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ENERGY FUTURES FOR TRANSPORT

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INTRODUCTION

A few years ago I took part in a workshop to begin the planning processes for a new town in Western Australia. I was placed in a small group charged with answering the question "what are the ten most important long-term changes that urban transport will have to contend with?". Everybody immediately identified "**Availability and price of energy**" as an issue. We then sat looking at each other and the whiteboard, and realised that compared with that, nothing else comes close.

WHY WORRY ?

Anyone whose planning horizons extend beyond the next five years should consider energy futures and their impact on medium- to long-term plans.

Which, if any, of these caricatures do you currently subscribe to ?

- **(environmentalists)** the world is heading for ruin unless we make major changes to our way of life
- **(planners)** there is a major transition to be managed, planners will save the day
- **(the man or woman in the street)** nothing is proven, no need to change behaviour just yet, something is bound to turn up
- **(engineers)** technology will come up with a way forward, engineers will save the day
- **(the oil and gas industry)** market forces will drive a gradual transition as competitive relativities change, no worries

In 1998, the Chartered Institute of Transport in Australia mounted a National Symposium "Beyond Oil : Transport and Fuel for the Future" to review the current state of knowledge. CITIA's conclusions after the symposium were released as an Outcomes Statement¹. This left little room for doubt about the level of concern.

... We have reached a crucial stage in the development of our local, national and international transport services . Our present path is leading us into potentially serious economic, social and environmental problems. New directions are

¹ Internet reference given at end of paper

needed for our future transport fuels and vehicles. "More of the same" in our current transport plans and ways of thinking is no longer tenable ...

... The unlimited use of cheap oil that has characterised this century will end and we will be faced with one of the greatest transformations of human affairs. The signs are already there. Risk of chaos, disorder and conflict will arise unless we face up to this great challenge and make the difficult decisions essential to the future well being of us all ...

... the Chartered Institute of Transport, the professional body of transport managers in Australia, calls for the development of greater understanding and awareness of these crucial issues and for their consideration in all policy formulation and decision making relative to the future of transport and fuel in Australia

If CITIA, a fairly conservative and pragmatic organisation, has become so concerned, so should the rest of us be.

HOW MUCH OIL IS THERE ?

One of the revelations at the Symposium was just how rubbery our data is on global oil resources and hence how uncertain our knowledge. One informed source is Colin Campbell, formerly of Petroconsult. His 1999 presentation "The Imminent Peak of World Oil Production" to an All-Party Committee of the UK House of Commons² is a comprehensive overview of the global issues. He also estimates resource levels based on access to industry data worldwide, and arrives at lower figures than those from industry sources. For instance the American Petroleum Institute's estimate of total world reserves is twice that of Campbell.

In summary, according to Campbell, the world has already discovered about 90% of all the oil there probably is, and has already used up almost about half of what it has discovered so far. It is using up oil at four times the rate of new discoveries. The consumption rate is rising and the discovery rate is falling. (See Table below).

"Conventional Oil" Discovery and Consumption – estimates (gigabarrels) (source : C J Campbell, The Imminent Peak of World Oil Production, 1999)

1. Produced	816 Gb	
2. Reserves	821 Gb	
3. Ultimate	1800 Gb	
Discovered (1+2)		1637 Gb
Yet to Find (3-2-1)		163 Gb
Yet to Produce (3-1)		984 Gb
RATES		
Consumption (rising)	23 Gb/yr	
Finding (falling)	~6 Gb/yr	
Depleting	2.2%/yr	

1 Gb = 1.59x10¹¹ litres.

² Internet reference given at end of paper

Nor will the existence of other hydrocarbon fuels affect the broad picture, save by influencing the timing of the peak and of the levels of depletion. These resources are not renewable in any timescale meaningful to human planning and, once they are used, they are gone. Campbell's estimate was that world hydrocarbon production (all types) will peak in around fifteen year's time, at a level perhaps 25% higher than the 2000 level, and will thereafter decline rapidly. By 2050 total world hydrocarbon production may be running at a level just over half that of today.

The discovery of a new giant oil field in the Caspian Sea was announced in May 2000. Did this mean that the dangers of oil depletion had been greatly exaggerated ? Reflect on two things. One, some new discoveries are still to be expected, and this one is not out of the ordinary. Indeed, it conforms to expectations of where and how those discoveries may yet be made - the Soviets were unable to fully explore for undersea fields in the past for want of appropriate offshore technology. Two, although its size is uncertain, much of the oil will not be extractable and initial estimates suggest that it might yield the equivalent of six months global consumption at current rates.

HOW WILL TRANSPORT ADAPT ?

The Chartered Institute of Transport in Australia mounted a National Symposium on this subject in November 1998. It was held in Launceston, Tasmania and attended by :

- transport operators of road, rail, sea and air transport
- vehicle manufacturers
- the oil and gas industry
- politicians
- public and private sector planners
- environmentalists
- academics
- the military
- and others

The Keynote Paper ("Climaxing Oil : How Will Transport Adapt ?"³) was delivered by Brian Fleay of Murdoch University (WA), author of the book "The Decline of the Age of Oil".

Key points included the following.

- the implications of the "Energy Profit Ratio" (EPR) concept : to extract energy from oil fields and other sources, energy has to be expended. The more depleted the field the lower the ratio of the total energy content of the fuel to the energy needed to extract that fuel. Hence the gross size of a field is no guide to the net energy available.
- the characteristics (EPR and economic effectiveness in transport) of oil from the giant oilfields greatly exceed that of any other known energy source for transport: it is a unique asset
- Colin Campbell's summary of probable global reserves, discovery rates and depletion rates is about the best available at the present time, and paints a disturbing picture (as above)

³ Internet reference given at end of paper

- the peak of world oil production is estimated as 2015, but now (2000) for all sources other than the Gulf
- there is a similar trajectory for gas and other hydrocarbon sources
- total world hydrocarbon production was estimated to be 25% higher than 2000 in 15 years time, but 25% **lower** in 30 years time

Brian Fleay's conclusions from his analysis are many. The following seem especially noteworthy:

- the high future dependence on oil and gas resources located in the Gulf and in Russia/Eurasia will bring geo-political instability
- the present trend to replace labour with energy will be reversed – the world will have less constraint on its supply of labour in future than on its supply of energy
- there will be an increasing focus on sustainability and local self-sufficiency
- co-operation rather than competition must prevail
- the most daunting task will be feeding the world during the transition period as the Age of Oil ends, because the world cannot produce enough food for its present and future human population without using fertiliser (whose manufacture is a huge fuel consumer). World population is about 6 billion today, having doubled since 1960.
- agricultural requirements for energy will take priority over transport
- essential commercial traffic will be the highest transport priority
- urban car travel is the least necessary transport use of energy and will bear the brunt of the decline
- urban road projects are therefore "disastrous investments"
- metabolistic economic models are needed, not the present mechanistic models
- there are hard decisions to be made
- change can be managed constructively or destructively
- if the destructive path is taken, scarce resources that are needed for the transformation process will be squandered

Further keynote speakers added their perspectives, including :

- Fleay's thesis depends on many implicit assumptions about stability in the way the wider world works, despite copious evidence over the last 100 years that the future is inherently uncertain and unpredictable.
- the way we use energy now is not well understood and would not be considered anywhere near optimal if it was.
- evolutionary change in fuel availability will come about through market preferences and consumers exercising choice, as technical and price relativities change slowly.
- "We are not passengers on Spaceship Earth - we are the crew and it is time we started taking our responsibilities seriously".

Two of the above views came from oil/gas industry sources, and two did not. There are no prizes for guessing correctly which are which.

SUSTAINABILITY

The Symposium I have been describing⁴ was designed to help transport managers and equipment suppliers to plan appropriately for the future provision of their transport services, in whatever form. A range of innovations were canvassed, including :

- gas powered vehicles
- greater emphasis on walking and cycling in urban areas
- smarter, lighter, cleaner cars
- integrated land use and transport planning
- market forces
- light rail
- heavy rail upgrading

Most of these were essentially different – and not necessarily exclusive - ways of achieving the same outcomes. Those who focus their thinking on sustainability might question whether those outcomes are achievable (or rather, sustainable) at all.

“Sustainability” is a concept that means different things to different people. At its most basic, moving away from unsustainable development (of which transport is a part) means better management of the demand for water, better management of the demand for energy and better management of the production and disposal of waste (including vehicle emissions).

Of these three, transport displays strongest links with the demand for energy. Hence, unless “sustainable development” fades away as a concern, energy assessments will come to be a central feature of transport planning in the medium to long term.

WHAT DOES THE FUTURE HOLD FOR TRANSPORT ENERGY ?

CITIA’s Outcomes Statement⁵ eloquently emphasised the seriousness of this issue. My own supplementary thoughts are as follows.

(a) transport modes

- Aviation is the mode most vulnerable to future energy problems. There is no feasible alternative in the wings for powering high-speed passenger aircraft as we know them. Nuclear power for aircraft is out because of the weight of shielding that would be necessary to preserve the passengers. Hydrogen is perhaps the best alternative, but the need to store it in large quantities on-board in liquid form presents safety hazards. (Airships might make a limited come-back for freight and special uses).
- Rail transport and sea transport are the least vulnerable. A railway locomotive is basically a rolling power station, and can potentially be powered by whatever fuel is most economical at the time – oil, gas, reticulated electricity, coal, wood, etc. Even in times of severe energy constraint, rail transport will be at an advantage

⁴ Internet reference for a review of the Symposium given at the end of the paper

⁵ Internet reference given at end of paper

over road transport because of its greater inherent efficiency though lower friction, easier grades and radii, and fewer interruptions once in motion. Similarly for ships – it is not that long since the principal source of energy for moving ships was wind, supplemented by the salted pork and beer that fuelled the humans who pulled the sails up and down.

- For road transport, we can expect to see vehicles different to today's but more of them. The world is not going to give up personal mobility, although it might eventually come to accept that achieving it via manually-controlled metal monsters is not the best option. (For instance average vehicle weights in Europe have increased steadily over the last fifteen years. If this trend continues, it could on its own be responsible for a 17% increase in energy use 1990-2050 at constant engine performance.) Road freight vehicles will also continue to diversify, especially at the biggest and smallest ends of the size spectrum.

(b) energy sources

- Tightening supply and rising prices will probably hit Australia's diesel fuel first - the country exports its own light oil (as used for petrol) but imports the heavy oil needed for diesel, bitumen etc. From an energy security perspective Australia should be trying hard to wean users of heavy vehicles away from diesel and onto natural gas. The New Tax System, via the diesel fuel rebate for rural users, is doing the opposite at present.
- Hydrogen fuel technology will be very prominent in future. General Motors and Daimler-Chrysler are racing each other to launch the first commercial hydrogen-powered fuel-cell car by 2004. Japanese companies are also known to be well advanced. Some commentators predict that the "Age of Hydrogen" will take over from the "Age of Oil" long before the oil actually runs out. According to Amory Lovins⁶, when fuel cells become cost-effective, cars will become in effect clean silent power plants on wheels and will continue to be run when parked in order to send (sell) electricity back to the grid.
- Renewable sources will figure increasingly prominently in future – photovoltaics (solar power), wind farms, hydro-electric or geothermal power plants where nature allows it, and so on.
- Nuclear power will probably remain out of contention – at least in Australia - until there is an acceptable solution to waste disposal issues.

(c) planning processes

- There is no call for panic – yet.
- The government's reliance on fuel taxation as a revenue source, and its taxation policy in general, has huge potential to influence outcomes - for better or worse. Fuel excise and GST on petrol accounts for about half of what you pay at the pump, and the resource cost of the oil, the processing and distribution costs and commercial margins applied at all points in the chain the other half. Hence

⁶ Internet reference given at end of paper

although the cost of crude oil has more than trebled in the last two years (from a historic low of \$US10/barrel in November 1998), the knock-on effect on pump prices in Australia has only been in the order of a twenty percent rise.

- Energy issues **cannot** be overlooked in long term planning. Bear this in mind whenever you see trend extrapolations of demand (eg for the international tourism sector of aviation).
- Energy flows need to be modelled. We do not do this well. I recently attended a talk about hydrogen fuel cell technology and how this would probably be the future source of choice for buses. I asked “but where does the hydrogen come from?”. “From bottles on the roof” was the rather unsatisfying response. Hydrogen can be produced on a large scale from water, oil, coal or natural gas by the application of energy. What I meant was – how much energy does it take to produce the hydrogen to put in the bottles on the roof to power your highly efficient and clean fuel cells – and what else do you get (eg lots of carbon monoxide if you take the hydrogen out of natural gas, its most common source). The on-board part of the energy delivery system does not work in isolation.
- Strategic risk assessments will become more important – how robust are the plans for major infrastructure projects or other programs in the face of variations in future energy scenarios?
- Sustainability issues will come to dominate planning processes. When commenting on sustainability earlier in this paper, I qualified my statements with “...unless “sustainable development” fades away as a concern ...”. I will dispense with scientific caution here. It won't.

For further information, see (prefixing with “[http://](#)”) :

- www.kilsby.com.au/brainfood.htm “Beyond Oil” – includes a review of the CITIA Symposium, the full CITIA Outcomes Statement, and other material
- www.wistp.murdoch.edu.au/OilFleay/oil.html Brian Fleay's Keynote Paper from the CITIA Symposium
- www.oilcrisis.com/campbell/commons.htm Colin Campbell's 1999 Presentation “The Imminent Peak of World Oil Production” to an All-Party Committee of the UK House of Commons.
- www.iea.org The International Energy Agency site, which monitors the oil and gas position regularly
- www.hubbertpeak.com Discussion on the “Hubbert Peak” of oil production.
- www.opec.org The producers' view (OPEC).
- www.natcap.org Natural Capitalism, the new book from Amory Lovins and colleagues