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Peak oil

The fundamental issue: resources are finite

Fifty years ago it was widely assumed that resources were unlimited, so new technology and economic growth would inevitably produce a better future for all. A global event in the early 1970s shattered forever this complacent assumption that the future was inevitably a linear extension of the past. The Organization of Petroleum Exporting Countries (OPEC) decided that its members were not getting a fair return for the oil they were selling to the affluent world and decided to impose an embargo on production. Fuel retailers ran out of supplies. There were fist fights at the bowser as tensions ran high in the UK and other European countries; in the more violent culture of the USA, shoot-outs occurred at the pump. There was some public indignation about the community being 'held to ransom' by the mainly Arab nations that produced oil, until OPEC placed advertisements in local papers pointing out that the producer nations received much less of the pump price than European governments! The world market price for oil increased dramatically, from less than US$2 per barrel in 1972 to nearly US$30 by 1980.

Then OPEC increased production and demand was reined in by conservation measures, so the crisis was resolved and oil prices actually declined. Some decision-makers reverted to the assumption that resources were unlimited. On the other hand, those who had their eyes open in the 1970s saw a preview of the future as transport rapidly became much more expensive. So did heating in some northern hemisphere countries that use oil for this purpose. Those countries began measures to use energy more efficiently, for example by insulating buildings and setting new efficiency targets for electrical appliances. Many northern hemisphere countries also moved to make transport more efficient, by developing their bus, train and tram networks. Some went further and set fuel efficiency targets for vehicle fleets or for cars. The final major consequence of the 1970s oil crisis was that northern hemisphere countries that used oil to produce electricity, notably France and Japan, found the economics unacceptable and invested instead in nuclear energy. Other countries switched to gas for electricity and heating.

Who saw it coming?

The 1970s oil crisis had been predicted in the mid-1950s by a US petroleum expert, King Hubbert of the US Geological Survey. Hubbert had noticed the striking similarity between a graph showing local oil discoveries and a graph of oil production. In simple terms, the curve of oil production curve resembled the pattern of discoveries with a time-lag of about fifteen years, representing the average time taken to bring discoveries into full production. In a famous paper to a petroleum industry conference in 1956, he used this insight to predict that US oil production would peak in the early 1970s and force the US to purchase oil on the world market to maintain its level of consumption. Hubbert suggested that this would change the balance of power between producers and users of oil – as it did, right on cue in the early 1970s. Others then used the same technique to examine likely world oil production. As long ago as 1977, it was reported that the best estimate of when world oil production would peak was about 2010, with pessimists thinking it could be as early as 2000 and optimists thinking it might be as far away as 2020. This knowledge gave us about thirty years to plan an orderly transition away from the age of cheap oil. That is about how long it usually takes to radically transform something as complex and vital as the transport system. The problem is that we have now frittered away most of that time.

Refining calculations of oil production

When King Hubbert made his original predictions about US oil more than fifty years ago, he did not have accurate data about the eventual production peak and the discoveries that would be made in the future. Fifty years later, other analysts have re-worked the data and determined that the graph most accurately depicting oil production profiles is the famous curve known as the normal distribution, the Gaussian or the 'bell curve'. It is the same graph that shows the distribution of IQ in the population or the marks if a large group of students do the same examination. Pessimists now think we have passed the peak of world oil production, with the chaos in Iraq obscuring the picture, while some optimists think the peak might be as far away as 2010 or even 2015, but there is no real disagreement with the fundamental conclusion that the peak of oil production is either in the near future or the recent past. Demand is increasing rapidly as countries like China increase their use of transport fuels. So it is increasingly unlikely that we will have time for an orderly transition. The large motor vehicle companies have prototype cars that use other technologies like hydrogen fuel cells, but there is little chance of them being widely available before oil production begins its decline.

Kenneth Deffeyes has plotted the discovery of world oil and its production using the technique pioneered by Hubbert, taking advantage of more recent data. He concluded in 2001 that the most likely peak year would be 2003 and noted that other published estimates ranged from 2004 to 2009. As he says, it is hard to be more precise because the reserves and production capacities of the oil provinces are closely guarded secrets. But his overall conclusion is that "no initiative put in place today can have a substantial effect on the peak production year". No alternative could be brought on stream fast enough "to avoid a bidding war for the remaining oil". Deffeyes can only offer the hope that "the war is waged with cash instead of nuclear warheads".

Alternatives to oil

There are alternative technologies to produce transport fuels, most obviously by using other hydrocarbon fuels such as natural gas and coal. The German war effort in World War II was powered by synthetic liquid fuels from coal, because Germany had no oil. When imports were restricted by sanctions against its policy of apartheid, South Africa built refineries to produce transport fuels from coal using a modernised version of the same German technology. In addition to other fossil fuels (coal and natural gas) that can be used to produce transport fuels, there are large deposits of hydrocarbon resources such as tar sands and oil shales. The fundamental problem with these 'low-grade' resources is clear from their history. In the early 1970s, speculators who controlled oil shale deposits said that it would be economic to extract oil from shale if the price of oil reached US$5 per barrel. When it did reach $5, they re-calculated and said it would need to be $7.50. When the price reached $30 per barrel, the cost of extracting oil from shale had risen to US$45. Even recent oil prices well over $100 a barrel have not made shale oil economic.

Why does the cost of producing shale oil increase every time the oil price goes up? It takes so much fossil fuel energy to extract oil from shale that the increasing energy price drives up the cost of the product. Gerald Leach calculated in 1979 that shale oil would only be economic if the shale yielded at least 100 litres of oil per tonne. When a local plant extracted oil from shale at Glen Davis, near the New South Wales town of Lithgow, it used a rich deposit that yielded 350 litres of oil per tonne. As the huge deposits in central Queensland and the western USA only give 80 to 100 litres, it would take about four times as much fuel to dig up the rock, crush it and process it to yield the hydrocarbons. So the economic prospects are dubious. There are also severe environmental impacts from the present levels of resource use, ranging from urban air pollution to global climate change, so further increasing energy use would worsen these problems.

Future alternatives

It is possible to produce substitute transport fuels from crops, but the present bio-fuel technologies are inefficient, require large areas of land and thus compete with food production. Researchers are trying to develop new bio-fuels that use land and energy more efficiently. We are likely to see more farmers growing fuel crops for their own use, while bio-fuels might in future power essential services like food production.

If we look forward thirty years, the only credible energy sources for individual transport vehicles are hydrogen fuel cells or electricity stored in batteries. The electric car has been technically feasible since the time of early petrol cars, over a hundred years ago. In 1903 it was predicted that the electric car would take over if a better storage system than the lead-acid battery was developed. That could still be true, as it is not yet clear that we have a better system! There are new types of batteries now in use, such as the nickel-metal hydride variety used in the Toyota Prius, but all these alternatives are more expensive than the lead-acid battery. There are now prototype cars running on hydrogen fuel cells that convert hydrogen into electric power. Again, there are problems. Fuel cells are still very expensive. Hydrogen is the lightest substance known, so it is very difficult to store enough to drive a vehicle reasonable distances.

The cheapest way to produce hydrogen uses natural gas. This is a more plentiful resource than oil, so using gas would do something about the problem of peak oil – but it would in turn help to create a new problem, peak gas! If the global transport system were powered by gas rather than oil, it has been estimated that the peak of world gas production would only be about thirty years away. The next cheapest option would be to produce hydrogen from coal. Using coal or gas for the hydrogen would mean that the greenhouse gas burden of transport would not be reduced at all, unless it becomes practical to capture and store the carbon dioxide produced in the process.

It is possible to produce hydrogen from water, using an electric current to split the water into its oxygen and hydrogen atoms. This would be a sensible application for renewable sources like wind or solar, because it does not require continuous energy supply; it could use the energy of the wind or sun when available, essentially storing the energy in the form of hydrogen for transport. This would be clean transport energy – but it would cost much more than people now pay. There would also be possible environmental impacts arising from the fact that hydrogen is a very light gas and hard to confine. Just as natural gas now escapes into the air from gas wells, storage vessels and delivery systems, hydrogen would also escape if it were widely used. A rough calculation by US researchers found that global use of hydrogen for transport could release 100 million tonnes a year into the atmosphere. Optimists hope that it would combine with oxygen to form water and return to the oceans, or simply escape into space; pessimists believe we should be doing research now on the atmospheric chemistry to ensure that there aren't nasty surprises.

The social and economic importance of oil

The question of 'peak oil' is vitally important because petroleum fuels are the basis of our entire transport system as well as being widely used for food production. Almost everything we use, from food to clothing and household appliances, is produced some distance from where we live and transported to shops. So if the price of fuel goes up, so do the prices of all the goods we buy. When oil prices increased rapidly in the 1970s, it caused rapid inflation as the higher transport costs flowed through into the shop prices of goods. If fuel becomes scarce, some transport will not be available. It will be possible in some cases to replace the goods with local alternatives; the amount of Queensland potatoes freighted to Victoria is almost the same as the amount of Victorian potatoes carried to Queensland! But some commodities can't be replaced. Mangoes only grow in the northern parts of Australia, so Victorians and Tasmanians can only eat mangoes if they can be moved south. The opposite is true of cold-weather fruits; raspberries only grow in southern States, so people in Queensland will have to go without fresh berries if transport fuels are not available.

As discussed earlier, there are alternatives for land transport. It will become steadily more expensive to move goods around, so our consumption patterns will change. You might expect that Victorians will eat less tropical fruit and Queenslanders will consume fewer berries as transport makes those choices more expensive. Increasing fuel prices or scarcity will also require re-thinking of personal transport. In 2007, as many as 90 per cent of urban journeys were made by car. Fifty years earlier, most urban Australians lived within walking distance of a train station, a bus stop or a tram stop and the majority of trips were on public transport. Since buses, trams and trains use transport fuel much more efficiently than cars, increasing prices are likely to cause a return to public transport.

It is likely that use of bicycles will increase. Cycling is by far the most efficient transport technology, only using about 5 per cent of the energy per kilometre of a car with one occupant. Australians regard the bicycle mainly as a technology for young people until they graduate to a more wasteful and dangerous alternative, but there are quite civilised cities in western Europe where up to 40 per cent of all trips are by bike. Cities such as Adelaide and Perth, which are comparatively flat and have wide streets, could easily promote high levels of bicycle use. That would be more difficult in cities such as Sydney and Hobart that are hillier and have narrower streets. Most adult Australians don't get enough exercise, so riding a bike makes people fitter and healthier.

Finally, petroleum is really the only fuel for civil aviation as well as being the basis of most plastics we use. It would be rational to try to save oil for those applications and actively discourage its wasteful use in surface transport.

The change away from an oil-dependent society

In 2007 and early 2008, world oil prices increased rapidly. As a consequence, pump-prices of petrol and diesel went up to unprecedented levels. Opposition politicians in Australia blamed the newly-elected government and indulged in blatant populism by promising to reduce excise on transport fuel. There were even calls for transport fuels to be excluded from the planned emissions trading scheme, a silly proposal since the whole aim of the scheme is to reduce carbon dioxide emissions. For once, economists and environmentalists were united, both groups pointing out that rising prices represented an imbalance between limited supply and growing demand.

The social problem is that rising transport fuel prices hit hardest at lower income households. Those who live on the outer fringes of our sprawling cities tend to travel longer distances in older and less efficient cars with fewer public transport or bicycle options. Subsidising fuel prices, as has been the practice of the Queensland government, is not a good way to deal with this problem. The subsidy goes to all fuel users, rich and poor alike, rather than to those who are suffering. A much better approach is to provide financial support directly to low-income households.

The economic problem is that low fuel prices and public subsidies of road freight have produced an economic system that is heavily dependent on transported goods so rising fuel prices inevitably lead to inflation. The increase in oil prices from $2 to $30 per barrel in the 1970s triggered inflation that led to the downfall of many elected governments. So politicians are understandably concerned about the issue. Economists, however, argue that rising transport fuel prices will make local products more competitive and encourage economic restructuring.

A study commissioned by the Australian Conservation Foundation in 2008 identified many large transport subsidies. The fringe benefits tax treatment of company cars amounts to a public subsidy of about $2 billion a year. The Fuel Tax Credit Scheme, originally aimed at reducing fuel costs for farmers, now provides a multi-billion dollar subsidy of mining and road transport. Aviation fuel attracts an excise duty of 3 cents per litre compared with the standard rate of 38 cents for petrol and diesel, representing a subsidy to air travellers estimated by Treasury to be $900 million a year.

Climate science shows that we must rapidly reduce the carbon dioxide emissions that are causing serious changes to global systems. That rules out some of the alternatives to oil such as producing substitute liquid fuels from gas or coal. These alternatives are technically possible – Germany over-ran most of western Europe in World War II using liquid fuels from coal – but they would **increase** the greenhouse pollution from transport. We should follow Iceland's commitment to a carbon-free society by 2020 (a country with some similar characteristics to Australia). Rising fuel prices should provide an extra stimulus for the transition needed. Phasing out the public subsidies of petroleum fuels would accelerate the process. But some of that money must be used to assist low-income households through the difficult times ahead.

Useful sources

Kenneth S. Deffeyes (2001), *Hubbert's Peak*, Princeton University Press, Princeton USA.

Jeremy Leggett (2005), *Half Gone*, Portobello Books, London UK.

Association for the Study of Peak Oil and Gas: **www.peakoil.net**

Australian Association for the Study of Peak Oil and Gas (ASPO Australia): **http://www.aspo-australia.org.au/**

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