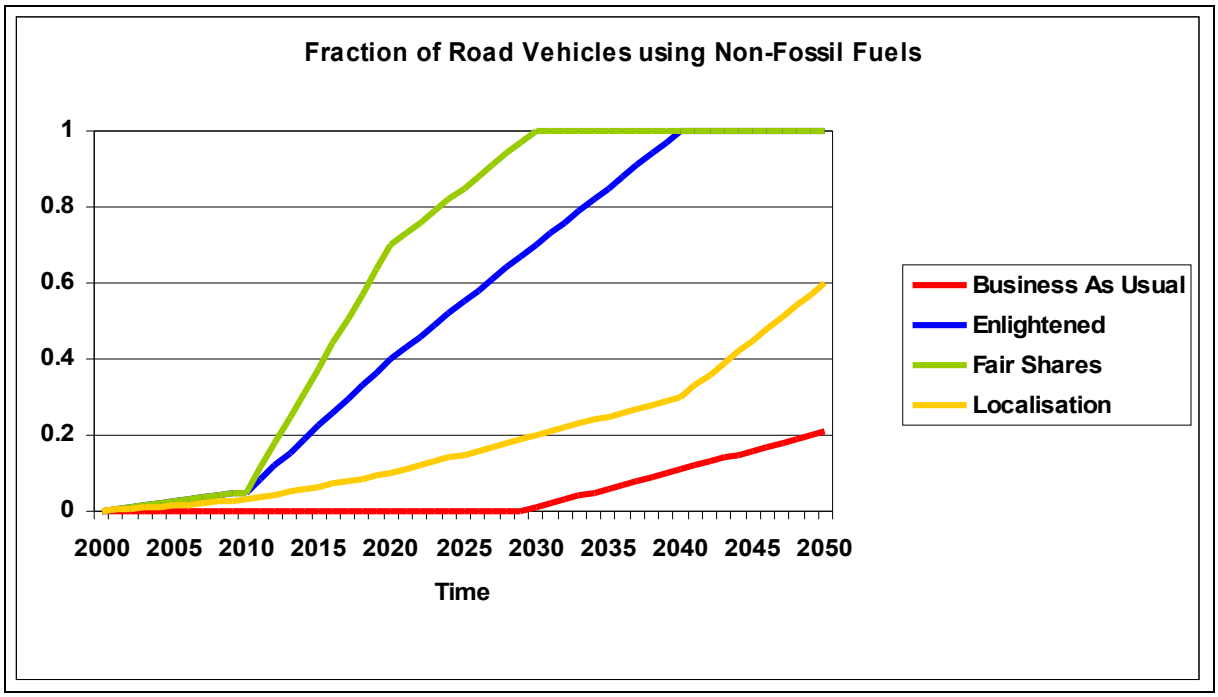


Figure 5.5: Road transport demand met by electric, biofuel, hydrogen fuel cell and compressed air vehicles

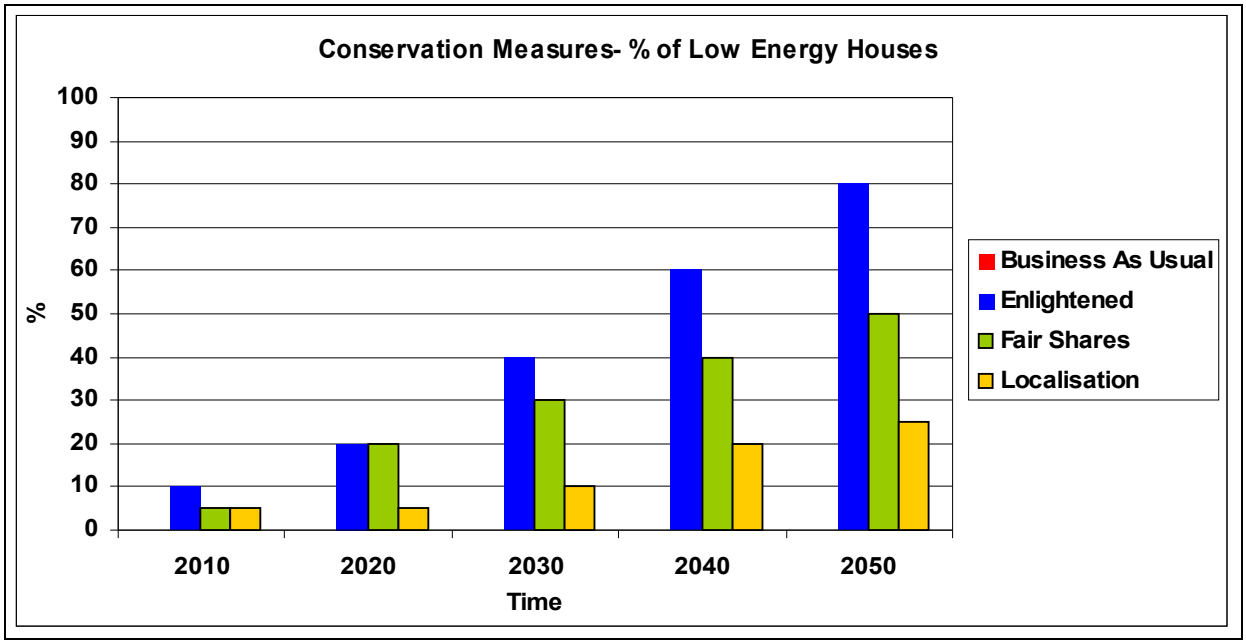


Figure 5.6: The proportion of houses converted or built to a high energy-efficiency standard relative to 2002 standards. Under Enlightened Transition, low energy buildings make up 40% of the building stock in 2030, rising to 80% by 2050. Fair Shares achieves 30% in 2030 while Enforced Localisation stands at just over 20% improvement by 2050 because it has not had the resources to invest in energy conservation at a more rapid rate. No energy conservation measures are taken in the Business As Usual scenario.

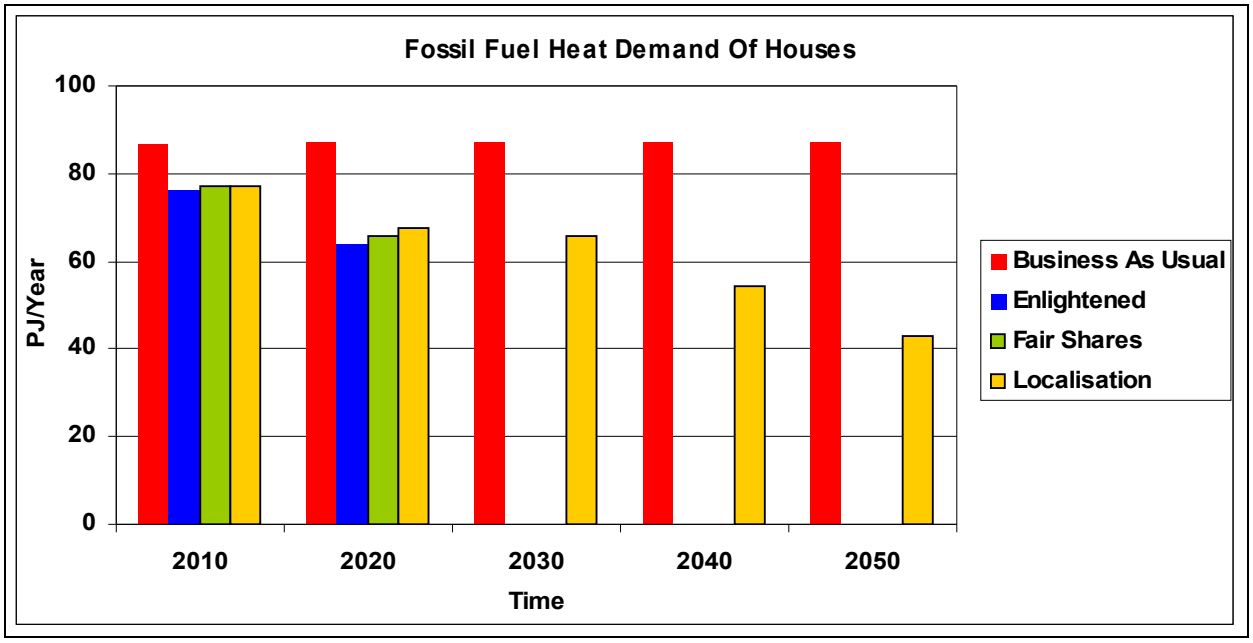


Figure 5.7: Fossil fuel heat demand of houses. In the Business As Usual case, Ireland continues to use fossil fuels for domestic heating, while Enlightened Transition and Fair Shares both eliminate them by 2030 by moving to alternative energy sources and improving energy conservation In the Enforced Localisation scenario, due to the very poor and cyclical nature of the economy there is little or no movement to alternative energy sources and energy conservation before 2040. The model assumes that fossil fuels will still be the main heating fuel in this scenario as the economy would have only a limited ability to mass produce cheap woodstoves and that open fires would be more common. The fossil fuel demand falls after 2030 due to the scarcity of supply.

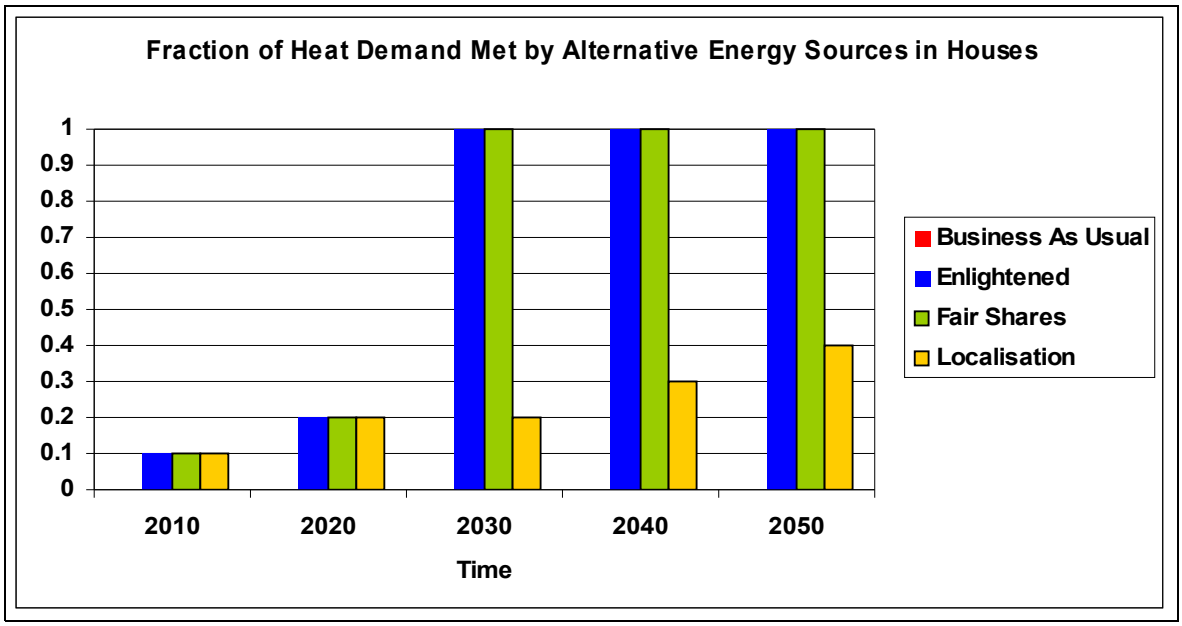


Figure 5.8: Fraction of domestic heating demand met by alternative sources of energy

Along with the energy conservation measures Enlightened Transition and Fair Shares are using alternative energy sources by 2030 for space heating with some move to alternative energy sources in the localisation scenario from 2040 as shown in Figure 5.8. In Business As Usual there is no move to alternative energy sources for domestic space heating.

Conclusion

The results of this preliminary run of the Irish ECCO model show that following the business as usual path will leave Ireland in a very bad situation whenever the oil peak occurs. The best strategy is for the country to adopt the Enlightened Transition approach and then work to share out the world's limited fossil energy resources both internationally and within the country so as to move to Fair Shares as soon as it is clear that the peak has been passed.

Chapter 5

How the Irish economy might respond to rising fossil fuel prices

This chapter is a summary of the major conclusions the project reached about the way Ireland might develop if oil peak was sufficiently delayed for the Enlightened Transition scenario to be followed for 25 years. The thinking behind these conclusions and the sources on which they are based can be found in Appendix 2. If the oil peak occurs sooner, much the same changes would take place under Fair Shares but, since less money and less energy would be available, they would take longer to come about.

Energy supplies

1. We expect two distinct electricity markets to emerge, one largely urban, the other largely rural, unless this is blocked by the Commission for Energy Regulation. The urban market will be supplied through the transmission side of the electricity grid by wind farms, onshore and offshore, scattered along the coasts of Europe, imported nuclear power and from a declining number of ageing fossil-fuel-fired stations in Ireland and elsewhere plus an increasing number of new coal stations which will operate at very high temperatures and sequestrate their carbon dioxide emissions. This power will be expensive because of line losses, the capital cost of the offshore wind farms and of the massive trans-European undersea grid required to link them up, plus the high price of the fuels used by the non-sequestering fossil stations and of the emissions permits they will require. Cheaper power will be available in many rural areas. This will be supplied by community-based, and possibly community-owned Energy Supply Companies (ESCos) which will draw their supplies from a variety of small-scale local sources and supply their customers through their own networks. These networks will be linked to the transmission grid but they will use this largely for back-up, although some ESCos may sell power into the grid when high prices are available at peak times.

2. Large thermal power stations such as Moneypoint waste two-thirds of the energy in the fuels they burn. They will not be replaced at the end of their design lives. Instead, smaller stations burning biomass residues left after a refining process will be set up in areas where biomass is available and there are uses for the "waste" heat. The giant new sequestering super-critical coal-fired power stations will be built in Europe's industrial areas where there are uses for low grade heat.

3. Just as textile firms established themselves on sites where they could set up waterwheels to provide their power in the early days of the Industrial Revolution, so businesses whose energy bill is an important component of their costs will locate in communities where renewable energy is available at an attractive, fixed price. In many cases, such companies will be an ESCo's

“anchor tenant”, enabling it to raise the capital for the development of its supply system and network.

4.Some contributors to the electricity networks - windfarms, for example - will only offer intermittent supplies. Such power will be sold cheaply when its is available via smart meters which allow customers to set the maximum price levels at which different activities are carried out. The freezer, for example, will only get a boost if the power price falls below a certain figure unless the internal temperature is getting dangerously high.

5.Householders and businesses will wish to use wind turbines and photovoltaic panels generate their own electricity whenever possible to minimise the amount they buy in. As selling to the local grid will be unimportant, they will use low voltage, DC systems. For example, householders will charge the batteries of their electric cars and bicycles while companies will set up banks of batteries charged by PV panels of their office roofs to run their computer equipment.

6.There is insufficient biomass in Ireland to meet the country's present heating needs, even if none of it is converted into liquid vehicle fuels to replace the declining supplies of oil. Heating will be regarded as the least valuable use of the biomass resource and bio-refineries and bio-digesters will be established throughout the country to process the biomass, with only the residues, or non-easily-transportable bi-products, such as gas, being burned for heat. The sequence could be as follows – leaf material will be pulverised and soaked in a dilute solution of sodium carbonate to extract the protein, which will be used for animal food. The residue will be combined with animal slurries and digested anaerobically to produce methane, which will either be used in a local CHP plant or cleaned and compressed to be used as a vehicle fuel. The fibrous residue will then be combined with organic municipal and wood waste and hydrolysed in a solution of dilute sulphuric acid at 200 deg.C to produce levulinic acid, furfural and lignin. The lignin will then be charred and the water gas reaction is used to produce hydrogen, which is then used to convert the levulinic acid and furfural into motor fuels. Alternatively, both can be used for the production of other chemicals such as nylon. The liquid motor fuels produced by this process will be readily transportable and will consequently be sold at world market prices. The methane, however, will be a local resource and, for those with access to it, a cheaper way of fuelling a vehicle.

7.The shortage of biomass for space heating will make better insulated and passive (i.e., requiring no external heat) buildings much more desirable. The alternative will be to use heat pumps combined with heat stores, and to run these when the householder's own or low cost electricity is available. Heat stores use a phase-change material such as Glauber's Salts (sodium sulphate decahydrate, Na_2SO_4, $10H_2O$), which take in energy when they melt and give it out again when they solidify. Solar water heaters can be expected to become common.

Transport

1. The shortage of liquid fuels for the transport sector and their consequent high price will lead to the adoption of three strategies:

   a. Reducing transport demand. People will seek to reduce the amount they travel and the amount of goods they move about. Living within walking or cycling distance of one's work, and to shops and schools, will become much more important, and, if this is not possible, on a frequent public transport route. Working from home on certain days of the week will become more common. Video conferencing techniques will be greatly improved. The trend to locate activities where there are local energy supplies will also reduce transport demand by producing a more even spread of economic activity around the world. High transport costs will mean that it will no longer make economic sense to take the restricted supply of concentrated forms of energy (oil, gas and coal) to places where labour is cheap, manufacture there, and then use more energy by shipping the finished product all over the world. Much more local production for local use will be carried on using renewable energy and firms will also minimise their transport use by getting fewer deliveries and holding larger stocks.

   b. Making movement more energy efficient. People will have smaller, lighter cars, with a limited range, and use public transport for longer journeys. Changes in relative prices will mean that they shift to lower energy transport modes – for example, travelling by train rather than by plane. For companies, the higher prices of the high-energy forms of transport will mean that more imports from the Continent will come by sea rather than by truck and that air freight will be avoided except for light, high value items. High speed ferries will not be replaced as they come to the end of their lives and many journey times by all modes will get longer as speeds are kept down to save fuel. Airships will make a come-back. Ships will use kites for propulsion while at sea. Ireland will consider building a new canal network for moving bulk goods, redistributing water from west to east and also for recreation.

   c. Switching to Irish-produced, non-exportable types of energy: Liquid transport fuels, whether imported or domestic, or from fossil or renewable sources, are likely to be more expensive than Irish-produced types of energy with no export potential. Accordingly, biogas which has been cleaned and compressed at a local digester will be used for trucks and long distance vehicles while electricity from the wind will power most small private cars and local delivery vehicles.

2. It is not only the fuel costs that will make transport more expensive. The cost of maintaining and renewing the vehicles and infrastructure will also become more expensive because of the rising cost of the energy embodied in their manufacture. This will be a lagged effect. For example, in the short-term, an airline will only pass on the higher costs of fuel and maintenance. It is only in the longer term, as it begins to replace its fleet, that that cost will have to be passed on too.

Tourism

1.Instead of the travel element being a small part of the total cost of a holiday, it becomes a much bigger one. The result is that people take fewer trips but that those they do undertake involve more nights away. Once at their destination they usually use public transport rather than a hire car. They also walk and cycle. Tourists will therefore want plenty of things to do in whichever base they choose for their holidays.
2.A greater proportion of holidays are taken at home and the numbers taking long-haul holidays by air declines. On the other hand, cruise ships and passenger liners become more popular and budget-priced trans-Atlantic crossings become available on ships specially built for the purpose.
3.Ireland finds that it has built too many hotels during the recent boom and some of the companies operating them go bankrupt. Their properties are sold to other operators for much less than their current valuation. Thanks to having less debt to service, the new operators bring their room rates down, putting pressure on their competitors and forcing them to cut rates too. The cycle of bankruptcies and capital write-downs only stops when enough capacity has been removed from the market to balance supply with demand.
4.Because fewer people use their cars for touring holidays, restaurant and B&B owners relying on passing trade and not served by public transport have to close down or find another way of getting business, perhaps from walkers or cyclists
5.Hotels become much more conscious of their heating costs and many of the bigger ones install CHP systems to supply warmth, cooling and electricity, using their swimming pools as heat dumps.

Manufacturing

1.The whole basis of competition will change. At present, firms achieve a competitive edge by minimising labour costs per unit sold but, as direct and indirect energy costs become an increasingly large part of their total budget, they will find that there are better prospects of making savings by cutting them than by saving labour since all the easy labour-savings have been accomplished over the years. The firm with the lowest energy costs is now most likely to win and, because transport is so energy intensive, the winners are likely to be smaller firms taking the highest proportion of their raw materials from the countryside around them and selling the highest proportion of their produce within their own areas. Processors selling to distant markets will wish to be near a port so that they can send their output the low energy way, by sea.

2.Food processing and distribution will see:

- The return of refillable bottles and jars. A deposit will be paid on most of these. The industry will establish standards for these so that the collectors can return them to the nearest manufacturer. Milk cartons and plastic milk containers will gradually disappear, as will cans for beer and soft drinks. Local bottling plants will be re-established, taking in bulk beers and soft drink essences, so that the bottles can be re-

used locally. The hot water for washing the bottles will come from a CHP district heating system.

•Mini-breweries will be set up, many in existing pubs.

•Shops will buy in fewer pre-packed items. They will sell items loose to customers who bring their own containers. Cleaning fluids, detergents and cooking oils will all be sold that way. Oil-based plastics for packaging will disappear, replaced by bio-degradable materials made from plants, such as cellophane and paper.

•Many more craft bakeries and confectioners will appear, producing and selling from their premises. Bakeries with big van distribution systems will lose sales, putting up their transport costs per item sold and making them uncompetitive. Most will close.

•Most towns will have their own abattoir to minimise farmers' transport costs. Meat from these will go to local butchers and craft manufacturers of bacon, pies and other specialities.

•Refrigeration will be powered in different ways. Some firms will use their own wind turbines and find ways of storing the energy for windless periods. Others will use solar energy either as heat or as electricity from photovoltaic panels. They will find that both make energy available during the day, when the fridge or cold store is having things put into it or taken out, rather than at night when less energy is required to maintain temperatures. Other firms will use heat from a district CHP plant.

•Fruit and vegetable imports will be by boat rather than truck or air. As a result, the geographical area from which these imports come will be more restricted than at present and there will be increased opportunities for local growers, particularly those growing the more perishable items, most of whom will use heat from CHP in their glasshouses to extend their growing season. Imported fruit and vegetables will be significantly more expensive outside the port towns because of the road transport costs. Greengrocery shops will compete to get local produce as it will be fresher and offers the prospect of higher margins.

•Many more people will take up vegetable gardening and,as a result, will wish to preserve their surpluses by bottling, freezing or drying. The proportion of meals cooked at home will rise, cookery courses will become popular. Ready-meals not made locally will become too costly to compete.

•Every town and every urban area will have a farmers' and local food producers' market at least one day a week. Supermarket chains, with their truck-based distribution systems, will find it hard to compete, not just on cost, but in terms of interest and excitement, particularly as people will generally have more time but less money. These chains will have to radically re-assess their business model.

•The giant milk processing plants will give way to a new generation of local creameries which will essentially get rid of the water. They will produce butter and cheeses and send the whey to nearby piggeries which will depend largely on local feedstuffs. The dung from the pigs will produce biogas and liquor which will go back on to the land. Bi-products from the whey will be concentrated at the creameries and sent to regional factories for further processing.

3. As distribution costs rise, companies that need to get their goods into the shops quickly move away from foreign sources towards local production. The fashion trade will move first. Later, branded window and furniture manufacturers like Velux and Ikea will subcontract production to local factories because even when the wood used is not locally sourced, the shipment's bulk is substantially reduced.

4.Higher transport costs will cause manufacturers to abandon the just-in-time approach to stock levels. The savings from keeping inventories low will be far outweighed by the losses involved in not shipping in full container loads and in having to use expensive energy-intensive courier services if a spare part is missing.

5.Firms will respond to the rise in the price of plastics and metals by recruiting higher calibre workers since the cost of a mistake – something that spoils a whole production batch, perhaps – is now more costly in comparison with the additional wage to be paid.

6.It will become increasingly worthwhile to repair products rather than scrap them as this preserves the investment the customer made in raw materials and their fabrication. Designs will be developed to make this easy. Electrical and electronic products will come equipped with a socket which will allow them to be interrogated over the web by a remote computer and a fault report e-mailed to the owner, offering to supply the required spares through the post. The availability of spares will be an important issue and customers will steer clear of brands which they fear may not be around in future.

Construction

1.As the economy will not grow and may possibly shrink, very few new buildings will be required for existing activities. Indeed, the total building stock may well decline because owners will not maintain properties which are badly-located or inappropriate for a fossil-energy-scarce world. Those new buildings that do go up will have fewer floors as more expensive transport means that fewer people can assemble conveniently in the one place. Site values will fall to reflect this.

2.Lower embodied-energy materials will be used such as local timber, field stone from the site itself, hemp and lime, in conjunction with lower-energy construction techniques. Cement will be avoided where possible because of its high cost. Overall, buildings will be grown much more than mined

3.Most of the activity in the sector will come from energy-related projects. These will range from insulating and adapting existing properties to building bio-refineries and bio-digesters.

Agriculture and Forestry

1.The price of agricultural products will rise in step with the price of energy because, on the margin, farmers have the choice of growing either energy or food. Food will therefore cost more in relation to people's wages. This will enable farms to employ more workers in order to use less energy and fewer energy-intensive inputs like fertilisers and capital equipment. The movement of people from the country to the city can be expected to cease.
2.Farmers will try to meet their own energy requirements. Some will convert their tractors to run on rape oil which they will grow. Others will replace their tractors with horses since these were already economic for some farm operations even before oil prices began to rise. Small ethanol or biodiesel engines powering baling and cutting equipment and mounted on floats pulled by horses will become popular. No-plough methods of cultivation will be widely used.
3.The price gap between organic produce and conventional production will narrow considerably.
4.Feedstuffs brought from other areas and from abroad will tend to be replaced by local production because of the higher trucking costs.
5.Land prices will shed their property speculation element and fall to levels which can be justified by the return that can be had from growing things on the land involved. Since higher energy costs will mean, in many cases, negative returns to scale, big farms will tend to be split up into units that allow closer management and the better use of horses and labour.
6.Overall, farm work will become more skilled and complex as a new form of mixed farming develops. Besides animals and poultry, the new version will involve more crops grown for energy rather than food and more processing on the farm to give maximum value added, and thus enable more wages to be paid. This diversity will ensure that the farm has a reasonably stable income from year to year, as if one crop or market fails, others will probably compensate. Almost every farm will wish to sell a high proportion of its diverse output itself to get the full retail price.

Chapter 6

Adapting the ECCO model to incorporate the sectoral effects

The results of the ECCO run set out in Chapter 4 were based on the assumptions we put into the model about the pace at which changes would be made in the key variables, such as the pace at which non-fossil-fuel powered vehicles would be introduced, under each of the scenarios. These assumptions were crude estimates. However, the conclusions we reached in Chapter 5 as a result of the discussions with the various sectors of the economy about the changes they might expect as result of higher energy prices gave us a somewhat more realistic feel for what might be possible. We therefore carried out an ECCO run, *Towards Enlightenment*, incorporating the changes that people expected to be able to make. These are set out in the table below. How far would these changes take Ireland towards reducing its dependence on fossils fuels?

The distinctive assumption made for this run of the model was that the property bubble would burst and the rate of construction activity, and the high level of energy use that entails, would drop by enough to cut the amount of energy used by the combined construction and manufacturing sector by a third.

TOWARDS ENLIGHTENMENT			
Policy	***2010***	***2030***	***2050***
Electrical, compressed air and biofuel vehicles	5%	70%	90%
Energy conservation in buildings	10%	40%	80%
Alternative energy sources for heat	10%	70%	90%
Passenger-km travel by other means than private car	10%	50%	60%
Electricity generation from renewable energy sources	20%	70%	100%

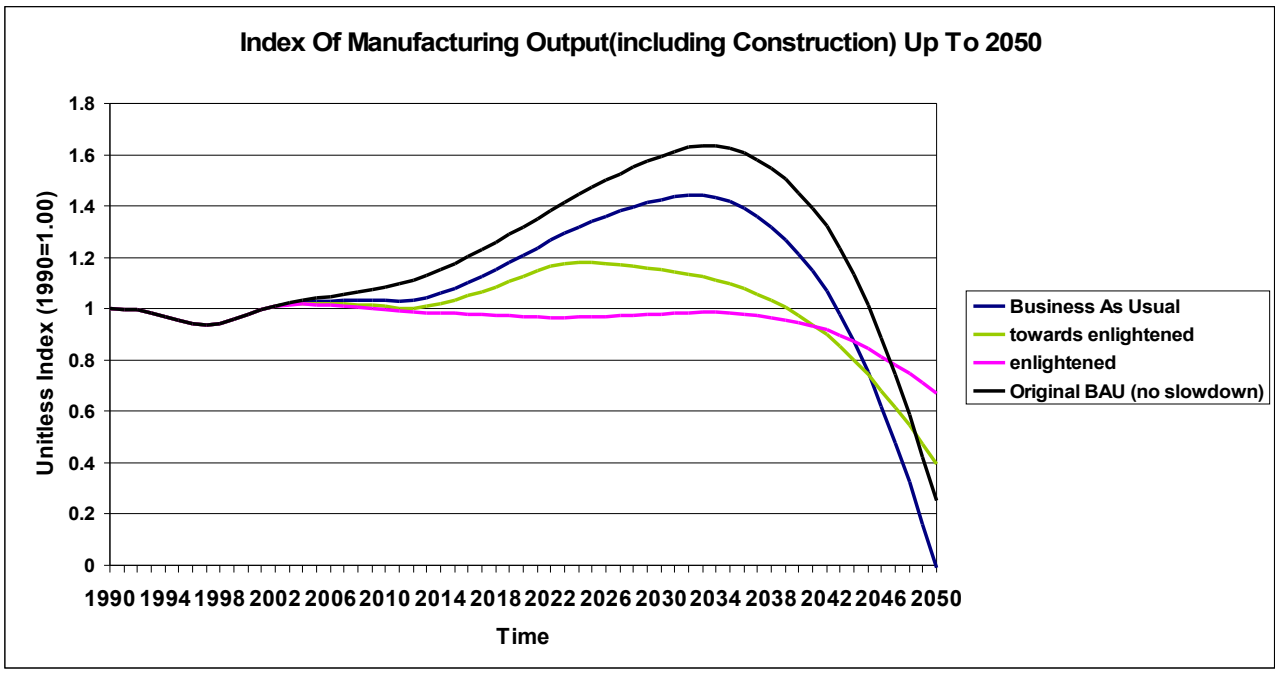


Figure 6.1 Manufacturing Output. We assume that the effect of a property bubble bursting reduces manufacturing output but this does recover later. The original Business as Usual curve with no property slowdown is included (in black) for comparison. As might be expected, Enlightened Transition once again offers higher, more sustainable incomes in the future than the other scenarios.

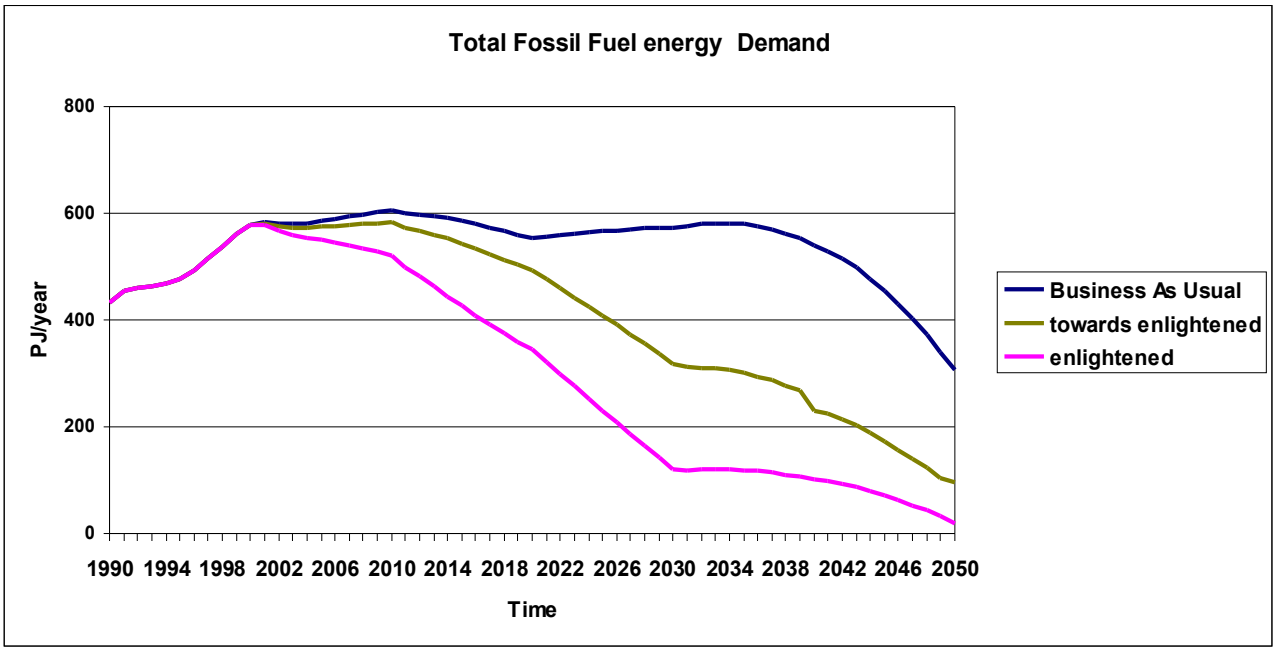


Figure 6.2: Fossil Fuel Demand. The slowdown in energy demand in all scenarios is due to a property bubble burst. In Business As Usual, an economic upturn after 2020 increases the demand for fossil fuels again. As nothing is done in this scenario to move to an economy independent of fossil fuels the demand for fossil fuels falls again after a 2030 oil peak due to scarcity of supply and ever increasing prices. Enlightened Transition is just as it was described in Chapter 4. The determined effort made under it to phase out fossil energy regardless of fuel prices steadily replaces them with alternative sources up to 2030. Fossil fuel demand then stays relatively stable but eventually disappears as fossil fuels rise in price as supplies run out. The Towards Enlightened Transition scenario is primarily driven by rising fossil fuel prices. These reduce fossil demand directly and also as a result of the development of alternative energy sources and energy conservation.

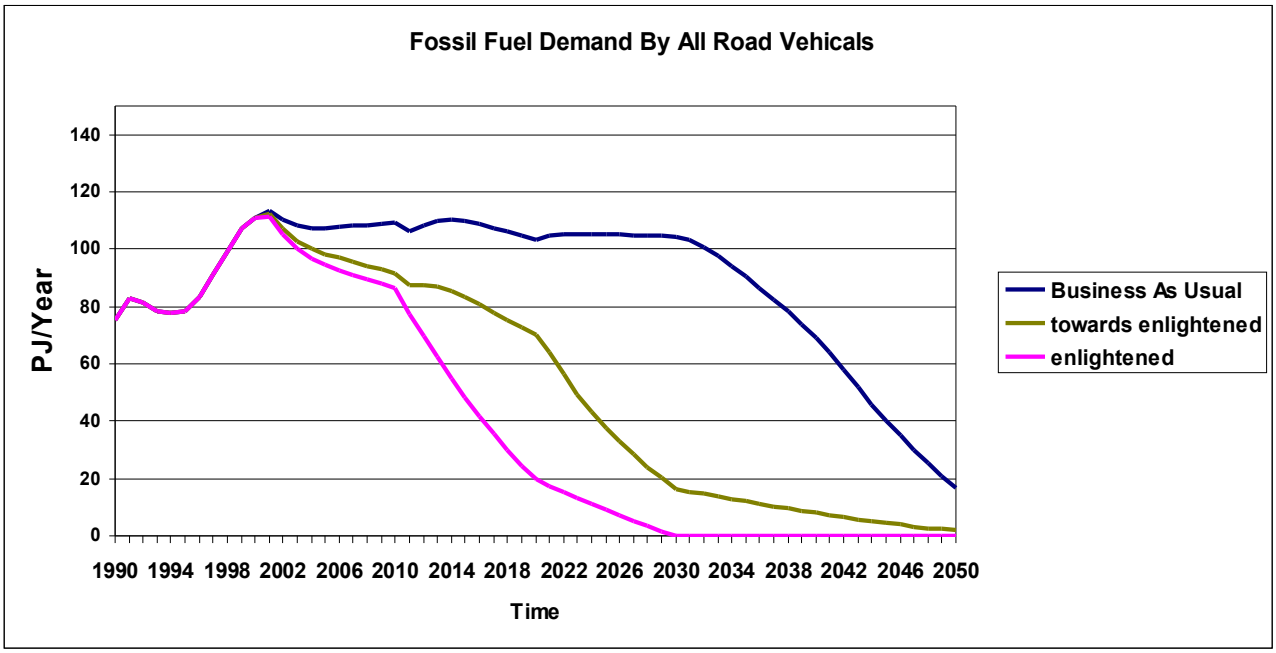


Figure 6.4: Fossil fuel demand for all road vehicles. In the economic slowdown that follows the bursting of the property bubble, passenger travel drops as people have less money to travel. Nevertheless, the majority of people continue to travel by car because of poor public transport infrastructure and poor planning. As a result, the demand for vehicle fuel stays high under Business as Usual, while it falls in the other two scenarios as efforts are made to improve public transport and introduce vehicles powered by wind-generated electricity and biofuels. In the T*owards Enlightenment* case, it is the combination of a move to electrical vehicles and rising fossil fuel prices that causes a sharp reduction in passenger travel beyond 2020.

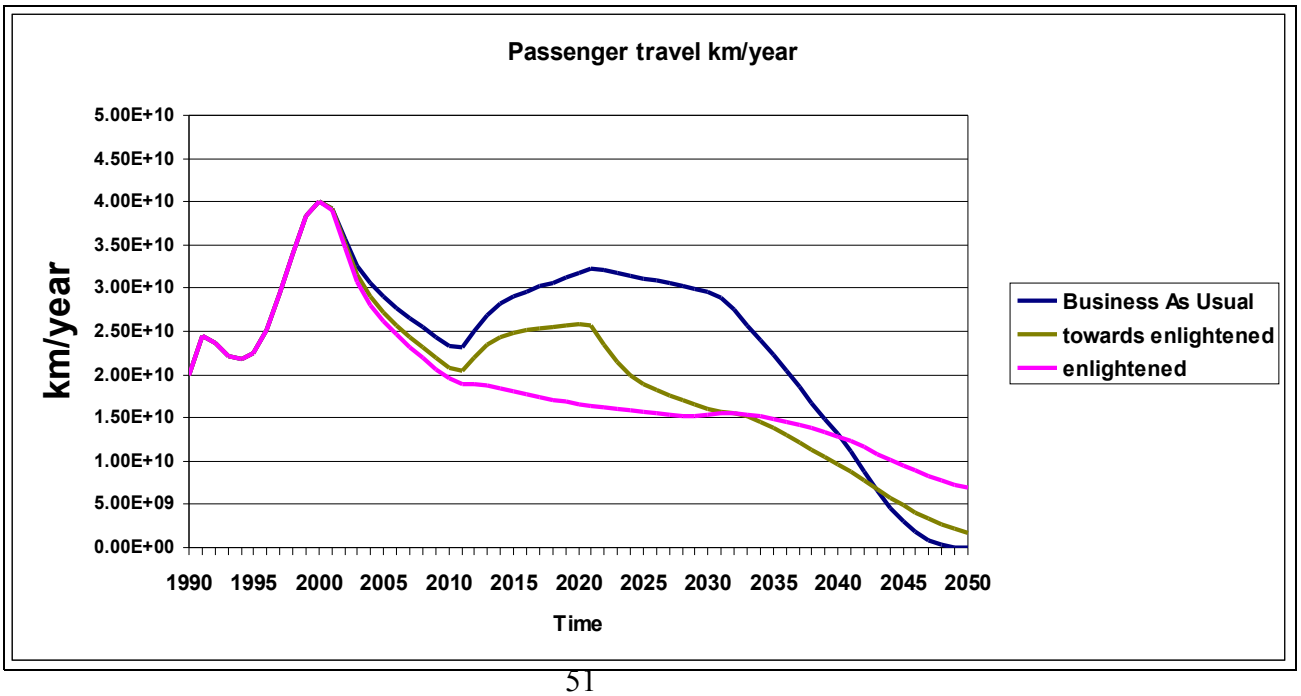


Figure 6.5 Distance travelled. The distance people travel is closely linked with their income levels. The property bubble burst causes the amount of travel to drop sharply in all three scenarios. BAU recovers more strongly when the economy recovers but then falls much more precipitously when the oil peak is passed and energy prices rise rapidly. The other two scenarios prove much more robust.

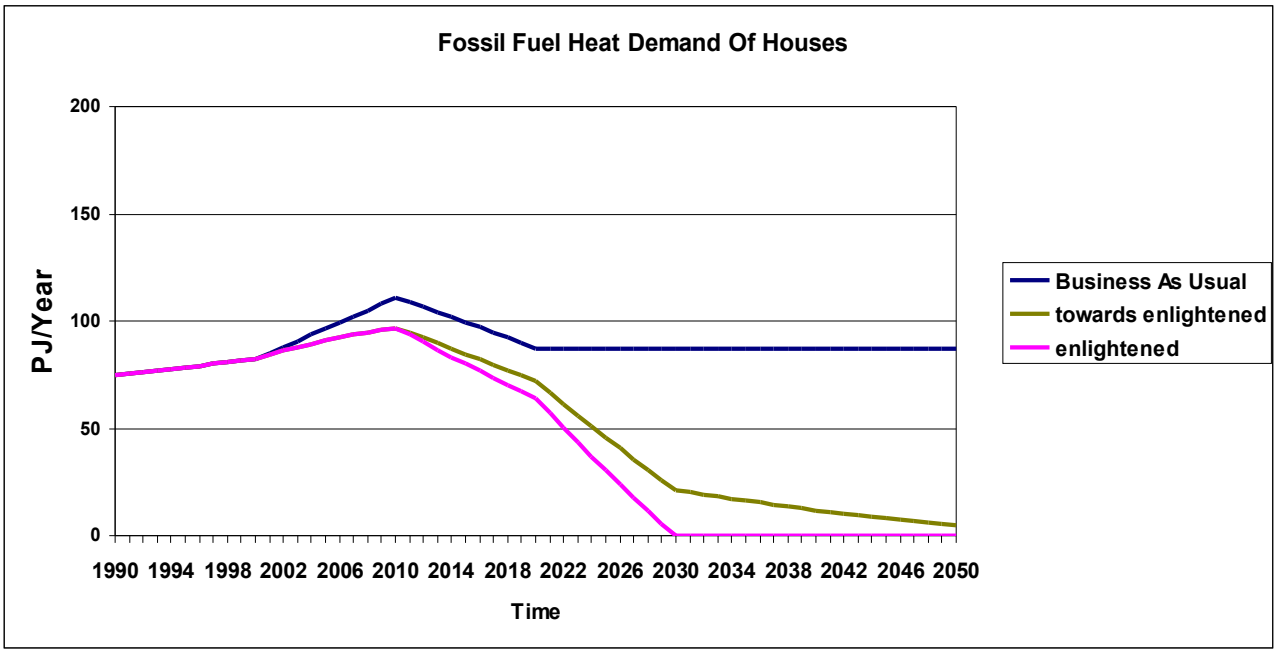


Figure 6.6: Fossil Fuel domestic heating demand: In the business as usual scenario, the fossil fuel domestic heat demand falls after the slowdown in the construction sector. As people's budgets become tighter they turn their thermostats down but since their heating appliances are inefficient and their houses are poorly insulated, only a small reduction in demand is achieved and this level stays constant after 2020. However, the move to alternative energy sources and conservation in the two enlightened scenarios greatly reduces the use of fossil energy for home heating

Conclusion

It is important to note that the ECCO model uses fixed input-output relationships which, by their nature, do not allow for future technological changes which, for example, improve the energy efficiency of production processes or transport technology or which enable renewable energy to be captured with a lower energy-as-capital cost. Accordingly, this final ECCO run does not incorporate the effects of the huge technological changes that can be expected to have taken place by 2050. What it does show is that, even with the present range of technologies that have been developed with the primary goal of saving labour rather than energy, it is possible to maintain Ireland's level of manufacturing and construction production, and thus, probably, its population's

income, to about 2040 if oil peak is delayed until 2030 and if either of the 'Enlightened' scenarios is followed. After that, output would fall at a rate determined by how far the dependence on fossil fuels had been reduced. Taking a Business as Usual approach would mean that the decline started within approximately two years of the peak occuring and was much more precipitate than with either 'Enlightened' scenario. In other words, following an 'Enlightened' course would buy this country time, time in which technologies can be developed and put into use. Indeed, technological change is certain to make any 'Enlightened' strategy give better results than those suggested here.

The choice this country has before it is therefore whether to continue to follow a path in which short-term economic growth is maximised – the BAU path – or whether to follow a low-growth path (Towards Enlightenment) or a no-growth one (Enlightened Transition) – in the knowledge that either would stand it in better stead when the oil peak is passed. Then, after the peak, as we discussed in Chapter 4, Ireland should make every effort to follow the Fair Shares path by trying to get the world community to share out the remaining fossil energy sources rather than allowing their distribution to be determined by a completely free market.

Chapter 7

The effects of higher energy prices on the consumer

How will families change their lifestyles and consumption patterns in order to balance their budgets once their real incomes begin to decline as a result of the rise in energy prices? We explored this question at two public meetings, one in Waterford in April 2005, and the other in Galway in May 2006. At each, the film *The End of Suburbia*, which deals with the consequences of a decline in oil production, was shown. Then, both audiences saw a series of slides indicating that they should expect that the 90% fall in the real price of energy since 1920 in terms of the length of time the average wage-earner had to work to buy a kWh would be partially reversed and that this would make their food and all other consumer goods less affordable. They were given a form to complete (see Appendix 5) which had on it hypothetical energy-cost related price increases for the major categories of consumer goods and services and told the proportion of their income that their purchases of each made up according to the 1999-2000 Household Budget Survey. How would they seek to balance their household budgets if these price changes came into effect?

The 68 completed forms we collected (42 from Waterford, 26 from Galway) bristle with practical and workable energy efficiency ideas and solutions. Interestingly, there was no discernible difference in the responses from the two meetings although they were held just over a year apart. Some suggestions from both indicated an awareness of some of the ideas and solutions being championed by environmentalists and proponents of sustainable development, and show that these discourses are beginning to permeate society and reach people in all walks of life. However, other solutions already in use in many places in the UK and here and there in the Republic of Ireland were conspicuously absent, such as using farmers' market box schemes.

Here are the suggestions respondents most often made in relation to food:

1. Buy local food at supermarkets
2. Reduce packaging
3. Cook and bake more at home
4. Eat simpler, more seasonal food and cut meat out of the diet
5. Grow one's own basic foodstuffs using fertiliser from a home compost bin and sell the surplus
6. Set up a LETS (local currency) system
7. Drink less alcohol

8. Plant hemp for linen and keep sheep for wool

These are the chief suggestions relating to transport efficiency:

1. Car-share
2. Move nearer to the town or city and drive less
3. Walk more
4. Take the bus more for local journeys
5. Use a bicycle for short trips
6. Reduce car size (engine size)
7. Work from home
8. Have government decision to build ribbon housing reversed
9. Take fewer foreign holidays and trips; avoid short haul flights
10. Shop online
11. Swap your present car for a Prius

A small number of respondents thought it might be a good idea if they travelled as much as they could before the oil crisis hits. "In an age of cheap oil, the world is our playground. Three or four hundred euro will get you all the way around the other side of the planet these days" one respondent said. People are clearly reluctant to give up the freedom to fly. Yet in a more sustainable world, the prospect of slow travel (like Slow Food) might make a welcome reappearance. One might stay longer in a foreign country, having taken quite a bit longer than nowadays to get there, with the result that one might get to encounter more of its culture, rather than passing through the place within a couple of days before jetting off home or elsewhere. Statutory leave might be adjusted to cater for longer but perhaps less frequent holidays.

Here are the most frequent suggestions relating to fuel and light:

1. Use local energy sources
2. Invest in solar and wind-based home energy systems and have the investment subsidised by the government
3. Leave no electrical appliances or equipment on standby
4. Switch off lights when leaving a room (obvious, maybe, but not always matter-of-course!)

5. Use energy-saving lightbulbs
6. Turn the temperature down a degree or two on the heating system and wear slightly heavier clothing at home
7. Install a wood burner
8. Install a geothermal heating system
9. Increase insulation
10. Avoid buying inessential household appliances, e.g. microwave oven, dishwasher, sandwich toaster

Turning down the heating, just heating one room, or turning it off altogether are likely to become widespread if not popular solutions since just reducing the temperature of space and water heating can cut household energy consumption by half. Wearing heavier clothing will be part of this solution. Other minor changes, such as solar hot water systems, can save another 10 to 20%.

The clear impression from both meetings was that people were perfectly sanguine about living in an fossil-energy-scarce world, if they had to do so, and were not short on ideas as to how to adjust to it. It was equally clear, however, that few in either audience was about to make any but the least effortful of these changes they suggested until price or some other signal prompted them to do so.

Chapter 8

Concluding remarks

The conclusions we have drawn from our research were presented in Chapter 1. However, the thinking process entailed by the study, rather than the study itself, led to two further thoughts. One is that the amount of usable energy available to the world from the remaining oil and gas is less than than the amount indicated by illustration 7 in Chapter 2, because increasing amounts of energy will be needed to extract the oil. The illustration shows the gross amount of energy (expressed in terms of giga-barrels of oil equivalent) that is likely to be available year by year. The net amount of energy will be less, particularly as the fields become increasingly depleted. Professor Charles Hall of the State University if New York College of Environmental Science and Forestry is working on an estimate of this effect at present[7]

The other thought was suggested by a lecture[8] given on May 11 2007 by Professor David Rutledge, the Chair of the Division of Engineering and Applied Science, California Institute of Technology. In his talk, Rutledge used the techniques used by King Hubbard to estimate the timing of peak oil production to estimate how much coal, gas and oil might be available to the world over the years to come. His figures are far lower than previously suggested, even though he does not take the energy cost of winning them into consideration and give a net figure.

One of his slides makes the point that using fossil energy to win fossil energy and to turn it into a useful form is an increasingly energy intensive process as a result of resource depletion. One can sink a coal mine today, and build the power stations and the other intrastructure to go with it, and when they reach the end of their working lives, it will take even more energy to replace them than it took today because the best coal seams will have been used up, as will the best deposits of iron ore etc for the capital works. However, less of the fossil energy required will be available because of the resource depletion. This is a very powerful argument against the use of nuclear power. The construction of a nuclear station will take a lot of fossil energy now and when that station is closed, there will be less energy available from any source available for its replacement. With renewables, on the other hand, there is no resource depletion so much less energy-as-capital will be needed in future to keep a flow of energy coming.

Both these thoughts should illuminate the choices that Ireland has to make and underline how urgent it is to ensure that every construction project undertaken from now on should be appropriate for a fossil energy-scarce future.

[3] Quoted in *The Economist*, 20 April. 2006. http://www.economist.com/finance/displaystory.cfm?story_id=6823506

[1] http://business.timesonline.co.uk/article/0,,13130-2124287,00.html (April 8th, 2006)

[4] Skrebowski, Chris, http://www.odac-info.org/bulletin/documents/cs_cera_letter.htm, December 2006

[2] http://www.platts.com/Oil/News/8423016.xml?p=Oil/News%82%22=Oil&src=energybulletin

[5] Werner Zittel and Jörg Schindler, *Coal: Resources and Future Production*, Energy Watch Group, Ottobrun, Germany, April 4th, 2007.

[3] Ben S. Bernake et al, "Oil shocks and Aggregate Macroeconomic Behavior: the Role of Monetary Policy, a reply" *Journal of Money, Credit and Banking*, Vol. 36, No. 2, 2004.

[6] Downloadable from http://www.feasta.org/documents/energy/rationing2007.htm

[4] The End of Fossil Energy: And a Plan for Sustainability, John Howe, McIntire Publishing, September, 2004

[7] Personal communication, April, 2007.

[8] http://rutledge.caltech.edu/ A video of the lecture, Powerpoint slides and an Excel spreadsheet can be downloaded.