HUBBERT CENTER NEWSLETTER # 2000/3

M. KING HUBBERT CENTER
FOR PETROLEUM SUPPLY STUDIES

M. KING HUBBERT CENTER
Petroleum Engineering Department
COLORADO SCHOOL OF MINES
GOLDEN CO 80401-1887

OIL AND AUSTRALIA

by
Brian J. Fleay

Australia is unique

Turn a globe of the earth upside down and Australia appears as a large island surrounded by ocean. You appreciate the isolation and the importance of transport both within the country and with the world. Transport that is powered by oil.

Australia is different from other continents. It was once part of Gwondanaland, a super-continent centered around the South Pole. It has since drifted to its present position astride latitudes where deserts prevail. This history did not favor generation of oil and gas nor create the recent episodes of glaciation, mountain building and volcanism that have served to re-mineralize soils in the rest of the world.

So Australia's ancient landscape has the world's most infertile and nutrient leached soils whose intrinsic biological productivity is extremely low. The landscape has a low profile and sluggish drainage. Add the erratic rainfall that is a consequence of the El Nino climate oscillations in the Pacific Ocean and you have the driest of all the continents. In the words of the poet Majorie Mackellar-Hall "…a sunburnt country, a land of droughts and flooding rains…". Most of the arable land is marginal by world standards. Only the Atherton Plateau in north Queensland, western Victoria and the adjacent corner in South Australia have fertile soils where minor volcanism ceased less than 10,000 year ago. That is why Australia will always have a small population.

That is why 94 percent of Australia's 19 million people live within 100 km of the coast, strung out between Cairns in Queensland and Adelaide in South Australia, and between Albany and Geraldton in the southwest corner of Western Australia. That is why the five coastal cities of Brisbane, Sydney, Melbourne, Adelaide, and Perth have 60 percent of the population. That is why transportation is a major issue in Australia.

Since its colonization 200 years ago, Australia has always been more urbanized than the USA. We are a maritime people.

All Hubbert Center Newsletter views are those of the individual authors and
are not necessarily those of CSM or its Petroleum Engineering Department

Our fossil fuels

Australia has nine percent of the world's coal reserves and is the world's largest exporter, mostly to Asia. Coal has been mined since the 1850s.

But we only had approximately half of one percent of the world's conventional oil endowment, a mere nine billion barrels. Most was offshore in the Bass Strait between the mainland and Tasmania, the rest is in Central Australia and offshore from the north west coast while condensate from natural gas makes a significant contribution. More than half of this crude oil has been produced since the mid-1960s. We consume 280 million barrels per year.

Our self-sufficiency in oil and condensate is expected to decline from 85 percent in 1999 to 42 percent in 2010 (AGSO 1998, Fleay 1998). Net oil imports from the Middle East will rise fivefold by volume next decade based on business-as-usual consumption forecasts. The import bill will rise from AU$1,200 million to AU$8,000 million, depending on oil prices and the dollar exchange rate. Australian oil production will most likely cease before 2030. Earlier editions of the Hubbert Center Newsletter (HCN #97/1; 97/2) have described how world oil production is expected to peak by 2010 and commence decline in the world outside the Middle East any time now.

Less than two percent of the world's natural gas endowment is in Australia, and we have produced nine percent of this since the late 1960s. Three quarters is located offshore from the north west coast and in the Timor Sea between Australia and Indonesia. The remainder is in the Bass Strait and Central Australia. A pipeline from the west coast to supply the eastern seaboard will be needed within 10 years. Australia's natural gas endowment is larger than that for oil.

Energy consumption and exports

Crude oil comprises 37 percent of total energy consumption, black coal 28 percent, natural gas 18 percent and brown coal 12 percent. Transport, manufacturing and electricity generation each consume just over 25 percent of total energy consumption. Two-thirds is consumed by energy end users, and the remainder is lost in energy conversion processes such as electric power generation.

Mining and mineral processing have grown substantially since 1960. Australia is the world's fourth largest coal producer after China, the USA and India. It is the largest producer of alumina and mineral sands, the second largest producer of gold, the third largest producer and the largest exporter of iron ore. There is significant mining of copper, nickel, and silver-lead-zinc. Oil and natural gas power these mining operations and their associated heavy rail and road transport systems, mostly in "outback" Australia. Most of the energy used in manufacturing is for mineral processing, including iron and steel mills, nickel, alumnia refineries and aluminum smelters.

Petroleum products comprise 50 percent of energy end use, and three-quarters is directly consumed by the transport sector which is dominated by road transport followed by aviation. Australia is the third highest per capita consumer of gasoline in the world after the USA and Canada. Natural gas consumption is growing at the expense of other fuels.

Australia is the only developed country with significant energy exports, 70 percent of production is exported as coal, uranium and liquid natural gas in that order.

Agriculture

The land's low biological productivity has inhibited development of agriculture and the transport systems needed to support it. Cattle ranching and grazing sheep for wool initiated rural development, and both still have a prominent place. Cereal cropping and cane sugar did not really develop until the late 19th century, then only after phosphate fertilizers were introduced and finally oil powered tractors. These fertilizers prevented the early collapse of cereal cropping, a farming practice now being widely questioned as inappropriate to the climate and poor soils. Diesel power plays a critical part in mining the phosphorus minerals and sulphur needed to manufacture and distribute the superphosphate on the farms. Australians of this earlier era pioneered many developments in the mechanization of agriculture. Transport costs are critical for farmers.

Since 1960 nitrogen fertilizers, such as urea made from natural gas, have become extensively employed to maintain yields and farm produce quality from Australia's poor soils, but at the price of extensive soil and water degradation. Their manufacture is 8 to 10 times more energy intensive than for phosphate fertilizers. Minimum tillage practices and herbicides for weed control have been introduced to reduce soil degradation. Irrigation systems constructed this century have diversified crops to include fruit, vegetables, vines, rice and cotton, but only by severely degrading associated waterways and rivers.

It has been said this form of agriculture – mechanized agribusiness – is a way of converting petroleum into food. It is the way we force alien European farming practices to work in Australia's fragile landscape, and it is the way Australia feeds 60 to 80 million people in the world. Australian farmers face a greater challenge than anywhere else in the world in adapting industrial agriculture to an era "beyond petroleum" by the middle of this new century.

Dryland Salinisation

Farmland salinisation is a massive problem across Southern Australia. This land's rain mostly comes off the Southern Ocean and has a high salt content. Only a very small percentage appears as river flow, and most rain is lost to evapotranspiration, leaving the salt behind in the sub soil where it has accumulated below the tree root zone for thousands of years. Clearing the original woodland for pasture and cereal cropping has drastically reduced evapotranspiration and increased ground water recharge, often more than tenfold. The rising water table slowly mobilizes salt into rivers and the land surface. In South Western Australia (WA) 20,000 sq km of farmland (10 percent) has already become too saline to farm and another 40,000 sq km is under threat over the next 30 to 40 years. Half of the river flow has become saline, and half of the remainder is under threat.

However, the farmers and scientists of WA lead the world in understanding this problem and how to combat it. This understanding has matured in the 1990s, and it is now recognized that the rest of Southern Australia has the same problem.

A report to the Prime Minister says present trends indicate that another 100,000 sq km of farmland in southeastern South Australia and in the Murray-Darling Basin, the country's biggest river system, will become saline by the middle of this century. Together with WA, salt-affected land has an area equal to the state of Victoria (PMS, E&IC 1999). Salinity levels in the lower Murray River will exceed drinking water standards by then. The Murray is the major

water source for public supply and irrigation in South Australia. The report is quite blunt, present farming practices are not sustainable. A major Land and Water Audit on degradation of these resources has been released (MDBC 1999).

The West Australians are finally learning how to change farming practices to successfully halt and turn back the salt tide. The new agriculture must mimic the water managing characteristics of the original vegetation both at the local and regional scale to stop ground water recharge and control its discharge. Every conceivable farming practice and crop is under review and new ones are on the agenda, including deep-rooted perennial crops and engineering solutions. Years of research and on-farm experience have shown that nothing less will do. This involves knowing where the salt is located in the landscape and understanding the sub-surface geology, hydrogeology and hydraulic conductivity of soils to depths up to 100 meters and more.

Aerial magnetic survey techniques used for mineral exploration have been successfully adapted to this purpose, providing information for planning farm operations. No single prescription will serve, and what methods are appropriate, where, when and how is dictated by the sub-surface environment both on farm and catchment-wide scales. No farmer can act in isolation from other farmers, and all must synchronize with catchment-wide plans. These concepts are emerging in the draft 30-year WA Salinity Action Plan (SAP) and from the flourishing on-farm Landcare movement. A more varied and diverse range of agricultural products is likely. But it will take more than a century to fine-tune the new agriculture that is emerging and to lower groundwater tables, if that is possible. A far-reaching cultural transformation is beginning as the leading farmer groups and supporting science agencies search for a new vision, a new relationship with the land that focuses on stewardship rather than human domination.

SAP recognizes that farmers need substantial financial and other help from the community, government and the urban population. They cannot make this transition alone. There is a substantial morale problem in rural Australia. Mechanization of agriculture has led to declining and aging populations, fragile communities and loss of services on top of these daunting environmental challenges in this tired landscape of droughts and flooding rains. The political landscape is changing.

The time frames for the initial combating of salinity and adapting Australian agriculture to an era “beyond petroleum” coincide. Both programs must merge and become one. Both require petroleum fuels to carry out these transforming tasks while maintaining viable farms during the transition. Farmers are not yet aware of the petroleum dimension, but this writer hopes some progress will be possible in the near future.

Certainly Australia’s agriculture must get first call on our remaining petroleum fuels, and private car travel in our cities must bear the brunt of declining oil supply. If we fail on the agriculture front, then everything else fails.

Transport background

Most railways were built by State governments before 1940 to foster agricultural and mining development. Traffic potential was too low for privately owned railways to prosper, unlike in the USA. Parochialism and capital constraints led to three different track widths and six different operating systems that were and still are barriers to interstate rail traffic, though new works since 1960 have eliminated most of the track width barriers. The major cities in this

period developed rail and electric trolley public transport systems followed by buses after 1920. Coastal shipping had an important role in freight and passenger traffic.

Motorized road traffic and paved road construction began after World War I and surged after World War II. Australia has more roads per person than anywhere else in the world and 90 percent of the road transport task is carried out on 20 percent of the network. Diesel locomotives have replaced steam on railways. Commercial aviation has flourished; Quantas is one of the world's few successful airlines. Heavy rail has been constructed since the 1960s to transport iron ore and coal to ports, mostly by mining companies.

After years of neglect, attempts are being made to revitalize interstate railways to compete more effectively with trucks for long haul freight. There is a focus on being internationally competitive. The growing numbers of heavier and faster trucks are damaging roads in regional Australia faster than road building can be funded to keep up, given the long distances and low population density. Rail is five times more fuel efficient and is becoming a competitor to trucks. But there are many obstacles to rail reform; historical, political, financial and managerial with dissension among competing interests and ideologies that prevent development of a coherent national transport strategy. State investment is funded by loans repayable with interest from rail revenue, whereas most road works are funded from fuel taxes. The road lobby has the numbers and is well organized.

Damage to buildings, transport and other infrastructure from salinity is a growing problem across Southern Australia.

Urban transport

Australia's population has grown threefold since 1945 under a strong migration program, mostly to the coastal cities where two-thirds of the population lives, while the rural population has declined. The motor car dominates personal land transport everywhere, and trucks dominate inter and intra urban freight. Sprawling urban form has developed around the car, but not quite to the degree as in the USA. The role of urban public transport has declined. Trolleys were removed after World War II in all cities except Melbourne, which has the largest light rail system in the world, outside Europe, as well as an extensive electric transit network.

Rapid growth of our major cities around the car as the prime passenger transport mode with its accompanying freeways and expressways is causing acute congestion and urban sprawl that is most pronounced in Sydney, Melbourne, Brisbane, and Perth. Public opposition to further major road building grew in the 1990s as the negative impacts of this development pattern escalate. In Brisbane and Sydney such citizen actions have contributed to the defeat of governments in state elections.

Catering for cars in the cities is getting beyond the capacity of governments to finance as each new road adds to the congestion. In the 1990s the New South Wales and Victorian governments promoted privately owned toll roads, five in Sydney at a cost exceeding AU$2,000 million and one in inner Melbourne for nearly the same amount. The companies finance them from loans for terms up to 20 years or more, together with shareholders equity funds assisted by tax concessions. The toll income streams cover dividends, loan repayments, maintenance, and operation.

In Western Australia the government raised gasoline taxes in 1997, then vehicle license registration fees to finance a ten-year road program of absurd proportions. Some of the urban road projects for Perth are facing fierce opposition from angry citizens.

Common to all these road projects are traffic forecasts 20 to 30 years ahead that completely disregard future fuel supply for the vehicles. It is like an electric power utility building a power station and making no provision for the fuel supply needed to run it! Company prospectuses for toll roads contain audit certificates from consultants certifying traffic forecasts and expected revenue from tolls, but without any verification on fuels supplies needed to back up the forecasts! Australia's precarious oil supply future has already been discussed.

The definitive work on urban transport is by Newman and Kenworthy (1999), *Sustainability and Cities: Overcoming Automobile Dependence*. The book draws upon a comprehensive database from 46 cities around the world, the only database of its kind. The authors take into account oil depletion along the lines described in Hubbert Center Newsletters. They concluded that reducing car dependence in favor of electric transit and changed land use patterns was the key strategy for cities to become more sustainable. Their principal conclusions were:

- Private transport energy use per capita is inversely proportional to city population density by factors of up to six-to-one.
- High urban density and the priority of transit over roads and car orientation were strongly correlated.
- Car-orientated cities spent a higher proportion of their wealth on journeys to work.
- Car-orientated cities spent a higher proportion of their wealth on passenger transportation. The range was five percent for wealthy Asian cities to eight percent in European cities and 12 to 13 percent for car based US and Australian cities. Perth, Western Australia and Denver, USA were the highest at 17 percent, the classic examples of urban sprawl.
- More persons walked or road bicycles to work in cities with high urban density.
- High mobility is not necessarily related to city wealth. Data suggests that cities with high wealth are associated with lower mobility (i.e. transit rather than car oriented). There is a need to distinguish between mobility and accessibility.
- Kilometers traveled per capita and travel time in car-oriented cities is high and increasing, offsetting gains in higher speeds, fuel efficiency and lower exhaust emissions from freeway travel.
- Fare box return covers a higher proportion of transit costs in transit-orientated cities than in car-based ones.
- Passenger transport energy consumption in transit-orientated cities (electricity) is half that in car orientated cities (gasoline).
- Greenhouse gas emissions and other air pollutants per capita are higher in car-orientated cities.

Readers of past Hubbert Center Newsletters (http://hubbert.mines.edu) would know that conventional world oil production is expected to peak around 2010. Commentators' timings differ but these center around this date. Even the International Energy Agency (IEA) has expressed this viewpoint in a report to the G8 Country Energy Ministers at their March 1998 meeting (IEA 1998). Newman & Kenworthy conclude that car-based cities will be at a competitive disadvantage.

Conclusion

The peaking of world oil production and the growing dependence on Middle East production over the next decade will present great challenges to Australia. Two massive problems confront its farmers - dryland salinity and a more extreme dependence on petroleum products in agriculture than anywhere else because of its climate and nutrient deficient soils. Australia's car dependent cities also face challenges, but not as great as those facing its farmers, and both will be competing for a rapidly shrinking oil supply. We cannot be assured of access to oil imports in an era of declining supply. Natural gas, if used wisely, can substitute for a brief but critical period.

Australian agriculture by mid-century will be radically different in ways not apparent now. A cultural renaissance is possible as we adapt to living in this country's unique environment without the use of petroleum fuels that have so far enabled us to impose our European cultural heritage upon it. Such changes in the countryside must have reciprocal consequences for our cities.

References

1). Australian Geological Survey Organization (1998) *Oil and Gas Resources of Australia 1998*. Australian Geological Survey Organization Canberra.

2). Fleay, B.J. (1999) Climaxing Oil: How Will Transport Adapt? *Theme paper presented to the Chartered Institute of Transport in Australia's National Symposium, Beyond Oil: Transport and Fuels for the Future*, Launceston Tasmania, 6-7 November 1998. Occasional Paper 1/99 by the Institute of Science and Technology Policy, Murdoch University Western Australia. http://wwwistp.murdoch.edu.au

3). Fleay, B.J. 1995. *The Decline of the Age of Oil*, Pluto Press, Sydney, Australia.

4). IEA, International Energy Agency (1998) *World Energy Prospects to 2010*. http://www.iea.org/g8/world/summary.htm

5). MDBC, Murray Darling Basin Commission 1999. *The Effectiveness of Current Farming Systems and Dryland Salinity*. Commonwealth Scientific & Industrial Research Organization report. http://www.mdbc.gov.au

6). Newman, P. & Kenworthy, J. 1999. *Sustainability and Cities: Overcoming Automobile Dependence*. Island Press, Washington, D.C.

7). Prime Minister's Science, Engineering & Innovation Council (PMSE&IC) 1999 *Dryland Salinity and its Impact on Rural Industries and the Landscape*, Occasional Paper Number 1, Dept. of Industry, Science and Resources.

The Author: Brian J. Fleay

Brian Fleay has a Bachelor of Engineering from the University of W.A. and a Master of Engineering Science in Public Health Engineering from the University of New South Wales. Brian's professional life was spent with the Water Authority of Western Australia, mainly in the operation and maintenance of Perth's surface and ground water sources.

He is an Associate of the Institute of Sustainability and Technology Policy at Murdoch University in W.A. where he pursues his long standing interest on the connections between ecology, economics, and energy, the future of petroleum supplies and the consequences for population, transport, and agriculture.

His book, *The Decline of the Age of Oil*, was published in 1995, and he has authored several papers for conferences on the future of petroleum supplies and the consequences for transport.

He comes from a pioneer farming background in the Avon Valley east of Perth.

Brian J. Fleay
Institute of Sustainability & Technology Policy
Murdoch University
Murdoch 6150
Western Australia
Phone +61 8 9360 2913; +61 8 9328 7065
Fax +61 8 9360 6421
Email istp@central.murdoch.edu.au

HCN#2000/3-1-7

The Oilman's Column #5 - by L. F. Ivanhoe

GASOLINE USE EXACTS SOCIAL COSTS

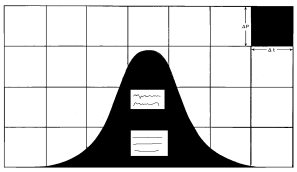
The U.S., with 4.5 percent of the globe's population, consumes 25 percent of the world's oil production. The U.S. Federal gasoline excise tax of only 18 cents per gallon is a form of subsidy when compared to the average tax collected (more than $3.00/gallon) in Europe and Asia. Our token gasoline tax is considered to be a major problem for the global economy. Foreigners feel that we consume more than our fair share of the world's petroleum resources.

A European economist once said: "It is hard to take seriously the economic problems of any nation that could be solved by levying a 50-cent-per-gallon gasoline tax." (Each cent of U.S. Federal gasoline tax brings in $1,000,000,000 per year.)

Some U.S. writers argue for increasing our gasoline tax, but only for "user fees" for transportation. However, there are many other "social costs" involved with gasoline usage. Gasoline could easily carry more "user share" for: Road maintenance; air pollution/clean air; mass transit; basic auto insurance; parking spaces; driver's education; traffic police and courts; emergency hospital rooms; safety research; freeway landscaping; alternative liquid fuels research; improved oil field production; military costs of defending Middle East crude oil supplies; etc., etc.

HCN#2000/3-2-1

H.C. NEWSLETTER



The M. KING HUBBERT CENTER FOR PETROLEUM SUPPLY STUDIES
located in the Department of Petroleum Engineering
Colorado School of Mines
Golden, Colorado

The Hubbert Center has been established as a non-profit organization for the purpose of assembling and studying data concerning global petroleum supplies and disseminating such information to the public.

The question of WHEN worldwide oil demand will exceed global oil supply is stubbornly ignored. The world's oil problems, timing and ramifications can be debated and realistic plans made only if the question is publicly addressed. A growing number of informed US and European evaluations put this crisis as close as now to 2014. The formation of this center is to encourage a multi-field research approach to this subject.

For further information contact:

Hubbert Center Chairman
Prof. Craig W. Van Kirk
Head of Petroleum Engineering Dept.
Colorado School of Mines
Golden CO 80401-1887
Phone 1-800-446-9488
Fax 1-303-273-3189
Internet Address: *http://hubbert.mines.edu*

Hubber Center Coordinator
L. F. Ivanhoe
1217 Gregory St.
Ojai CA 93023-3038
Phone 1-805-646-8620
Fax 1-805-646-5506

Notes:
This is one of the Hubbert Center's quarterly newsletters. Please retain for reference.

The views expressed by authors of Center publications are their own, and do not reflect the opinions of Colorado School of Mines, its faculty, its staff, or its Department of Petroleum Engineering.

The Hubbert Center welcomes pertinent letters, clippings, reprints, cartoons, etc.
The Hubbert Center will archive work files of recognized experts in this field.
Contributions to the Hubbert Center through the CSM FOUNDATION INC. are tax-deductible.

Reproduction of any Hubbert Center publication is authorized.