Sustainable Development Evaluation of Road Infrastructure Programmes and Projects

Section 4

Road Transport Volumes in the Future

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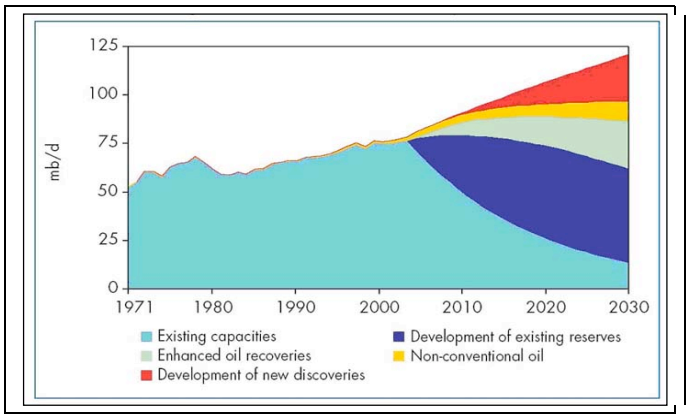
SOCIO ECONOMICS

The Socio Economics Section of the Environmental RTDI Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in this area. The reports in this series are intended as contributions to the necessary debate on Socio Economics and the environment.

Road transport is almost entirely fuelled by oil. As a result, the future volume of road transport in Ireland depends crucially on the availability of oil and its price or oil's replacement by other forms of energy. It also depends on the availability of emissions permits under the EU's Emissions Trading System, as the whole of the transport sector is likely to be brought into the ETS from 2013 if not earlier. I will deal with each in turn.

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.



Graph 1: 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. Graph 1, 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. This is just as well, since far less oil is being discovered each year at present than is being produced, as shown in Graph 2. Chevron puts the discovery rate at half the production rate in its press advertisements while others say the rate is a quarter or even a

sixth. What is certain is that 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*, (22.04.06) which has consistently taken the IEA's line.

Graph 2. Oil is currently being found at perhaps a quarter of the rate at which it is being used.

"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 they are questioning is whether supplies will be able to keep up with rising global demand. There is still plenty 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 becomes pointless. When that happens, world oil output will cease to increase, stay on a plateau for a few years and then 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. Initially, it was retired petro-geologists - people like Dr. Colin Campbell – who had the freedom to speak and used it to attempt to point this out, but top oil company executives have been saying so too with increasing frequency.

- "We've embarked on the beginning of the last days of the age of oil," Mike Bowlin, Chairman of ARCO, in February 1999.
- "We've run out of good projects. This is not a money issue…if these oil companies had fantastic projects, they'd be out there [developing new fields]." Matt Simmons, head of the oil investment bank Simmons and Company International and a former adviser to President Bush, November 2004.
- "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.

The oil companies' problem is that enough new oil production has to come on-line 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 (Graph 1) 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. He says that this year, 2006, 40% of the world's oil is being produced by countries including the US, Britain, Norway and Venezuela, whose output is already declining year by year and a further 10% is coming from countries such as Mexico, whose output is about to begin to fall. The growing shortfall from these countries, plus the increases required to meet the rising global demand, can only be met from fields in the Middle East and Russia, but he does not think this can 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.

Even the IEA has started admitting that there are 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,"

Many other 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.
After 2007	Skrebowski, C.	Petroleum journal editor: Ref 3
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
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	US energy consultants: Ref. 10

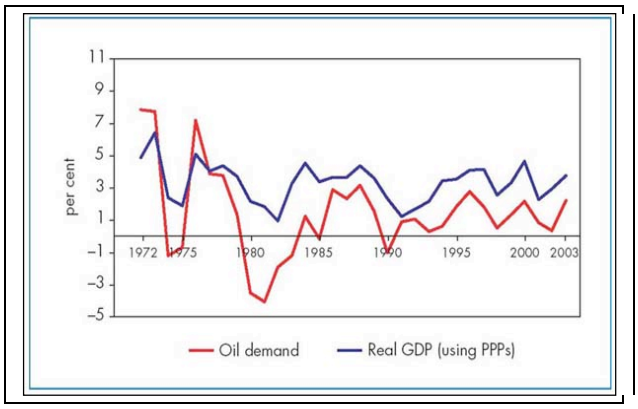
	Research	
2025 or later	Shell	Major oil company: Ref.11
No peak	Lynch, M.C.	Energy economist: Ref. 12

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, C. "Oil Field Mega Projects - 2004." *Petroleum Review*. January 2004.

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.

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 Graph 3 shows. Accordingly, unless other sources of energy can be found to replace oil or the efficiency with which oil is used can be increased more rapidly than output declines, or a combination of the two, world output will decline once the oil peak is passed. This will cut the demand for transportation.



Graph 3: The close relationship between oil use and world output. Source: International Energy Agency.

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

1. 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.
2. 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.

3. 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.

We will discuss each outcome in turn. However, before we do, another factor needs to be taken into consideration: Europe's determination to act to slow climate change. If the oilmen are right, world oil output will fall regardless of whether an international climate treaty is put into place and Irish road users will be competing for supplies with the rest of the world. If the economists are right, oil supplies will be adequate but oil consumption in Europe will be limited anyway by measures to control greenhouse emissions and Irish road users will, after 2012, be competing indirectly with other European road users for the limited supply of emissions permits. In effect, outcomes 1 and 2 are almost the same. In both cases, a limit is placed on oil's availability, in the first by supply problems, in the second by a limited supply of permits to use it. In either case, the volume of transport will be restricted unless non-fossil alternative energy sources can be found. There are two leading possible alternatives, biofuels and electricity from the wind powering hydrogen-fuelled, battery or compressed air vehicles.

1. Biofuels

(a) Biodiesel as a diesel substitute

Most attention in Ireland so far has been given to the production of biodiesel from rapeseed oil. A hectare of land can produce 1,100 kg of rape oil which is roughly equivalent to a tonne of mineral diesel fuel. Since the Irish transport system burns over 2 million tonnes of mineral diesel annually, 2 million hectares would be needed to produce enough rape oil to replace it. This is five times more land than the country currently has under arable cultivation. But rape, a member of the cabbage family, cannot be grown continuously in the same place without pests and diseases building up. If a four-year rotation was used, Ireland would have to have twenty times more land under arable crops than it does at present to produce the oil for its diesel-powered vehicle fleet. Even if that amount of land was available, even more land would be needed to grow extra rape oil to power the machinery used to till the rape fields and process the crop. Also, because natural gas is used to make fertilizer for rape, we would still be using a lot of fossil energy to produce the bio-energy version.

The fundamental problem with rape and all the other plants that could be grown in Ireland to produce oil is that they are annuals or biennials and thus take a lot of energy to grow. The EROEI is therefore poor. Tropical and sub-tropical trees and shrubs which produce fruits containing oil such as Jatropha and Moringa offer a much better energy return and Ireland will have to consider importing their oil for its diesel engines.

(b) Ethanol (ethyl alcohol) as a petrol substitute

The production of ethanol from maize, wheat, and sugar beet gives a poor return on the energy invested in the process. However, processes have been developed recently for breaking down the lignocellulose found in all plants into sugars which can then be fermented into ethanol. A demonstration plant was opened in Canada in 2004 which it is hoped will produce 100 million litres of ethanol this year and Sweden has ambitious plans for this technology using wood waste. It opened a plant using sawdust in 2005. These processes are said to have an EROEI of six at present with the prospect of increasing to ten. This would mean that the energy return was better than that for coal mining which, when used to produce electricity, is said to have an energy return of about eight. Ireland could almost certainly meet its petrol needs using this cellulose technology but it has to be remembered that there will be competition for the biomass

from people who wish to use it for Combined Heat and Power systems in large buildings and for domestic heating using wood pellet stoves etc. There will also be a demand for the ethanol itself from other countries seeking a liquid fuel for their transport fleets. The fuel will therefore not be cheap.

2. Wind electricity

Ireland has the potential to produce much more electricity from the wind than it is currently using. The main problem with this source of energy is its variability but its energy could be stored in batteries, as compressed air or as hydrogen, when the wind was blowing. However batteries are heavy. This effectively limits the vehicle's range since installing a bigger, heavier battery would require more power to move the vehicle, which would in turn quickly exhaust the additional battery capacity. Battery power is therefore likely to be restricted to small, light cars for short journeys and vans for urban use. Compressed air vehicles will have similar limitations because of the limited amount of energy that can be stored in a pressure vessel of reasonable size. Hydrogen, whether from biomass or wind electricity, seems to be required for trucks, tractors and longer-distance cars but its cost will be considerably greater than current petrol and diesel prices. If produced electrically, it takes 4kWh to produce 3kWh-worth of hydrogen. The hydrogen must then be liquefied or compressed. Liquid hydrogen is likely to be required for road vehicles because it requires less space than the compressed form but it takes about 14kWh of electricity to liquefy a kilo of hydrogen, and amount which can deliver about 33.7 kWh when burned. In other words, it takes about 16.24kWh to produce 280 grammes of liquid hydrogen, the energy equivalent of a litre of petrol. Overall, then, it takes 63.6 kWh to produce liquid hydrogen that can be converted back into 33.7 kWh in a fuel cell, a loss of 47%, a figure which omits the energy required to make all the capital equipment involved. Put another way, it takes about 16.24kWh to produce 280 grammes of liquid hydrogen, the energy equivalent of a litre of petrol. These losses have caused some commentators[3] to doubt the viability of the whole process.

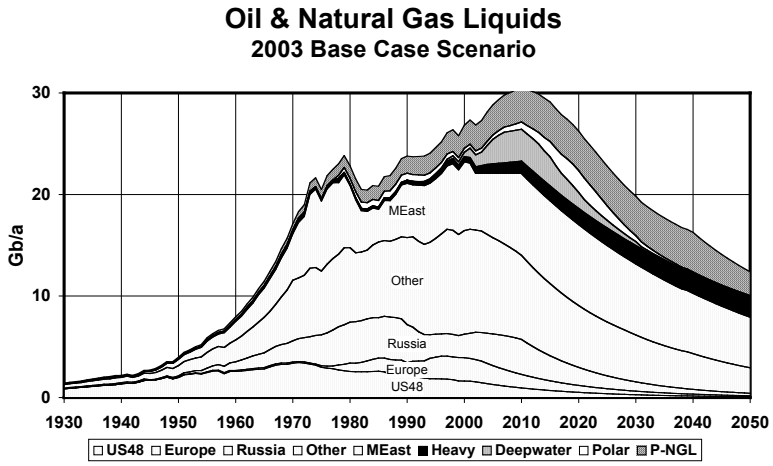
In 2003, a German expert, Werner Zittel, prepared the following estimates of cost of providing hydrogen to fuel an Irish fleet of 1.2 million passenger cars and close to 200,000 trucks. He wrote[4]:

> A rough calculation indicates that at least 300 fuelling stations should offer hydrogen to achieve public acceptance of the fuel. This corresponds to 10 percent of all fuelling stations countrywide. If this hydrogen were to be entirely supplied by wind power produced electricity, the total system cost would be of the order of 50 billion Euros or, spread over 30 years, about 2 billion Euro per year. In total about 20 GW offshore wind converters are needed for the power production.
>
> If this hydrogen was completely supplied from biomass via gasification, the total system cost would be in the order of 20 billion Euros, or spread over 20 years, about 1 billion Euro per year. Annually, about 13 million tons of dry biomass would be needed for hydrogen production, or a cultivated area of about 0.7 million hectare. Costs would be similar to those at present but with the difference that a large fraction of the money is now transferred to foreign countries, while domestic fuel production in the countryside would channel the money instead to a domestic labour force.

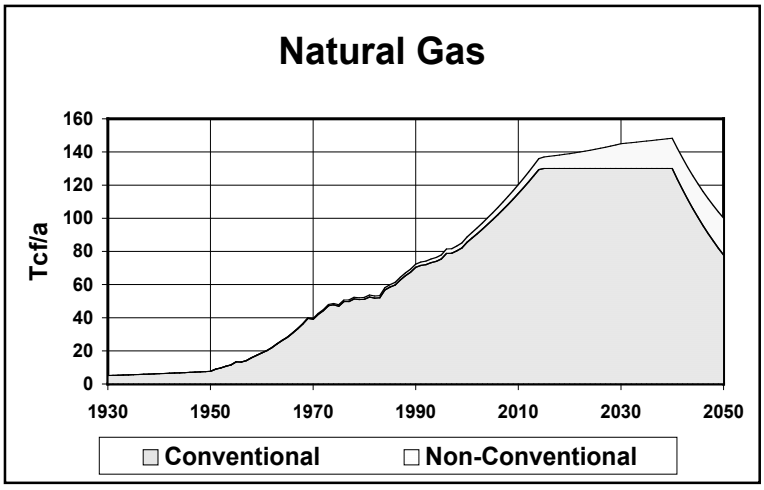
So, while Ireland has the potential to get enough energy from the wind and biomass to keep a transport fleet of the present size on the road if it chooses to do so, the cost of the energy would be high and its use would be at the expense of other uses.

We can now return to review the likely consequences of the three oil supply/oil price scenarios we identified earlier.

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 Graph 4. There are limited prospects for replacing oil with natural gas because supplies of that, too, are expected to peak in the near future. Graph 5 shows projections for global gas supplies and Graph 6 shows the total amount of energy that can be expected to be available from the two fuels. 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



Graph 4: 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



Graph 5. 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.

Graph 6. 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.

energy use, energy loss and expense. It seems highly unlikely that alternative energy sources can be developed rapidly to replace oil and gas if supplies decline as rapidly as expected by the Association for the Study of Peak Oil. The global economy is therefore likely contract and with it the need for transportation. The 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 to run its transport fleet – 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, it would also have to obtain the emissions permits to use it 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. Research[5] in America indicates 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. It would therefore take a very big, sudden increase in prices to send the US and the world economy into a recession. However, if the world's central banks used too heavy a hand when raising interest rates attempting to control the inflation that the higher energy and commodity prices inevitably impose on the consumer, they could raise the amount that consumers had to pay on their mortgages and other borrowings at the same time that the higher energy prices were forcing them to cut their expenditure in other areas. This would reduce 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 might 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 volume of road traffic would be greatly reduced in these circumstances. So would the incentive to invest in renewable energy and energy saving projects. This is a real threat. The Bank of International Settlements warned[6] in June 2006 that central banks must completely change the way they set interest rates to help avert a disastrous crash in the financial markets. It said that setting monetary policy to keep inflation low in the short term risked fuelling financial imbalances that could unwind suddenly, leading to a global economic slump.

How the Irish economy will react to higher energy prices.

If the global economy avoids a collapse, energy prices in Ireland and around the world are likely to rise significantly in relation to wages. Food and raw material prices will rise too, because of the amount of energy used in their production. Graph 7 shows that many commodity prices are already rising.

Graph 7: World commodity prices other than those of food have moved up with those of oil because of the higher cost of energy involved in their production. Food prices can be expected to rise in late 2006 because the higher cost of inputs led some farmers to fallow their marginal land and also because an increasing amount of cereals are being used to produce fuel.

Higher energy, food and consumer goods prices will leave the average family with less discretionary expenditure. In Ireland, the first effect of this will be on the housing market, which has been absorbing most of the income many families have had left after meeting their living expenses. If this market collapses, as many seem to anticipate, the demand for transport will drop both as a result of less materials being moved and fewer people travelling to work. All other sectors will be affected and joblessness will soar. Two income households hit by unemployment will probably sell one car.

More generally, and as the years pass, people will react to the higher costs of owning and operating vehicles in the following ways:

- Families will try to avoid the cost of operating a second car and, later, if incomes fall or prices rise steeply, the first one. They will wish to live near their work, shops and schools so that they can walk, cycle or use an electric moped. The demand for public transport will increase and services will become more frequent. Badly located houses, particularly those which are costly to heat, will become unsaleable.

- More shops will offer home deliveries of goods ordered via the internet. They will minimise the costs of this in rural areas by using contractors who will combine deliveries from several businesses and only deliver in a particular area once or twice a week. In urban areas, a surcharge will be introduced for deliveries not on the regular day.

- Road freight will become particularly costly. Fresh fruit and vegetables coming from elsewhere in Europe will arrive by sea rather than by truck and a variety of ports around the country will be used to minimise the distances the goods have to travel once landed. Irish Rail will start overnight container trains between the major centres and the ports, offering road haulage firms the option of just handling collections and deliveries. Companies like IKEA, which manufacture in bulk and then truck all over the world to a few depots which the public have to visit by car, will have to change their business model or disappear. Global brands will tend to licence their manufacturing to small, flexible factories in each country to minimise freight costs. Farmers will increasingly supply their local markets, local breweries using returnable bottles will develop and there will be significantly more local production for local use.

- Less construction work will be carried on because the country will be experiencing problems maintaining the stock of buildings it has. What buildings do go up will be made of lighter, lower embodied-energy materials such as timber, field stone from the site itself, hemp and lime. A proportion of any blocks required will be made on site using the soil found there. Lighter buildings will mean that strip and raft foundations

give way to piles linked by a ring-beam. As a result, far less cement, aggregate, and steel reinforcement will be needed and the energy used for excavation and site levelling will be reduced. Overall, much less transport will be required.

B. The availability of emissions permits

The European Commission intends[7] to bring aviation into the Emissions Trading System by 2009 or 2010 and other areas of transport will follow fairly quickly. Indeed, they might all be introduced together in 2009-10 or from January 2013 when the post-Kyoto arrangements come into effect as the argument can – and doubtless will – be made that it is unfair to place tight emissions limits on one type of transport and not on the others.

If aviation is brought into the ETS by itself, it will be as part of the present ETS which began in January 2005. However, if it is part of a set of arrangements for the transport sector as a whole, a standalone system as supported by the European Parliament in its vote on July 4th, 2006, would be possible as there would be a big enough pool of emissions permits available to make trading relatively stable. In general, however, more permits would be available for transport, and their cost might therefore be lower, if the sector was part of the present ETS. In the very short-term, it might even be possible for emissions from transport to grow, thanks to emissions savings in other sectors of the European economy. However, as the number of emissions permits was reduced over the years, emissions from the sector would have to fall too. This would mean, almost certainly, that road use fell some time in the next 10-15 years.

Further traffic growth?

The overall conclusion to be drawn from looking at the prospects for the Irish and global economies and the way emissions limits might be imposed has to be that the government should shape its roads policy on the basis that

- emissions restrictions are likely to prevent further growth in road traffic within 15 years, and possibly rather sooner.
- the world economy's growth is likely to be restricted and may well contract, even collapse, in the next 25 years as a result of energy shortages
- energy prices and the cost of vehicles are likely to rise significantly in relation to people's earnings, reducing road traffic volumes, and
- in view of the need to act to slow the rate of climate change, the use of fossil fuels for road transport should be phased out over the next 25 years.

If incorporated into the cost-benefit analyses carried out for new roads, these considerations would almost certainly mean that very few projects showed an acceptable rate of return because an increase in traffic volumes could no longer be assumed and that a reduction in volumes was more likely.

In August 2003, the NRA published[8] its traffic forecasts up to 2040. Its goods vehicles projections were based on "forecast growth in Gross Domestic Product (GDP)" while the growth in car traffic "took account of the forecast size of the adult population and of the level of car-ownership, as well as forecasts of the country's Gross National Product (GNP)." It

assumed that car-ownership per adult would reach saturation level within the 40-year period. It also assumed that that there would be "sufficient spare capacity in the road network to enable substantial growth in travel over the next 40 years." In other words, traffic growth was calculated on the assumption that there would be "capacity restraints on car-ownership levels, but not on the network itself." The report does not mention the restraints discussed in this section - the availability of oil and the restrictions on emissions.

The forecasts were that the number of kilometres travelled by heavy good vehicles on national primary routes would increase by 125% and by 107% on national secondary routes by 2040. Light goods and car traffic would grow by 97% on national primary routes and by 85% on national secondary routes by the same date. Of course, these projections should only be used to guide a planning process if the business-as-usual assumptions on which they are based can be accorded any credibility. In our view, they warrant no credibility at all.

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

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

[3] A leading critic has been Ulf Bossel. See http://thewatt.com/article1238.html

[4] *Before the Wells Run Dry*, Feasta, Dublin, 2003, p137.

[5] 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] The Independent, London, 26 June, 2006

[7] Peter Zapfel, Environment DG, European Commission, speaking at the EU Emissions Trading 2006 conference, Brussels, July 11, 2006.

[8] National Roads Authority, Future Traffic Forecasts 2002-2040, August 2003, downloadable from http://www.n4.ie/PublicationsResources/DownloadableDocumentation/Transportation/file,863,en.PDF