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 the complacent assumption that the future would be a linear extension of the past. The Organisation 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 fights at the bowser as tensions ran high in Europe and North America. 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 did 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 used 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 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 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 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 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 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. It is clear that the peak of "conventional" oil production [from land-based wells] has passed. There are some optimists who think the overall peak might be pushed as far away as 2015 by unconventional oil: that coming from deep ocean wells and the polar region, or produced from gas condensates or tar sands. There is no real disagreement with the fundamental conclusion that the peak of oil production is either imminent or has already happened. 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 plotted world oil production using the technique pioneered by Hubbert, taking advantage of more recent data. He concluded in 2001 that the most likely peak year for conventional oil 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 was that nothing would "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 could 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 like 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 the other fossil fuels that can be used to produce transport fuels, coal and natural gas, there are large deposits of such hydrocarbon resources 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 $70 per barrel, the cost of extracting oil from shale had risen to $100.

The cost of producing shale oil increases every time the oil price goes up because it takes so much energy to extract oil from shale. 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 near the New South Wales town of Lithgow, it used a rich deposit that yielded 350 litres of oil per tonne. The deposits in central Queensland and the western USA only give 80 to 100 litres, so it would take four times as much fuel to dig up the rock, crush it and process it. So the economic prospects are dubious. There would also be severe environmental impacts if we used low-grade resources like oil shale or tar sands – or coal – to produce synthetic liquid fuels to replace petroleum products. The present level of fossil fuel use is rapidly changing the global climate; further increasing use would worsen the problem.

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 therefore 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, so bio-fuels could power the essential service of food production.

If we look forward thirty years, the only credible energy sources for individual transport vehicles are hydrogen fuel cells or electricity. The electric car has been technically feasible for over a hundred years. In 1903 it was predicted that the electric car would take over if a better storage system than the lead-acid battery were developed. That could still be true, as it is not yet clear that we have a better system! Hybrid cars like the Toyota Prius use modern batteries, but these alternatives are much more expensive. There are now prototype cars using 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 more plentiful than oil, so using gas would do something about the problem of peak oil – but it would in turn 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 be only about ten years away. We could produce hydrogen from coal, but that would actually increase the greenhouse gas burden of transport.

It is entirely 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 energy sources like wind or solar, because it does not require continuous energy supply; it could use 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 could also be environmental impacts. Hydrogen is a very light gas and hard to confine. Just as natural gas escapes into the air from gas wells 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 studying 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 clothes 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. The same thing happened in 2007. This is the fundamental economic problem: low fuel prices and large public subsidies of road freight have led to heavy dependence on transported goods, so rising prices inevitably cause a wave of inflation. The related social problem is that rising transport fuel prices hit hardest at low-income households on the outer fringes of our sprawling cities. Some experts think the increasing cost of transport in the USA led indirectly to the 2008 global financial crisis; people in outer suburbs were unable to pay their mortgages, leading to a collapse of financial institutions that rippled around the world.

If fuel becomes scarce, we will use it less wastefully. It will be possible in some cases to replace goods with local alternatives, 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 and apples only grow in cooler parts, so people in the tropics will have to go without fresh apples and berries if transport fuels are unavailable or become so expensive that carting fruit long distances becomes uneconomic. More expensive fuel will change our consumption patterns. You might expect that Victorians will eat less tropical fruit and Queenslanders will munch fewer apples as transport makes those choices more expensive.

Increasing fuel prices or scarcity will also require rethinking of personal transport. In 2010, well over 80 per cent of urban journeys were made by car. Current taxation laws amount to an annual public subsidy of about $2 billion to company cars, while massive sums are used to build more roads, tunnels and bridges in our cities. Fifty years ago, 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 in 2008 caused a return to public transport. This trend is likely to accelerate as fuel prices continue to rise.

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 more wasteful and dangerous alternatives, but there are quite civilised cities in western Europe where up to 40 per cent of all trips are by bike. Cities like 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 like Sydney and Hobart that are hillier and have narrower streets. Most adult Australians don't get enough exercise, so riding a bike would make people fitter and healthier.

Finally, petroleum is really the only fuel for civil aviation at the moment 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. As a vision of the future, we could look to Iceland, a country with many similarities to Australia. It is committed to being a carbon-free society by 2020, replacing petroleum fuels with hydrogen produced from water by renewable energy. That approach is economically rational as well as being environmentally responsible.

Useful sources

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Author

Ian Lowe is Emeritus Professor of Science, Technology and Society at Griffith University.

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