OIL VULNERABILITY STRATEGY/ACTION PLAN FOR QUEENSLAND: RESEARCH PAPER

Report to the Minister for Sustainability, Climate Change and Innovation.

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ABBREVIATIONS

ABARE - Australian Bureau of Agricultural and Resource Economics

BAU - Business as usual

CCD - Census Collectors District

CNG - compressed natural gas

CSG - coal seam gas

CSIRO - Commonwealth Scientific and Industrial Research Organisation

ESM - energy sector model

ETS - emissions trading scheme

GDP - Gross Domestic Product

GE - General Equilibrium

GSP - Gross State Product

GTL - gas to liquids

IC - internal combustion

IEA - International Energy Agency

LNG - liquefied natural gas

LPG - liquid petroleum gas

NESA - National Energy Security Assessment

NETT - National Emissions Trading Taskforce

OESR - Office of Economic and Statistical Research

PHEV - plug-in hybrid electric vehicle

PT - public transport

VAMPIRE - Vulnerability Assessment for Mortgage, Petrol and Inflation Risks and Expenditure

Executive Summary

In October 2007 a report from the Queensland Oil Vulnerability Taskforce was tabled in Parliament[1] (The Report). In the light of this Report, the Government has commissioned the development of an oil vulnerability mitigation strategy and action plan.

This research paper provides an overview of a range of critical issues relevant to the development of such a strategy, including: possible broad principles and approaches to manage the inherent risks and uncertainties surrounding the timing and net impacts of peak oil on Queensland; projections of Queensland's vulnerability to the potential impacts of peak oil, drawing on currently available data and modelling; and suggesting the further work required to evaluate and refine possible initiatives to reduce Queensland's vulnerability to rising/more volatile oil prices and to the potential supply disruptions.

Analysis to date of the possible impacts of oil demand outstripping supply suggests that:

- At a broad macroeconomic level, Queensland's rich resource endowments of gas and coal provide a natural hedge against the oil price outlook that would be consistent with a nearer term plateauing of global oil production. Absent a major global recession, the general upward movement in energy prices would be reflected in improved terms of trade, economic activity and higher government revenue for Queensland;

- Higher prices would likely generate adverse sectoral impacts for industry sectors unable to pass on these higher input prices to downstream markets and/or exposed to end markets that are particularly sensitive to higher oil prices (such as air transport).

For households, there is some evidence that such a high oil price environment could combine with other proximate factors (location and low household income) to generate adverse equity impacts that would require consideration in terms of offsetting policy measures.

Detailed modelling of the road transport impacts of high oil price scenarios indicate a major response in terms of reduced oil-based liquid fuel use, delivered primarily via sharply increased fuel efficiency and fuel switching. Further work is required:

- To test and validate these assumptions, particularly those that involve large scale capital investments under conditions of significant uncertainty about future oil and carbon prices;

- To develop and test policy packages in the transport sector for robustness, cost effectiveness and coherence in relation to reducing liquid fuel demand and CO2 emissions and meeting other policy objectives for the sectors.

[1] *Queensland's Vulnerability to Rising Oil Prices Taskforce Report* (April 2007)

Physical supply risks, impacts and mitigation options have not been evaluated via either economic modelling or detailed interaction with critically exposed sectors.

Initial analysis suggests that Queensland's coal seam gas (CSG) resource provides a significant source of liquid fuel diversification away from conventional oil, both via compressed natural gas (CNG) and gas to liquids (GTL). Further work is required to validate/evaluate options in this area compared with a range of other supply side options.

Most of the work to date has been drawn on existing sources of data without the benefit of input from agencies with detailed knowledge of key sectors outside the transport sector and with broader oversight of economic issues/expertise. Interaction with these agencies would:

- Assist in generating deeper understanding of sectoral exposures to oil risk and approaches to oil risk mitigation.
- Clarify possible risk management objectives in relation to oil price and/or supply risk.

Clarifying and delineating an oil risk mitigation strategy for Queensland requires an extension and deepening of analysis and evaluation of risks and potential mitigation measures involving:

- Macroeconomic and sectoral modelling to understand future risks/impacts with and without policy interventions;
- Consultation and joint working between the Environmental Protection Agency (EPA) and key agencies (Department of the Premier and Cabinet, Department of Tourism Regional Development and Industry, Treasury /OESR, Department of Mines and Energy, Department of Primary Industry and Fisheries, Department of Planning & Infrastructure); and
- Finalisation of a strategy and action plan.

1. Context and Purpose

In October 2007 a report from the Queensland Oil Vulnerability Taskforce was tabled in Parliament[2] (The Report). In the light of this Report, the Government has commissioned the development of an oil vulnerability mitigation strategy and action plan.

This research paper provides an overview of a range of critical issues relevant to the development of such a strategy. It does not purport to be an exhaustive model based analysis of the risks to Queensland arising from a peak oil environment, nor the full range of appropriate policy responses. As such it draws primarily on a range of existing data sources as a basis for:

- Briefly setting out the evidence base supporting concerns about peak oil, including developments since the Taskforce Report was completed, drawing on pre-existing modelling work undertaken by the Queensland Treasury;
- Suggesting some broad principles and approaches to manage the inherent risks and uncertainties in understanding the timing and net impacts of peak oil on Queensland;
- Presenting illustrative projections of Queensland's vulnerability to the potential impacts of peak oil, with a focus on the possible direct impacts on the road transport sector, on key macroeconomic variables and social/equity impacts; and

2. The Nature of the Peak Oil Challenge

The Taskforce Report found that most published estimates consider that conventional oil production is likely to peak between 2005 and 2010. Given continuing strong and largely inelastic demand growth, this implies upward pressure on oil prices, with the potential for steep increases and increased price volatility.

As the Report makes clear, there are very large uncertainties about when and how the impacts of peak oil might play out. Among other things, these uncertainties include:

- The resulting level of oil and other energy prices globally and domestically out into the future; and
- The implications for physical supply.

There is a wide range of views on the medium to long term outlook for oil and energy prices.

One view is that there will be an initial retreat from current levels and from there a gradual upward trend in oil prices as flat or declining supply intersects with strongly increased demand. Another places more emphasis on the short run elasticity of supply and demand with sharp upward movements in prices, accompanied by high volatility and, possibly, by absolute physical shortages of

[2] *Queensland's Vulnerability to Rising Oil Prices Taskforce Report* (April 2007)

fuel.[3] These different perspectives reflect differing underlying critical assumptions, for example the size and productivity of remaining conventional oil, the availability of substitutes for liquid fuels and the behavioural response to rising oil prices.

a. The impact of these changes on the global economy

Analysis by a range of international agencies, together with the experience with previous global oil shocks, suggests the general impact of a long term higher oil price would be to reduce economic growth. A price increase transfers income from oil-consuming to oil-producing nations. The net economic effect is negative. Industries in which oil and gas are a higher proportion of input costs will be relatively more affected. These include transport (particularly road and air transport), mining and metals, explosives and agriculture, unless they can pass the higher input prices on to final consumers.

For consumers, higher fuel prices are likely to have most effect on those who are highly reliant on car transport and lack alternatives. These people tend to be outer suburban residents and rural and regional communities on average or below average incomes.

For both industry and consumers generally, there is an added danger of the higher interest rates from monetary authorities' attempts to control the inflationary impact of the higher prices.

Partly driven by the differing views about oil price and availability over the medium term, there are also widely divergent opinions on the likely onset and intensity of these impacts. This will be a factor of:

- how soon the world oil supply plateaus;
- how steep the decline in oil supply is afterwards;
- what the price effect is of a shortfall in supply (which depends on the elasticity of demand - consumer response to changes in the oil price);
- how much support governments give to encouraging alternatives to oil;
- the response from global financial institutions to the massive income transfers created by higher oil prices; and
- most importantly, whether market signals are sufficiently clear and timely for the necessary investments in new technologies or other adaptations.

One view is that an unexpected rapid onset of much higher oil prices and physical shortages would result in major geo-political disruption, akin to but much more sustained and severe than those

[3] See, e.g., Shares Rally as Oil Continues to Fall; http://www.nytimes.com/2008/08/09/business/worldbusiness/09markets.html?_r=1&oref=slogin; Crude Oil Retreat, Sunrise or a Lull Before a Storm; http://energybulletin.net/node/46199; August 2008.

experienced following the 1967 and 1973 oil shocks.[4] Another is that the world would adjust relatively smoothly to changing relative prices of fuels, reflecting more informed economic management, the declining energy intensity per unit of gross domestic product (GDP) of many developed economies and the ability of markets to provide solutions.[5]

The implications of peaking conventional oil production will also interact with a broad range of political, technical, environmental and social change drivers. These include other macroeconomic factors (e.g. the evolving implications of the sub-prime debt problems), population growth, environmental stressors (such as climate change), urbanisation, geo-political shifts and continued technological developments (for example, the convergence of IT and biological and physical sciences). These will combine in highly uncertain and probably surprising ways and the overall net impact will also be heavily influenced by government policies and programs here and overseas.

b. Australia's vulnerability to oil shocks

Queensland's vulnerability to oil shocks is mediated through its position as a major component in the Australian economy. How a major oil shock would ramify through the Queensland economy will depend on both the underlying resilience of the Australian economy which in turn is a function of both the country's resource endowments and the strength of its political and social institutions. Reaching an informed view on Australia's vulnerability is not easy.

Recent published work evaluating the relative oil vulnerability of 26 net oil-importing countries places Australia at the low end of oil vulnerability risk.[6]

This analysis uses seven indicators to assess relative oil vulnerability[7]. Using the principal component technique the analysis combines these individual indicators into a composite index of oil vulnerability. The index is intended to capture the relative sensitivity of the selected economies towards developments of the international oil market, with a higher index indicating higher vulnerability (Figure 1).

Australia ranks lowest of the 26 countries. This reflects the combination of large domestic energy resources, low population and underlying strength of its economy and political stability. This assessment is based on 2004 data and will clearly change over time. For example, Australia's oil import ratio has risen over the past four years. Also it may not take fully into account Australia's

[4] See, e.g., Geopolitical Disruptions #1, Theory of Disruptions to Oil and Resource Supplies, August 2008; http://www.theoildrum.com/node/4373#more.

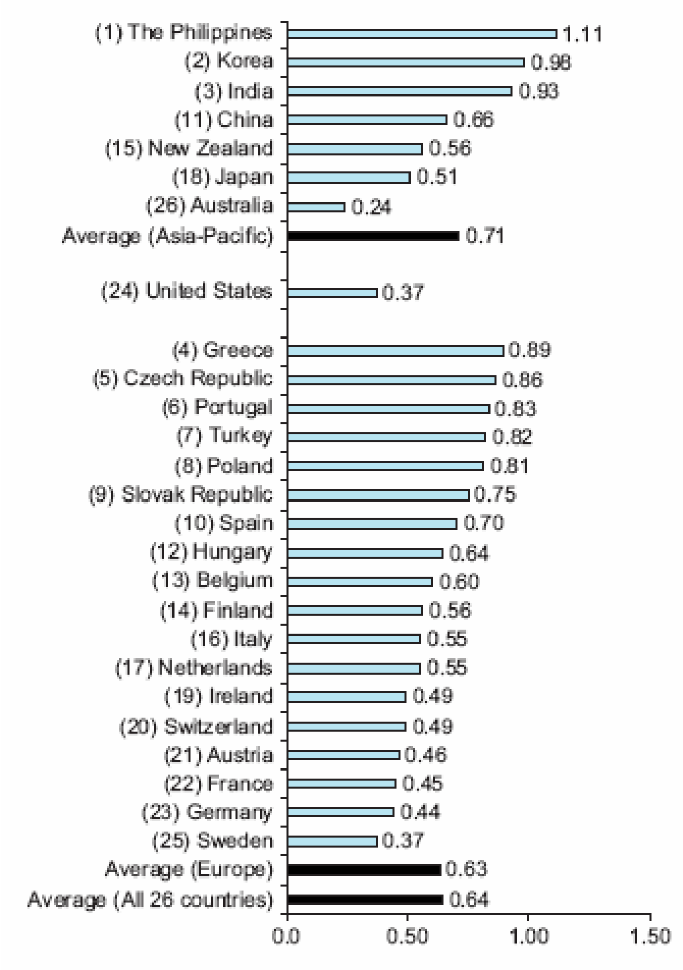
[5] See, e.g., Lovins, A .et al., *Winning the Oil Endgame*, Earthscan, London, 2004.

[6] "Oil vulnerability index of oil-importing countries": Eshita Gupta, The Energy and Resources Institute, India (Energy Policy 36, March 2008).

[7] These are the ratio of value of oil imports to gross domestic product (GDP), oil consumption per unit of GDP, GDP per capita and oil share in total energy supply, ratio of domestic reserves to oil consumption, exposure to geo-political oil market concentration risks as measured by net oil import dependence, diversification of supply sources, political risk in oil-supplying countries, and market liquidity.

potential exposure to stochastic supply shocks, particularly in relation to diesel where Australia is very dependent on Asian refinery capacity. On the other hand, recognised gas resources are likely to have increased over the same period.

Figure 1: oil vulnerability index of all 26 countries (2004)



3. Understanding the implications for Queensland

a. Challenges and opportunities

Queensland is part of the Australian and global economy and will therefore be affected by the changed level and pattern of Australian and world growth generated by sustained higher fuel prices outside historical experience. But, for the reasons discussed above, understanding how peak oil might play out for Queensland with any degree of precision is very complex.

Queensland's physical, economic and social endowments present both challenges and opportunities in a world of increasing constraints for conventional oil production and higher energy prices and potential disruption in physical supply.

The challenges include:

- The size and regionally dispersed nature of Queensland's population, leading to high dependence on personal vehicles, road freight and air travel.

- The current energy supply system which involves a high dependence on diesel generation for remote area power needs.

- The dispersed nature of Queensland cities, with lower income people located on the urban fringe.

- An economic structure with significant potential exposure to higher oil prices, in particular:

    - energy intensive processing operations that in turn reflects an inheritance of low cost energy supplies (particularly coal and gas);

    - food and fibre production that relies significantly in some cases on petroleum products; and

    - in-bound tourism that has been fostered by low cost domestic and international air travel.

The opportunities include:

- A diversified high quality natural resource base, including:

    - abundant and relatively low cost/high quality supplies of coal and gas (that will likely benefit from rising oil prices) and renewable energy potential (notably wind and geothermal energy); and

    - A large land mass with important areas of productive agricultural land and larger potential supply for second generation biofuels.

- A skilled and well educated workforce;

- An effective and fiscally sound government.

This is an important endowment Queensland can draw on to address critical risks and exposures that may come with peak oil.

b. Quantifying the impact on Queensland of sustained high oil prices

i. <u>Economy wide impacts</u>

For the reasons discussed above, forecasting the actual impacts on Queensland economy of the price and supply shocks possibly associated with the plateauing of oil supply is very difficult. This reflects the complex and dynamic nature of physical and economic systems at global, regional national or state level and the long timescales involved. It is not clear, for example, how these will translate for Australia into changed terms of trade, exchange rates, relative energy/commodity prices and hence the competitive position of key parts of Queensland's economy.

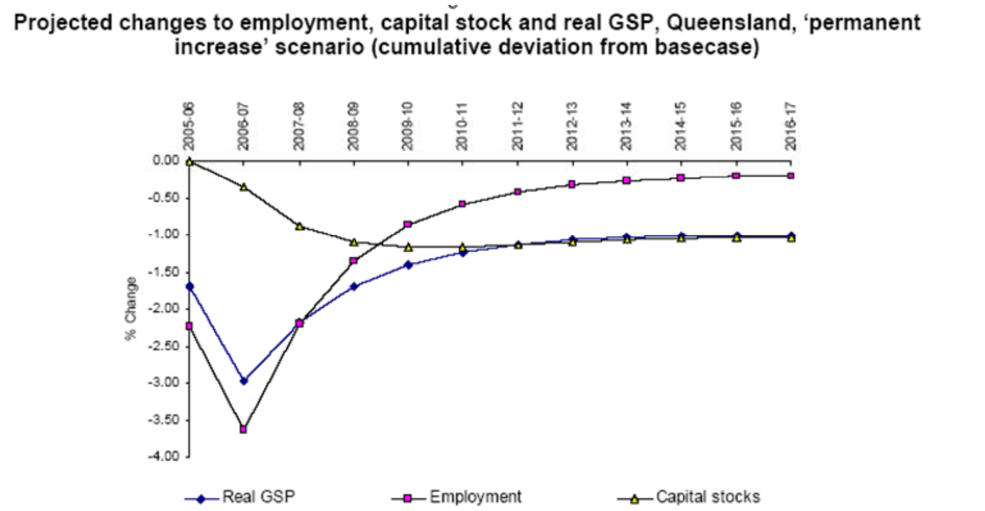
Broadly, however, the impacts of sustained and major increases in oil prices will impact Queensland's economy through three routes:

- the direct impact of higher fuel prices on operating costs and therefore output prices;
- lower real incomes arising from having to spend more on energy using activities, with resulting falls in real private and public consumption; and
- the effect of changes in Australia's terms of trade and thus the exchange rate – the direction of such changes is likely to vary between major trading partners so that the overall impact is unclear, as recent experience has shown. A depreciation would benefit the more trade-exposed industries.

Projections prepared by the Queensland Office of Economic and Statistical Research(OESR) in 2005 for the Queensland Government submission to the Federal Parliamentary Inquiry into petrol pricing examined the State wide and sectoral impacts of a permanent doubling of real oil prices (from US$30 to US$60/barrel.[8] This analysis showed an immediate major negative impact on Queensland Gross State Product (GSP), employment and investment/capital stock followed by some rebound as wages, prices and terms of trade adjusted to the new relative prices etc (Figure 2).

[8] Petrol Pricing in Queensland, Submission to the Impact of Petrol Pricing Select Committee, November 2005

Figure 2: Projected impact on Queensland economy of permanent doubling in the oil price



Projected activity changes for major affected Queensland industries, 'permanent increase' scenario (cumulative percentage deviation from basecase)

Positively affected	2016-17	Negatively affected	2016-17
Coal and gas	11.02	Retail trade	-4.73
Non ferrous ores	11.36	Health	-2.74
Meat	5.69	Education	-3.71
Beef cattle	3.13	Public administration	-3.00
Food products	10.06	Construction	-1.80

Source: Petrol Pricing in Queensland Submission to the Impact of Petrol Pricing Select Committee November 2005

At a microeconomic level, the projections indicated that those sectors least able to pass on the higher input costs suffered the largest negative impacts. The most adversely affected industry was air transport, for which activity was projected to be some 27% lower by 2016-17 than it would otherwise have been[9]. This was because air transport is the most fuel-intensive industry, and also because most of the exports that are assisted by the projected depreciation of the exchange rate do not use air transport. Conversely, water transport activity was projected to be some 12% higher than the base case level, because of its strong linkages with commodity exports. The impact on road transport was projected to be approximately neutral, because its core role in the domestic economy makes it relatively price-insensitive.

By contrast, trade exposed sectors were projected generally to benefit from higher oil prices because their sales compete globally with producers all facing the same increases and they also benefit from a falling exchange rate.

[9] This finding has been broadly borne out by airlines' recent experience with rising oil prices.

It is not clear how these projections square with the actual macroeconomic performance of the Queensland economy in a period when the oil price increase has greatly exceeded the modelled oil price movement. Modelling impacts is fraught with difficulty and needs careful specification to ensure robust and consistent assumptions.

The subsequent experience of oil prices rising threefold over the period 2005-2007 without a sharp disruption to the economy illustrates the challenges in the design and interpretation of such analysis. To date, the global forces driving oil price increases reflect rapid growth in China, India, Russia, Brazil and within some OPEC countries. The resulting broad growth in commodity prices and the deflationary impact of Chinese export prices have allowed the Australian and Queensland economy to maintain strong growth despite the rise in oil prices. That said, current levels of oil prices are contributing to inflationary pressures and exacerbating the fiscal and monetary management challenges created by the continuing fall out of the US sub-prime debacle.

As the OESR submission makes clear, for technical and time constraint reasons the projection did not model the effect of higher oil prices on the demand for coal or gas. Queensland's large reserves of coal seam gas (CSG) offer a potentially very significant economic hedge against rising global oil prices. Recent indications by a number of global oil and gas companies of an intention to establish liquefied natural gas (LNG) export facilities based on CSG provide the basis for a major new export industry whose prices will be directly linked to global oil prices at a time when Asian markets are short of LNG. [10]

Modelling is currently not available on the economic and budgetary implications of the development of a Queensland LNG industry. The size of the potential impacts, however, can be illustrated by reference to economic modelling carried out for the Pluto LNG project in Western Australia which is broadly consistent with scale of developments currently being discussed by proponents of CSG-based LNG projects (Figure 3). [11]

[10] In the last 3-6 months, global oil/gas majors (Royal Dutch Shell, Petronas and BG) have secured interests in Queensland's CSG resources, with Petronas and BG indicating an intention to develop LNG export facilities. It is not clear if Royal Dutch Shell's interest is in LNG or Gas to Liquids.

[11] Pluto LNG Development Burrup LNG Park Social Impact Study (Woodside Petroleum, March 2007) The production capacity of the initial LNG train will be 5 to 6 million tonnes a year. Planning has been done for future expansion. Current environmental approvals are based on LNG production of up to 12 million tonnes a year and provision for domestic gas supply.

Figure 3: Projected impact of Pluto Liquefied Natural Gas (LNG) project

Indicator	Value attributable to the development
Gross domestic product	$17.6 billion (NPV)
Gross state product (WA)	$28.6 billion (NPV)
Gross regional product (Pilbara)	$24.6 billion (NPV)
Employment – WA (direct and indirect)	
2007-10 average	Up to 4990 jobs
2011-23 average	Up to 4041 jobs
Employment – Pilbara (direct and indirect)	
2007-10 average	Up to 3223 jobs
2011-23 average	Up to 826 jobs
2024-35 average	Up to 287 jobs
Government revenue	
Commonwealth (including PRRT)	Increase of up to $8 billion (NPV)
WA state and local government	Increase of up to $445 million (NPV)

This analysis was carried out in March 2007 at which time Woodside presented illustrative revenue projections at oil prices in the range US$20-80/barrel. The onset of peak oil pressures would likely be associated with sustained oil prices well above the top end of this range which would in general increase the scale of investment in and output in CSG-based LNG capacity with commensurately larger benefits.

Given the linked nature of oil, gas and thermal coal markets, higher oil and gas prices would also be likely to translate into higher demand for Queensland coal exports (and some upward movement in prices), with broadly similar implications for GSP and government revenue growth, offset by the dampening effect on coal volumes associated with any system of international carbon pricing.

ii. Implications for equity

By contrast to the economic benefits from higher oil prices for the gas sector, there is ample evidence of the challenging equity implications of high oil prices for disadvantaged, low income groups. This is indicated by the 'Vulnerability assessment for mortgage, petrol and inflation risks and expenditure' generated at Griffiths University (VAMPIRE).[12] The VAMPIRE index measures the relative vulnerability of households to adverse socio-economic impacts due to the combined impacts of rising fuel prices, higher mortgage interest rates and general price inflation.

The Brisbane VAMPIRE index is constructed from ABS Census data on car use, mortgage tenure and income mapped to the level of the Census Collectors District (CCD). The area used in the analysis is

[12] Dodson and Sipe (2008) VAMPIRE 2006 Update, forthcoming paper, Urban Research Program, Griffith University.

the Brisbane Urban Area as defined by the ABS. Figure 4 (next page) shows the VAMPIRE for greater Brisbane in 2001 (a) and 2006 (b). Critical findings from this analysis include:

- There are strong geographic differences in oil and mortgage vulnerability across Brisbane. Where a household lives is therefore a critical factor in the experience of petrol and mortgage stresses;
- Inner and middle suburban areas are much less vulnerable to rising petrol and mortgage costs due to less car reliance and higher incomes;
- Households in new growth zones such as the Ipswich, Logan/Beenleigh, Capalaba and Caboolture corridors appear to be the most heavily exposed. Households in these areas are typically highly car dependent and have relatively lower incomes;
- High VAMPIRE exposure also appears to coincide with areas where public transport provision is poor. Outer suburban areas where public transport services are of lower quality are worse off than inner and middle areas, where public transport services are of good or high quality;
- Areas where oil vulnerability intensified the most over the 2001-2006 period were already the worst affected zones in 2001. The already highly oil vulnerable outer suburban growth corridors of Ipswich, Logan/Beenleigh, Capalaba and Caboolture saw the greatest relative increase in VAMPIRE scores;
- Suburbs less than ten kilometres from the Brisbane CBD show very little change in oil vulnerability over the 2001-2006 period;
- The 2001-2006 changes show that new outer-suburban growth areas in greater Brisbane almost immediately enter the highest petrol and mortgage vulnerability categories. These areas will be hardest hit by declining energy security/sustained oil price increases and its effects on petrol and food prices and interest rates;
- Those in the inner city appear to be protected from oil vulnerability because they are less car dependent, have higher incomes and better access to public transport. These areas will be less affected by declining energy security.

Figure 4: VAMPIRE locational analysis of equity implications of fuel prices in Brisbane urban area

Figure 4a: Brisbane 2001

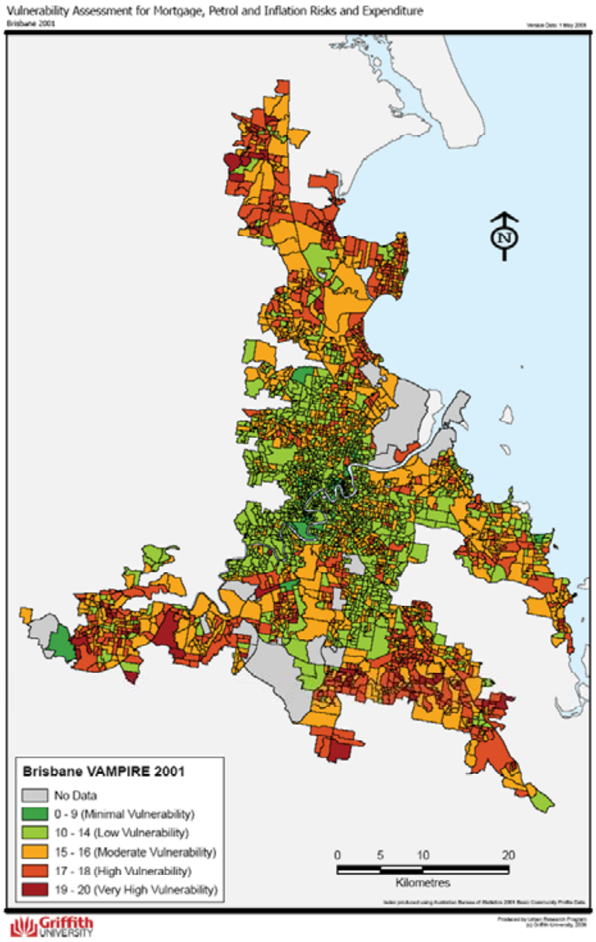
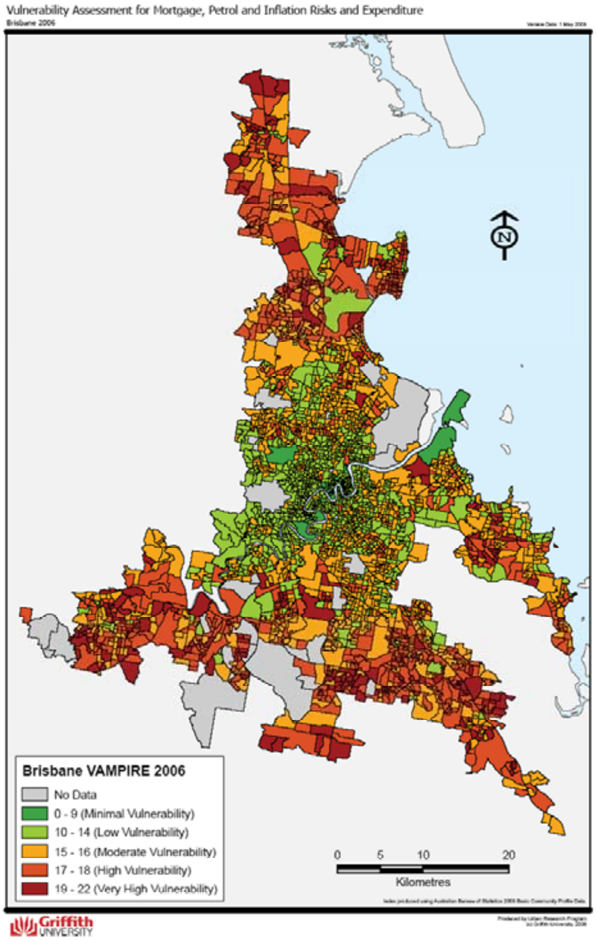


Figure 4b Brisbane 2006



This analysis of the equity implications has an urban/suburban focus and carries significant implications for Federal and State Government policies towards households/families on below average incomes facing the combination of higher mortgage/rental payments and transport costs. To support informed government decision making (e.g. in relation to transport provision), the work needs extending to other areas of Queensland. This would need to include both other urbanised areas and regional and remote areas that may be heavily reliant on oil.

This should include not only transport uses of oil but also remote power supplies and agricultural and horticultural activities. This would help identify those communities/areas particularly at risk from sustained high oil prices by virtue of their overall economic and social status and location, for example indigenous communities and other remote populations with limited or no ability to pass higher oil input costs via producer prices. The work would also need to take into account the impacts of carbon pricing.

4. Proposed policy making framework

a. Decision-making under uncertainty

As the range of outcomes associated with different oil price scenarios make clear, the essence of the peak oil problem is risk management. The risks involved are high if peak oil comes earlier than expected, or if Queensland cannot adapt quickly enough to the post peak decline.

In the face of these risks, Queensland (and other jurisdictions/countries) can take measures to deliver two broad outcomes:

- Reduced demand, for example through improved energy efficiency, fuel substitution and modal shifts away from road based transport; and/or
- Increased supply of liquid fuels, from either conventional resources and/or alternative ("non-conventional" sources).

Where governments choose to act will reflect the potential scale, cost and benefits of different measures to reduce liquid fuel demand, the particular endowments of their economy and their jurisdictional responsibilities. The timescales associated with different action also vary significantly, pointing to the need to understand the optimal mix of policies and measures that promote anticipatory action while maintaining necessary flexibility to manage surprises.

b. Principles underpinning the development of strategy

Against this background, it is proposed that the Government should evaluate any policies and measures for inclusion in an oil risk mitigation strategy/action plan against the following principles:

- Complementarity/multiple benefits – does the measure support or help deliver other critical policy objectives or does it conflict with critical policy objectives?
- Presence of market failure/public goods – does the measure address evident market failures or the presence of public goods that would otherwise lead to underinvestment by the private sector in liquid fuel supply or demand reduction measures?
- Cost effectiveness – what is the potential cost of the measure, e.g. the budgetary impact, the dollar cost per barrel of oil use avoided associated with the measure?
- Scale – does the measure, separately or in combination with other, make a significant contribution to reducing liquid fuel use?
- Equity – does the measure effectively address evident equity issues, such as disproportionate adjustment costs falling on people least able to afford or adapt to significant oil price increases?
- Efficiency in resource use – will the measure tend to encourage/discourage efficient use of scarce resources?

- Facilitating change – will the measure support necessary structural reform to adjust the economy to the impacts of higher liquid fuel prices?

- Implementation timescales – how quickly can the measure be implemented and when will it make a substantive contribution to risk mitigation, given the current technological and commercial maturity of the option?

- Political/institutional responsibility and capacity – what is the appropriate level of government to implement the proposed policy or program?

5. Suggested analytic framework for Queensland

The application of these principles would need to be underpinned by a strong quantitative and qualitative evidence base at both macroeconomic and sectoral level. The suggested approach is set out below.

a. A macroeconomic perspective

A starting point for Queensland (and possibly Australia) would be consideration of what would be the acceptable costs to macroeconomic growth of an oil supply shock (whether via price or physical supply disruption) in terms of GSP forgone, say a loss of no more than 1% of GSP over a one year period from the onset of the shock. The starting assumption could be that beyond this impact some form of insurance would need to be put in place to bring any affects back within the defined limit.

This would require specifying a number of oil supply shock scenarios (global macroeconomic context for the shock, scale, length of time, price impacts etc) and then running them through the Government's General Equilibrium model of the Queensland economy to identify:

- the overall impact on critical macroeconomic variables (GSP, employment, prices);

- the impact on major sectors of the economy; and

- desirably, the implications for regions.

Building on work already completed as input to peak oil analysis, this would provide a clear measure of the resilience of the Queensland economy to such shocks and the distributional implications. For trade exposed sectors, oil price risk would generally be naturally hedged since their international competitors would be subject to the same input cost pressures and would be able to pass these costs on to the final consumers. But the modelling would also capture the potentially disruptive effects of lost output from physical shortages of product.

A starting point for this approach would be to run a range of scenarios through the macroeconomic model used by the Queensland Treasury, looking out to 2030.[13] These could include:

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[13] The EPA has been in discussion with OESR about running such scenarios but this work has been precluded to date by the demands of the modelling tasks being undertaken for the Garnaut Review.

- Business as usual (BAU) i.e. the current Treasury/OESR medium term projections and oil price assumptions

- Different oil price assumptions consistent with a more constrained oil supply outlook, such as:

    - A flat real oil price of US$100bbl out to 2030;

    - A sharper escalation in oil prices i.e. from 2008-15 US$100bbl real; from 2015-2020, US$150 real; and from 2020-2030, US$ 200 real;

    - 2b above but with scenarios involving physical shortages of oil leading and associated physical and economic disruption to critical end use sectors (such as transport, mining etc).

BAU would reflect current assumptions about the path of energy prices, terms of trade, future industry structure and employment GSP. It should exclude the potential growth in an LNG export industry or Gas to Liquids projects. Given the current direction of greenhouse policy, the remaining scenarios would test different trajectories for oil prices and the introduction of an Emissions Trading Scheme and the resulting flow through effects to other commodities which Queensland has in large resources. The BAU projections would assume no flow on benefits to Queensland from higher gas and coal prices. The other scenarios would, however, test the macroeconomic impacts of Queensland's gas production and prices movements consistent with the scenarios, including the implications for LNG or other gas conversion technologies and with coal demand/production and prices responding to the global oil price assumptions.

b. Oil Demand – a sectoral perspective

To complement the macroeconomic perspective, initial analysis has been undertaken:

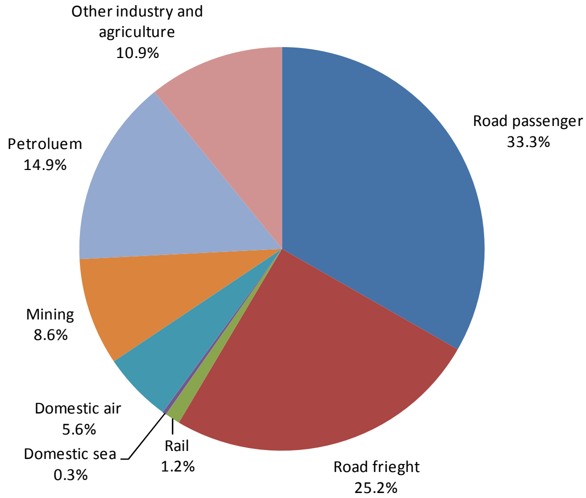
- To understand in broad terms the possible growth trajectory and make up of oil demand in Queensland under business as usual – this has been prepared by Heuris Partners, based on official Queensland long term growth projections for gross state product (GSP) and population to drive projections of sectoral oil demand based on historical relationships between GSP, demographics and oil demand; and

- The impact of the different oil price assumptions set out in the four macroeconomic scenarios described in section 5a above on the road transport sector which currently accounts for some 60% of oil demand (Figure 5) – this modelling has been undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), using their Energy Sector Model which generates projections of sectoral and state based energy demand for the Australian economy.

    - The modelling addressing road transport oil demand has been formally commissioned by the Queensland Department of Transport (QT) as an input to their evaluation of the impacts of different demand management and other measures on the road transport task.

- Heuris and QT have worked together with CSIRO to agree on the critical input assumptions to the model, notably the global oil price, to provide insights into the oil vulnerability and adjustment issues relevant to Queensland associated with a future of sustained, high real oil prices.

Figure 5: Queensland oil use by sector: 2006



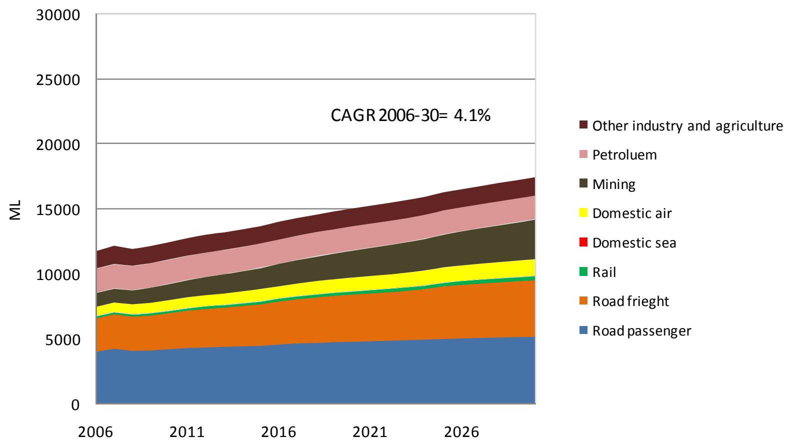
This next section summarises the results of this assessment on a Business as Usual basis (i.e. without measures), addressing the possible evolution of total oil demand (based on Heuris projections) and then focuses on road transport oil use, which is the largest liquid fuel-using sector, generated by the CSIRO modelling. The underlying purpose of this high level analysis is to understand the likely response of Queensland oil demand in a critical liquid fuel using sector to different oil price trajectories.

c. Queensland's oil demand without additional measures

i. <u>Total oil usage</u>

The Business as Usual (BAU) scenario involves a world without carbon pricing and with oil prices falling from current levels back to a real long term price of US$60/barrel. Based on these assumptions, total oil usage in Queensland is projected to increase by 50% between 2006 and 2030, from some 11,700 million litres (ML) to just over 17000ML in 2030. The largest absolute increases are in road passenger, road freight and mining usage (Figure 6). Passenger growth is driven by rapid population growth but assumed to be constrained later in the period as car ownership and usage plateau. Freight and mining usage is a function of continued strong growth in GSP/mining output[14].

Figure 6: BAU total oil demand 2006-2030 (Source: CSIRO & Heuris projections)



ii. Total road transport usage

Total transport usage is projected to increase by 50% by 2030, from some 7300ML to over 11000ML (Figure 7).[15] Underlying fuel efficiency for road transport is assumed to improve by about 0.5% a year (i.e. at the rate indicated in the Australian Bureau of Agricultural and Resource Economics (ABARE) energy projections to 2029/30).

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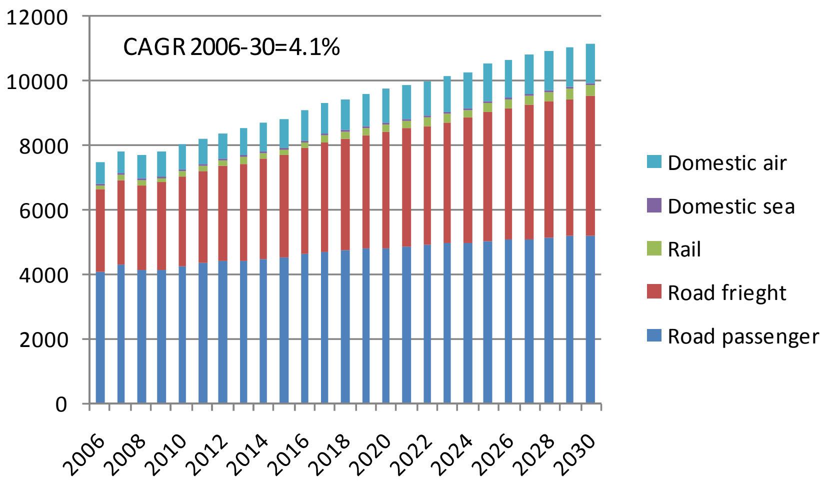
[14] These projections comprise road transport figures generated from the CSIRO's ESM model while the other sectors projections are generated by Heuris regression analysis based on the past relationships between oil use and GSP, population growth etc. The overall picture should therefore be treated as provisional and illustrative.

[15] These numbers reflect a mixture of ABARE projections (Australian Energy: national and state projections to 2029-30; ABARE update, Dec. 2007) and CSIRO modelling using their Energy Sector Model to derive more detailed projections and scenarios for the road transport sector.

Figure 7: Queensland's transport oil demand, 2006-30 (million litres)



The sectoral make up in liquid fuel usage shifts somewhat to freight over the period with marked increases in rigid and articulated trucks share of fuel use, offset by a declining proportion of passenger car usage (Figures 8 and 9). This reflects the impact of an assumption of continued strong GSP growth over the period and levelling off of car ownership/use.

Figure 8: road passenger and freight use 2006-2030 million litres (ML)

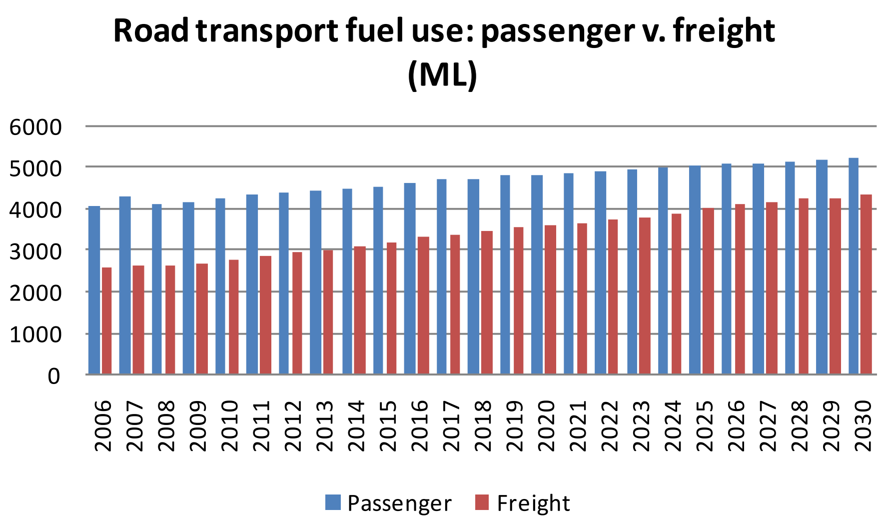
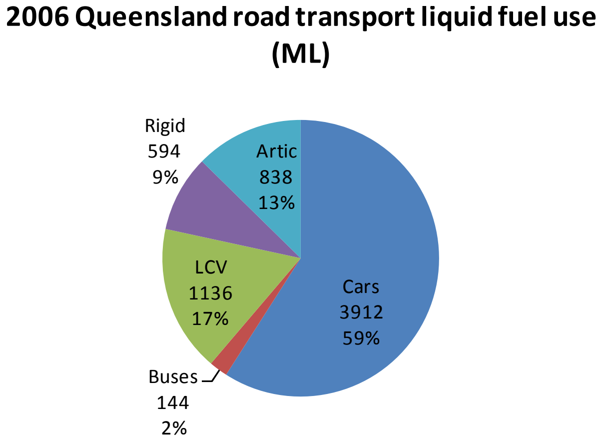
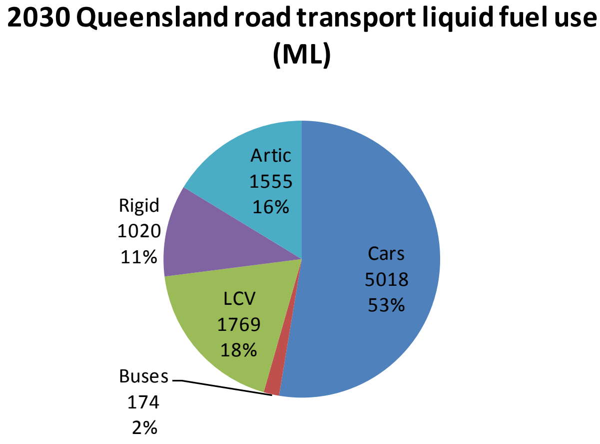


Figure 9: Change in the size and composition of Queensland's road transport liquid fuel use (million litres)

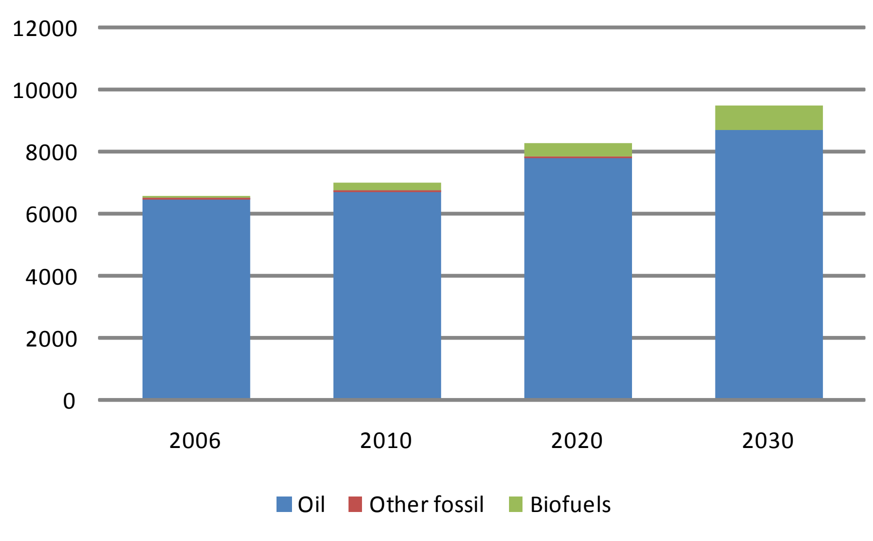




iii. <u>BAU liquid fuel composition</u>

Under the BAU scenario, transport remains heavily dependent on oil-based fuels, with biofuels comprising some 5% and 9% of usage in 2020 and 2030 respectively (Figure 10).

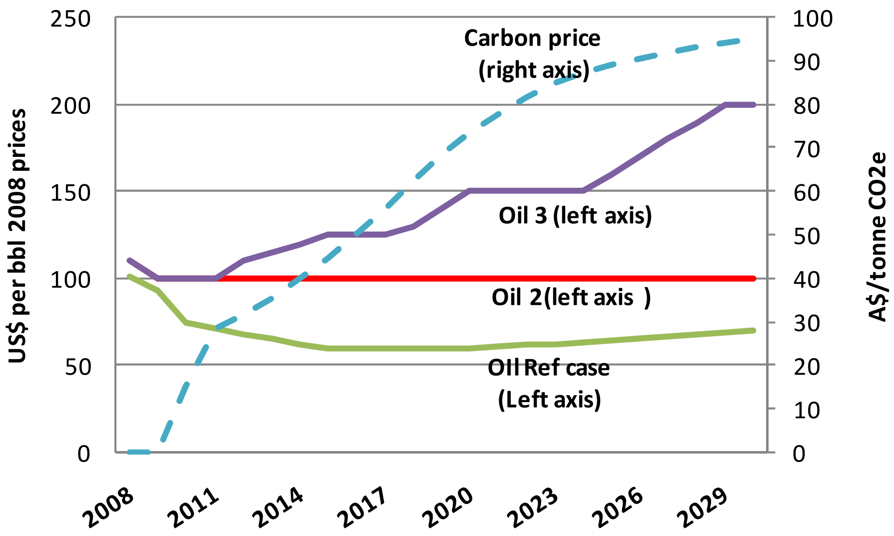
Figure 10: BAU composition of road transport liquid fuels – 2006-2030 (ML)



c. Implications of carbon pricing and higher oil price scenarios for liquid fuel usage

In addition to the BAU case, CSIRO have modelled three sets of projections for road transport demand using the oil and carbon price parameters shown below which broadly reflect the proposed macroeconomic scenarios proposed in section 5a above (Figure 11).

Figure 11: Oil price scenarios and carbon price projections



The oil reference case is generated from work for the National Emissions Trading Taskforce (NETT) undertaken by the States & Territories in 2006 and 2007 and reflects CSIRO's default oil price assumption used to test the impact of the introduction of an emissions trading scheme (ETS) on energy demand. Scenarios 2 and 3 have been modelled to test the impact of sustained higher oil prices – Oil 2 involves world oil prices at flat real US$100/barrel over the period to 2030; Oil 3 models the impact of real oil prices increasing progressively to $150 and then US$200/barrel through to 2030.

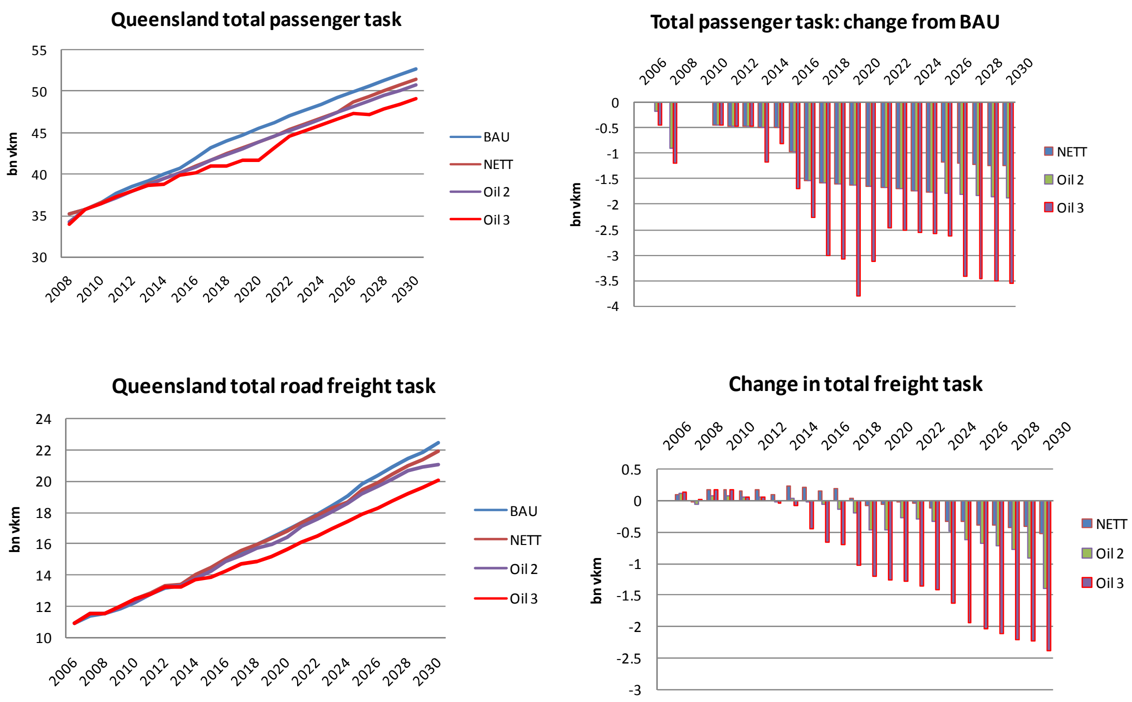
All three scenarios include the impact of the introduction of carbon pricing on the trajectory shown in Figure 9, i.e. the introduction of an ETS from 2010 with carbon prices operating at the level the model estimates will be required to deliver a 60% reduction across the Australian economy as a whole by 2050, i.e. not the transport sector alone. (For brevity's sake the oil reference case is labelled the NETT case in subsequent graphs.)

i. <u>Impacts on travel behaviour – vehicle kilometres (vkm)</u>

The analysis indicates the relatively insensitive nature of travel demand to price: the introduction of carbon pricing at the level indicated in Figure 11 reduces total passenger vkm by 2% below BAU in 2020; the imposition of a higher oil price - $150 real in 2020 – increases the reduction against BAU to 8%. These numbers become 2% and 7% by 2030, even with an oil price of $200 (Figure 12).

Freight demand shows a similar pattern. The introduction of carbon pricing alone reduces BAU by about 2% from 2020 onwards; the sharply higher oil price in the Oil 3 case results in a 6-8% reduction in demand on average against BAU over the period.

Figure 12: Queensland transport task (vehicle kilometres (vkm)



These results need to be treated with caution since they reflect assumptions in the CSIRO model about the response of passengers and freight carriers/users to rising oil prices (whether in combination with carbon prices or not). Evidence from past research indicates that a 10% increase in fuel prices usually results in only a 1%-3% decline in travel.[16] Many individuals have few choices about the mode and distance they travel, once they choose their location of residence and work. If they do have a choice, fuel costs may be a small factor in their decisions.

Increases in fuel costs, however, may encourage the purchase of vehicles with better fuel economy or, possibly, switching to alternative fuel vehicles that can run on a less expensive fuel. Therefore, fuel consumption and emissions of CO_2 may be more responsive than travel to changes in fuel prices over the medium/long term. It is also possible however, that much larger changes in travel behaviour might take place if oil price increases are much greater and more sustained than in the past (as they might be in response to strong decline rates in oil production), particularly if supported by additional measures such as non-road transport infrastructure development.

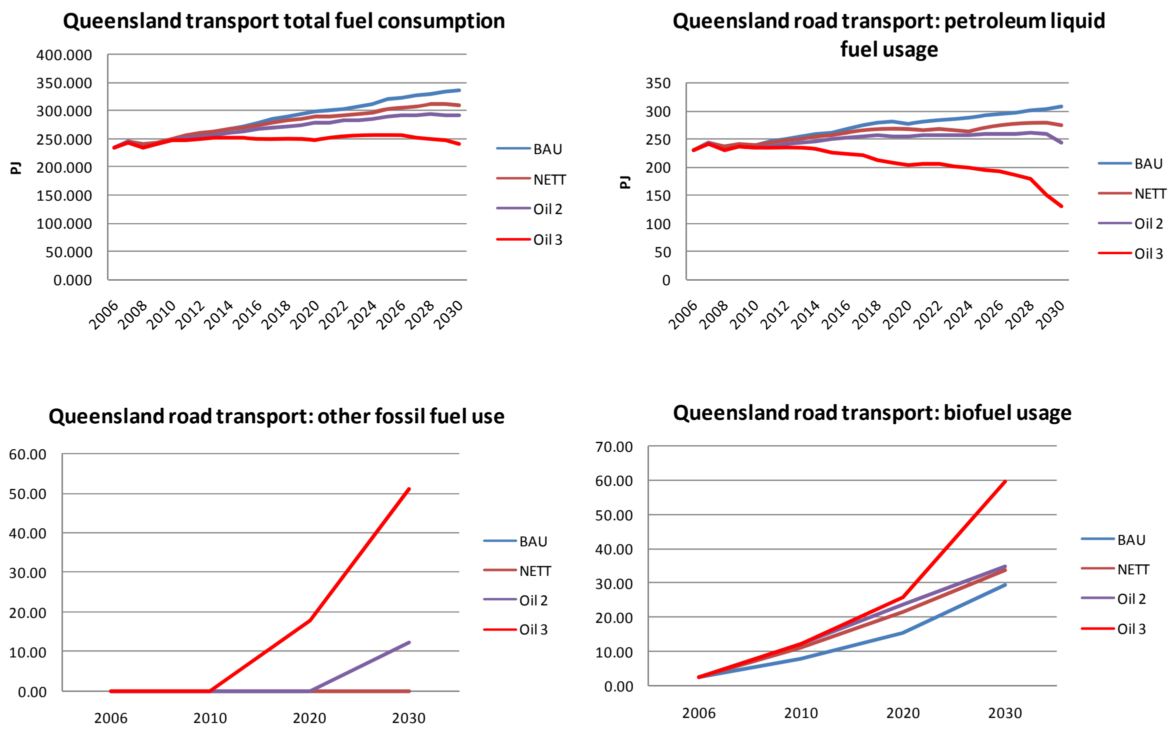
[16] Within the ESM, price elasticities for demand have been assumed based on data available from the Transport Elasticities Database Online available at http://dynamic.dotars.gov.au/btre/tedb/index.cfm. For road transport these are generally in the range of -0.2. In ESM CSIRO assume that for large changes in price (more than 50 percent difference from current levels) the price elasticity for passenger vehicles more than doubles to around -0.4 to -0.7 depending on the vehicles size. Heavy vehicle owners are expected to have a higher elasticity because they have a greater exposure to non-fixed costs (e.g. fuel) in their total transport costs.

ii. Impacts on liquid fuel demand/mix

The low price elasticity of demand for transports services is reflected in the impact of different pricing scenarios on total liquid fuel demand. In all but the highest price scenario, total liquid fuel demand continues to increase over the period to 2030 (top left graph, Figure 14). Even in the Oil 3 scenario, total liquid fuel demand remains static over the period.

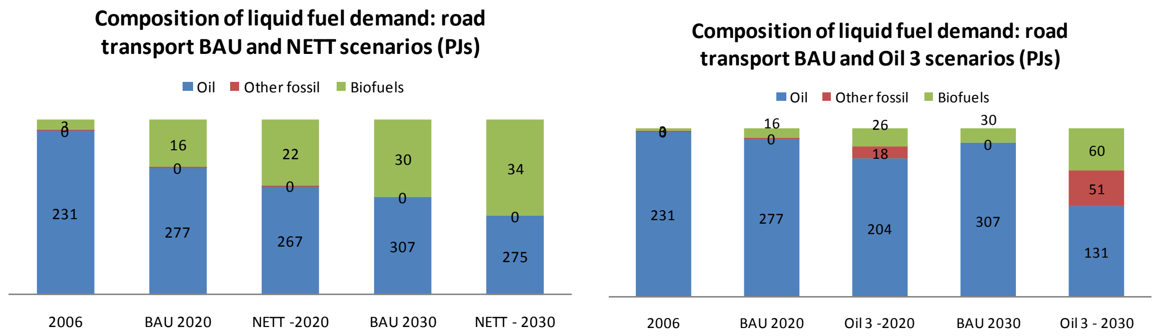
Price, combined with carbon pricing, has however a significantly larger impact on fuel mix. In the high price scenario, oil based fuel demand drops by some 12% by 2020 and over 40% by 2030 (Figure 13, top right graph). This reduction primarily reflects a switch in liquid fuel mix to: other fossil fuels (early on to compressed natural gas (CNG) and, towards the end of the period, gas to liquids (GTL)); and biofuels in the form of ethanol and biodiesel (the modelling in all non-BAU cases assumes the introduction of the 5% ethanol mandate).

Figure 13: Queensland's fuel demand and mix in the different scenarios



The differing composition of liquid fuel mix under a NETT with the current oil reference case and a high oil price is shown in Figure 14.

Figure 14: Liquid fuel mix in different price scenarios



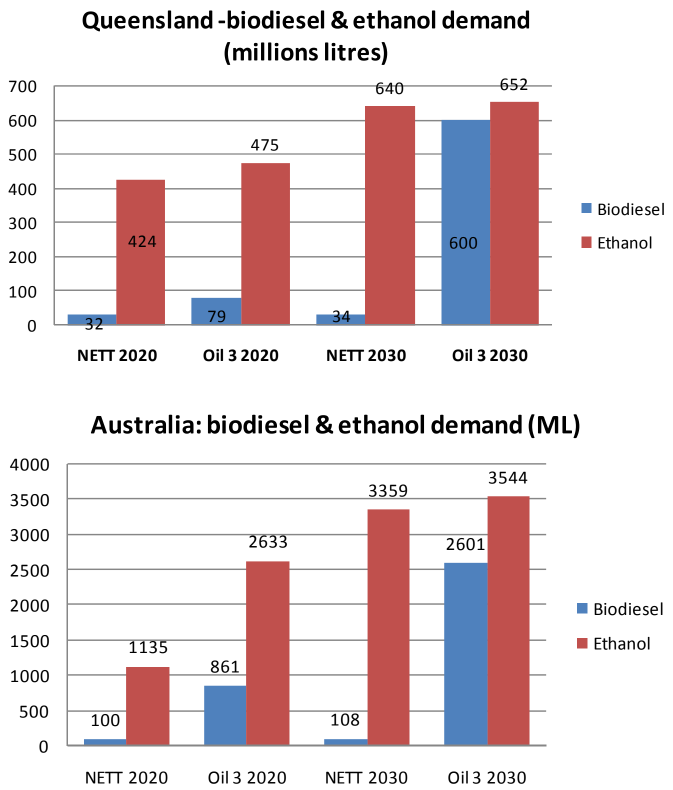
In a medium oil price world with an emissions trading scheme (ETS), there is a small increment in biofuels usage over BAU in both 2020 and 2030. In the highest oil price case (with an ETS), by 2020 some 44 petajoules (PJ) of liquid fuel demand is met by non-conventional sources (17% of the total on an energy basis), rising to over 100PJ by 2030 (46% of total demand, of which biofuels meets 25% and other fossil fuels 21%).

d. Non-conventional fuels in more detail

i. Biofuels

Figure 15 shows the implications of the ETS and high oil price scenario for biofuels converted to mega litres for Queensland and nationally. The growth in ethanol usage is relatively insensitive to the ETS/reference oil price case and the high oil price case. By contrast, the sustained higher oil price case has a major stimulatory effect on biodiesel usage, doubling against the NETT case in 2020 for Queensland and increasing more than eightfold nationally. The impact is even more marked by 2030.

Figure 15: Biofuel liquid fuel supply (ML): Queensland & the national picture

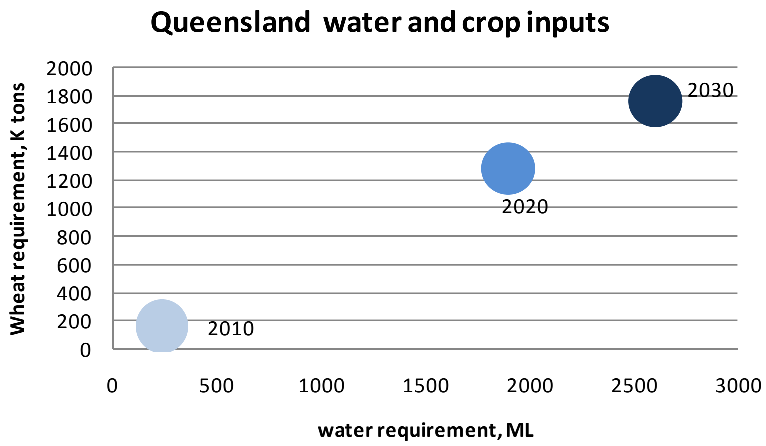


The biofuels assumptions as to cost and supply are critical to the model results and for managing price and supply risks (e.g. environmental/water constraints). In summary, over the next decade biodiesel supply is assumed to be constrained to some 5% of that potentially available from feedstock because of competition with food production (equivalent to some 160ML). Total available ethanol is forecast to be some 10000ML, with about one third of this available from waste starch/wheat at a production cost of 35cents/litre (c/l). Larger volumes (from grain and sugar) are assumed to be available at production costs of 100-110c/l. Lignocellulosic feedstock for ethanol is assumed to be available after 2020 at costs below grain/sugar.[17] Prices of all biofuels feedstocks are assumed to decline by 25% from 2020.[18]

The large differential between the NETT and Oil 3 scenario in relation to biodiesel would appear to reflect the commercial headroom created by the latter's supportive price environment for canola – based biodiesel that has an estimated cost of production of some A$1.60/litre. Ethanol is cheaper to produce at scale with grain and sugar based production costs of between A$1.00-1.10/litre, even without assumed second-generation supply from crop and wood wastes.

Ethanol capacity in Queensland is forecast to increase to 170ML by 2009, driven by an assumption of a more aggressive alternative fuels policy, compared with a mandated 5% requirement for 2010 of some 160ML. Delivering the required supply in the high oil price case from Queensland sources therefore involves more than doubling of projected capacity over the period 2010-2020. The most prospective feedstock for this expansion initially would likely be a mixture of wheat and sorghum. Current combined production of these crops would support just under 400ML of ethanol. To support such an output would require the diversion of both wheat and sorghum from export markets. Further analysis is required to understand the potential availability of feedstocks to support this level of ethanol output and the environmental and natural resource implications of alternatives (Figure 16).

Figure 16: illustrative ethanol resource draw - high oil case

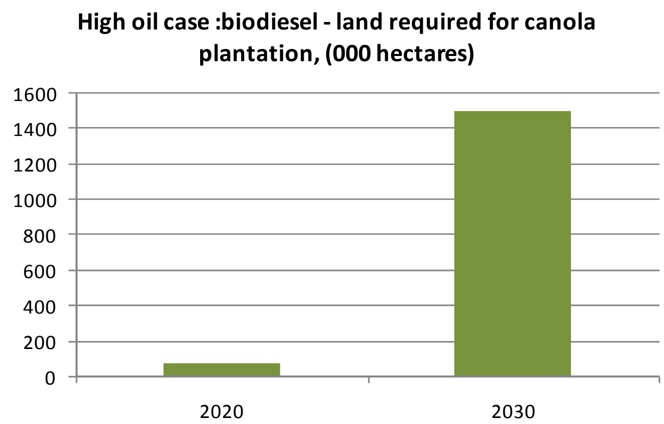


It is also not clear how the current trajectory of food prices will affect the economics and relative commercial attractiveness of biofuels feedstock prices and how these square with the assumptions underlying the CSIRO modelling.

[17] Claims for the commercialisation of lignocellulosic (2nd generation) ethanol need careful scrutiny given the substantial period over which commercialisation has been claimed to be imminent.
[18] ESM transport modelling assumptions (CSIRO, May 2008): decline reflects in part the assumed introduction at scale of 2nd generation ethanol.

Current biodiesel capacity in Queensland is some 190ML, about a third of what would be required to deliver the supply implied by the high oil case scenario. (Capacity utilisation at present is very low - about 20ML - resulting from very high input costs of tallow and palm oil.) Existing feedstock sources within Queensland would be unlikely to provide a basis for meeting this demand (see Figure 17 below which provides a purely illustrative projection of the possible land requirements to meet canola based biodiesel requirements).

Figure 17: land required to supply Queensland biodiesel to 2030 (Source: Heuris projection**)**



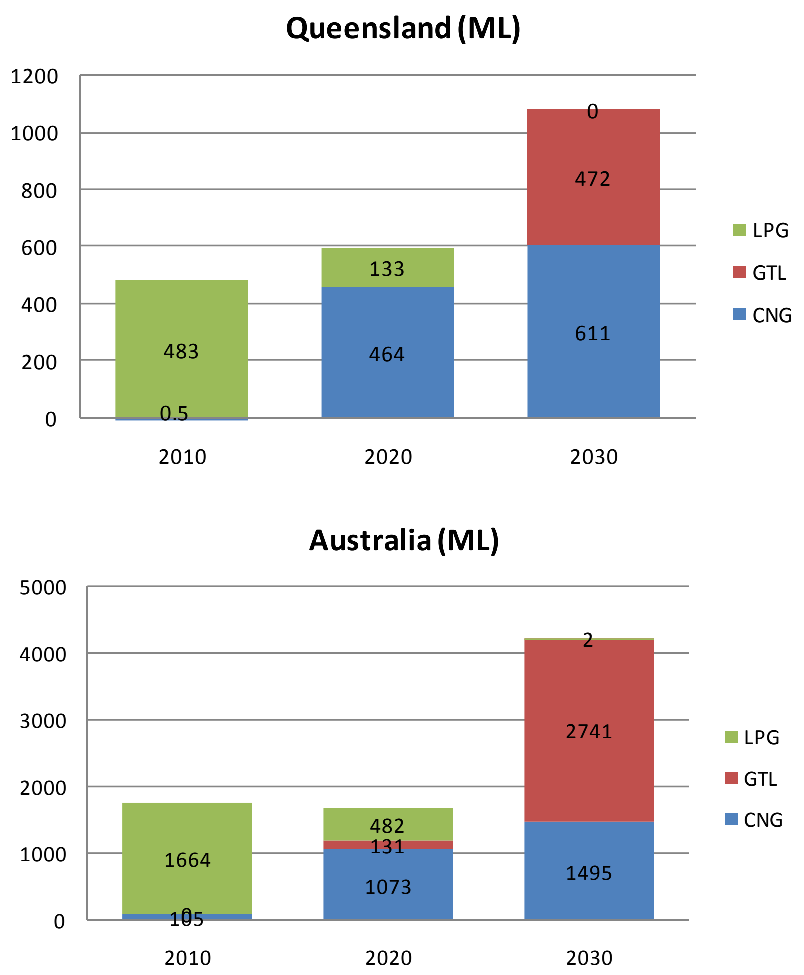
Potential alternatives suitable for Queensland cultivation have been identified but further analysis is required to determine their commercial viability and environmental suitability.

More generally, further work is also required to understand the full cycle greenhouse and other environmental impacts of biofuels in the Queensland and Australian conditions in the light of concerns raised about the costs and benefits of alternative fuel types and feedstocks. This analysis needs to take into account the increasingly close linkages between food/fibre and energy prices in response to greenhouse pressures and secular increases in oil and gas prices as intermediate inputs into agricultural production systems.

ii. <u>Other fossil fuel sources</u>

Currently liquid petroleum gas (LPG) dominates non-conventional fossil fuels for the transport sector. But this is supply constrained over the medium/longer term. A high oil price environment with carbon pricing therefore induces a significant switch from oil-based fuels to non-conventional sources. Compressed Natural Gas (CNG) largely replaces LPG out to 2020. Gas to Liquids (GTL) – in the form of low sulphur diesel – enters the market towards the end of the period, accounting for some 40% of non-conventional fossil fuel in Queensland in the sector by 2030 (Coal to Liquids supply does not take market share until 2035). The GTL switch is even more marked at national level, accounting for 65% of supply from this sub-sector (Figure 18).

Figure 18: high oil price case: other fossil fuels – Queensland & Australia

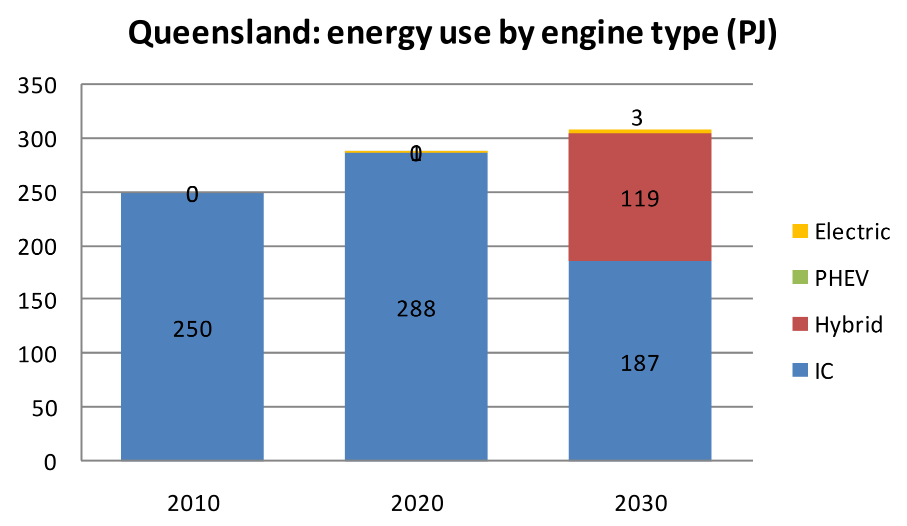


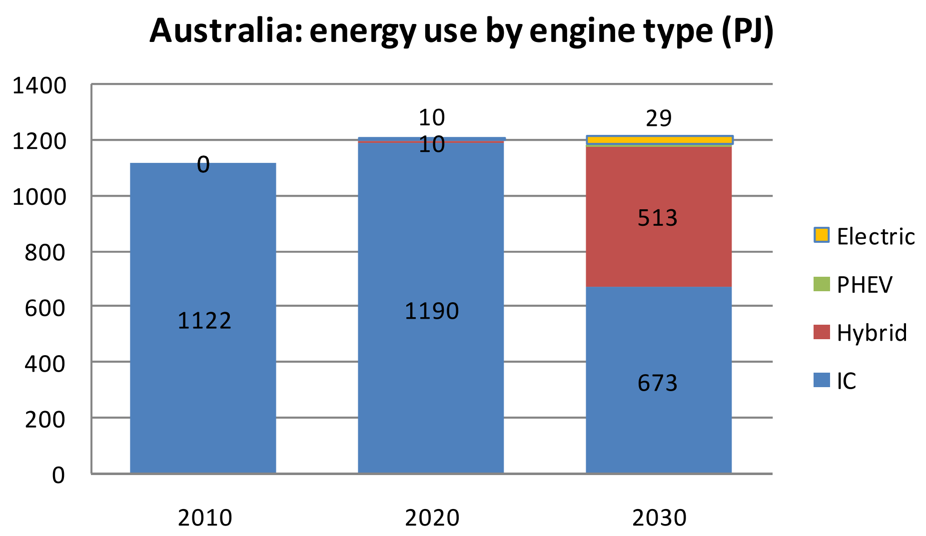
The projected level of GTL transport fuel demand in 2030 would equate to some 8000 barrels of product a day. At current construction costs, this would involve an investment of some A$850 million. The Australian capital roll out would be commensurately larger.

e. Engine technology choices in the high oil price scenario

The engine configurations allowed for in the CSIRO modelling are: internal combustion (IC), Mild hybrid internal combustion-electric (Hybrid), Plug-in hybrid electric (PHEV) and full (100 percent) electric (Electric). The impact of high oil prices is to induce the take up of mild hybrid technology by 2030 to around 40% of total fuel use (Figure 19).

Figure 19: High oil price case: impact on engine technology choices

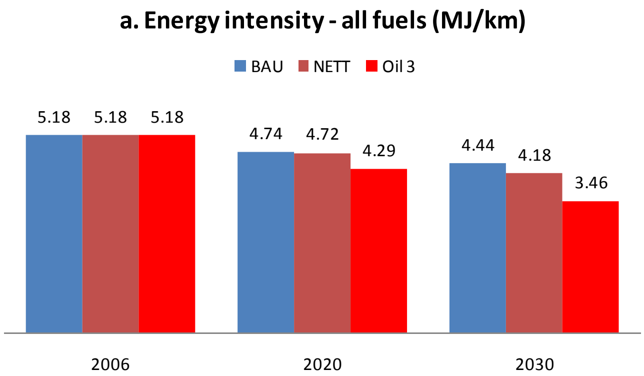


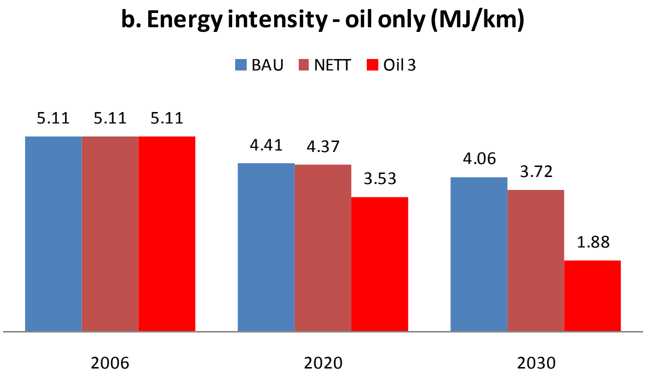


f. Transport oil vulnerability – what the modelling is showing

At an aggregate level, the model results for an ETS and higher oil prices generate a significant reduction in the overall energy intensity of the transport task in Queensland (Figure 20a). In the highest oil price scenario – broadly consistent with a plateauing of world oil production – the oil intensity of the transport task falls by over 60% by 2030 (Figure 20b).

Figure 20: trends in energy intensity of Queensland transport task

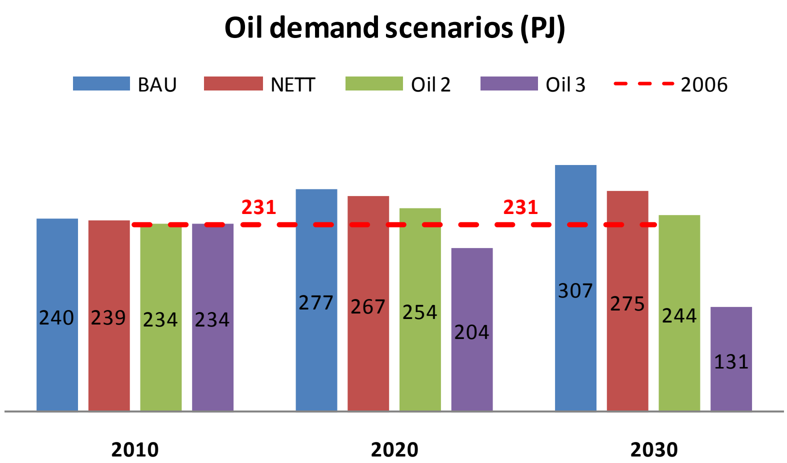


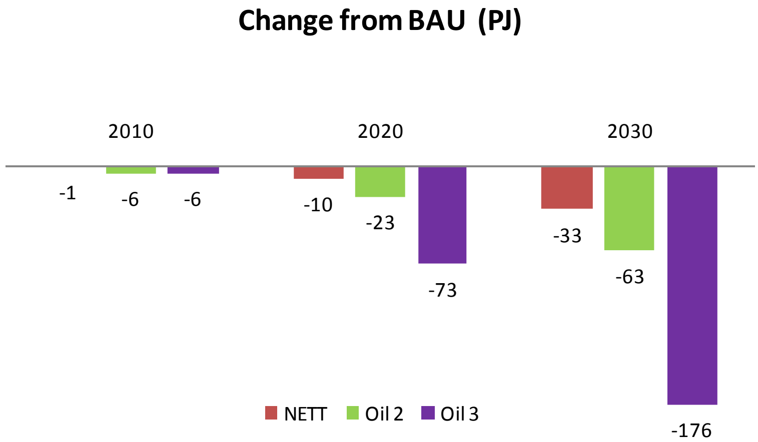


These shifts primarily reflect the impact of changes in drive train technology across the freight and passenger fleet and fuel switching generated by higher oil prices, together with a smaller element of demand destruction.

These impacts underpin Queensland's projected demand for conventional oil-based fuels under the different pricing scenarios (Figure 21). Under the highest oil price scenario, by 2020 oil demand in the road transport sector is some 70PJ lower compared with BAU and 60PJ lower than the NETT scenario. By 2030 these numbers increase to 176PJ and 140PJ respectively. Compared with the 2006 actual consumption, the highest oil price scenario results in a projected outcome that is 100PJ less than the figure for 2006.

Figure 21: road transport sector's oil demand under different scenarios





6. Implications of the modelling for oil supply risk and uncertainty

The scenarios modelled suggest that the Queensland (and national) road transport sector could adjust over time to sustained high oil prices and carbon pricing in a way that would significantly reduce demand for oil based liquid fuels, with price doing most of the heavy lifting. In the highest price case - which seems broadly consistent with a world where oil production reaches a plateau in the face of continuing growth in demand - this results in conventional oil-based liquid fuel demand of some 60% of the current level.

There remain, however, two critical considerations. These are, firstly, the uncertainties and limitations inherent in the model structure and its use; and, secondly, the acceptability from a policy perspective of the risk profile generated by the model results and their interpretation.

On the first point, there are a number of uncertainties surrounding critical assumptions in the model, for example:

- The continuation of historically low levels of price elasticity of demand for transport in the face of continued real increases in oil prices:
    - Recent evidence in the United States suggests that oil demand in developed economies with relatively high levels of car ownership may respond more sharply to both the experience of and belief in sustained higher oil prices (compared with developing economies where income effects tend to overwhelm price).

The modelling also assumes little or no diversion of passengers or freight from road to rail and quite limited passenger modal shifts to buses:

- Recent experience in Australia suggests significant public transport (PT) demand response to increased petrol prices In aggregate terms which is already having implications for capital and recurrent spending in PT systems and which may be understated for higher oil price environments.

The availability/continuity of supply is also a strategic issue – particularly of diesel (which is assumed to become increasingly important for the passenger sector for fuel efficiency reasons) and, from 2020 onwards, biofuels and GTL diesel. Under the CSIRO modelling, as long as production costs are covered by the fuel prices, and the appropriate vehicles are available, it is assumed that the fuel volumes demanded will be supplied to the market. The critical issue here is the risk from an investor perspective generated for capital intensive projects by government policy (for example, carbon pricing) and price uncertainty. In the face of significant uncertainty investment in alternative fuels will only occur if risk adjusted returns are expected to exceed costs by a large margin.

In addition:

- The model does not address risks to conventional diesel supply arising from the current outlook for Australian refining capacity and the domestic crude oil mix (which is not generally suitable for diesel production).
- It is also not clear whether there are potential economic and/or environmental constraints to major expansion of biofuels production and GTL capacity over the period to 2030 which both form an important part of fuel switching towards the end of the period modelled.

More generally, the analysis needs to be extended to other significant oil using sectors in the Queensland economy to understand how robust they are likely to be to oil price volatility and supply disruption, notably the implications for agricultural and horticultural products and the flow on effects to food prices.

Against this background, it is for consideration whether the adjustment path, and its associated risks, implied by the modelling are acceptable in terms of the economic, environmental and social implications. Issues here include:

- The appropriate response to the geographical equity and access issues raised in the Dodson and Sipe analysis (section 3 above)
- A reliance on market responses that are predicated on a relatively smooth transition to sustained higher oil prices which in turn leads to demand reduction and fuel switching that occurs predominantly towards the end of the modelling period. Risks here include the more rapid onset of both a higher and more volatile oil price environment

Such an environment (particularly if coupled with carbon price uncertainty) could undermine the willingness of investors to put in place the supply capacities needed to facilitate a transition to a lower oil intensity path. In the limiting case this could result in absolute physical shortages, particularly in products for which Australia does not have refining capacity (such as low sulphur diesel).

Both price and supply risk would have implications for not only the transport sector but all major oil using sectors (such as agricultural, mining, petrochemicals).

7. Policy responses and options

a. Oil price/supply risk – current policy framework

The current State and Federal policy framework very largely leaves the management of both oil price and supply risk with the private sector. The Government's policy role in relation to liquid fuel markets is essentially restricted to emergency preparedness in relation to defence and terrorism issues and to give effect to International Energy Agency (IEA) emergency preparedness policies involving allocating fuel for essential services under the Liquid Fuel Emergency Act 1984. Implementation of these measures is devolved to State Governments.[19]

ACIL/Tasman has just completed a review of the 1984 Act for the Federal Government which is expected to recommend no major changes in the current framework but has identified risks associated with the age and capacity constraints of refining and pipeline capacity which point to the need for expanded on-site storage for major users of petrol and distillate.[20]

The Federal Government is also currently undertaking a National Energy Security Assessment (NESA). This is intended to address the current strategic energy security issues in the liquid fuels,

[19] Within Queensland, day to day responsibility for liquid fuel emergency preparedness rests with the State government's Department of Mines and Energy.

[20] Private communication.

natural gas and electricity sectors and those likely to influence the level of energy security in 2013, 2018 and 2023. The assessment will consider how the identified strategic issues affect adequacy, reliability and affordability in each of these energy sectors. It is expected to be completed by the end of calendar 2008.

The direction the NESA review will take is not known at this stage. The likely starting point in terms of the rationale for policy intervention will be the identification of market failures where any potential costs of government intervention are significantly outweighed by the public benefits. But it is not clear, whether, and if so how such review will address the potential interaction of global oil supply shocks (arising from the high sovereign risk in many supply provinces), physical supply constraints (associated with underinvestment) and the underlying dynamic of largely inelastic demand in the fast growing developing world.

Beyond general policies relating to fuel security, there is a wide range of Federal and State government measures that directly or indirectly influence liquid fuel demand – taxes, subsidies, infrastructure and service provision, fuel efficiency standards/regulations, urban planning/design. The importance of, and need for change in these policy areas is currently being heavily debated in relation to their potential for cost effective reduction in energy demand and greenhouse gas emissions, compared with relying solely/primarily on the pricing of carbon through an emissions trading scheme.

8. Identifying Insurance options for Queensland - demand reduction

a. The transport sector

This section examines from a high level perspective the impact on transport related fuel demand of two critical change vectors operating at faster rates than determined by the CSIRO modelling of pricing/carbon impacts – an accelerated modal shift in the way passenger and freight services are delivered and an increase in the fuel efficiency of the passenger and freight vehicle fleet.

There is a wide range of detailed policies and programmatic approaches to delivering travel reduction and improved fuel efficiency which are broadly summarised thematically in Figure 22.[21]

Figure 22: Overview of travel reduction and fuel efficiency measures

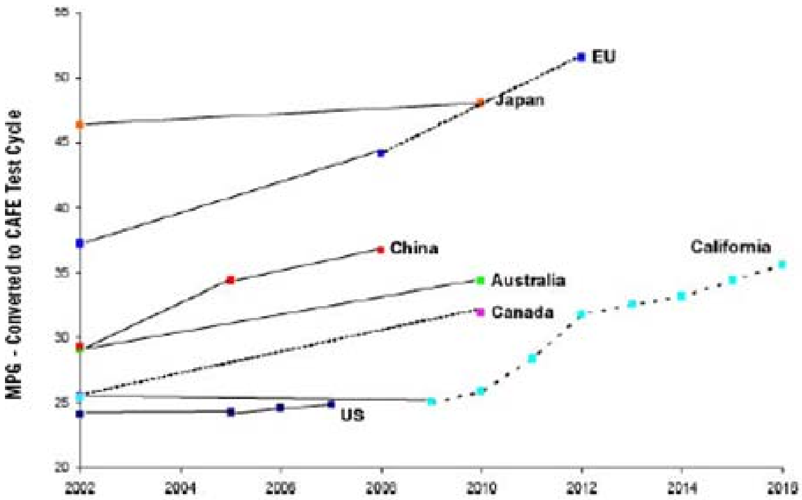
Vehicle Travel Reduction	Reducing Vehicle Fuel Use /CO2 Emissions
Pricing of vehicles, fuels, and roadway usage to discourage vehicle ownership and driving Land use changes and related	Increased new car and freight vehicle efficiency through technical measures, including greater adoption of near-term and “next-generation” technologies Encouraging consumer purchases of the most efficient

[21] Sitting alongside these measures, there is potential to remove/reduce policies that effectively incentivise increased fuel consumption and/or discourage use of public transport.

measures that promote transit and non-motorized travel Improvements in public transport services and incentives for increased patronage Facilitation of telecommuting Changes in work patterns (e.g. 4 day weeks) Freight modal shift (road to rail & sea)	vehicles available Optimizing on-road efficiency through appropriate capacity enhancements, traffic flow improvements, vehicle maintenance and driver education Improved freight vehicle utilisation – larger vehicles/better logistical planning Promoting alternative fuels that reduce oil use, increase overall energy efficiency, and reduce CO_2 (and other GHG) emissions.

The currently proposed trajectory for Australian fuel efficiency standards falls well short of those in the European Union, Japan and China (Figure 23).

Figure 23: Comparative light vehicle fuel efficiency standards



Policies to improve vehicle fuel economy will, however, tend to increase travel levels (by lowering the cost of driving) and therefore, as a group, generally work in a different direction than policies that are directly targeted toward vehicle travel reductions (this is the so-called rebound effect).[22]

22 If mandated fuel efficiency standards resulted in a more fuel-efficient fleet, resulting greenhouse gains would be reduced by the 'rebound effect'—the tendency for people to drive more when the fuel cost per kilometre decreases. Hence, a 10 per cent improvement in fuel efficiency, regardless of the source, will not translate into a 10 per cent reduction in emissions. Estimates of the rebound effect vary but range between 20

Policies that effectively increase roadway capacity or improve traffic flow may also induce increased travel.

Previous analysis of a wide range of transport related measures in other countries suggests that most offer modest oil (and carbon dioxide, CO2) reductions when implemented alone, typically in the range of 1% to 3%. A few offer bigger reductions, notably measures targeted at technical improvements in fuel efficiency (as is clear from Figure 23).[23] However, this analysis also indicates that when properly combined, it is not difficult to construct a package of measures that can result in savings of 10% or more.

Further development of an oil mitigation strategy suited to Queensland's needs and circumstances therefore requires:

- Model based analysis to understand the likely size and cost of avoided oil demand and CO2 emissions associated with individual transport measures; and
- Integration of individual policies and measures into packages that benefit from a synergistic interaction among the components and are supportive of other policy objectives.[24]

It is for consideration whether and, if so, how the air transport sector should be included in the options analysis. It is one of the fastest growing sectors and one in which the Queensland Government has a major direct interest via its assistance to regional and remote area air services. Given the national linkages in the air transport system and the international nature of technology change drivers it may best be primarily managed as a national issue.

b. Non-transport oil using sectors

The current composition of non-transport oil use in Queensland is shown in Figure 24. Growth in all sectors out to 2030 is assumed to grow in line with GSP. More detailed analysis is required:

- To calibrate likely demand growth against more recent GSP and sectoral analysis carried out by OESR for the Garnaut Review;
- To understand the implications of higher oil price trajectories and supply disruptions for each of the sectors; and
- To identify and evaluate potential options for managing oil price and supply risk via demand reduction and or fuel switching.

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and 40 per cent, depending on the price of fuel. (Greenhouse Policy Options for Transport, Bureau of Regional & Transport Economics, 2001)

[23] Saving Oil and Reducing CO2 Emissions in Transport: *Options & Strategies* (IEA, 2001)

[24] Governments often implement transport policies primarily to have effects other than on oil use or CO2 emissions (e.g. safety, congestion reduction, economic development, air quality improvements).

Figure 24: Queensland non-transport oil demand - 2006 (ML)

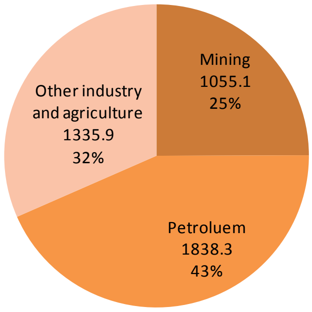
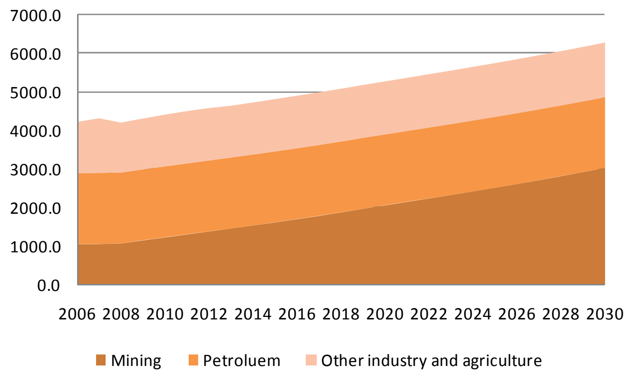


Figure 25: Other oil use - 2006/30 (ML)



9. Identifying insurance options for Queensland: Increasing/diversifying liquid fuel supply

The CSIRO scenarios modelled reflect generalised assumptions about the supply response to emerging shifts in demand for different fuels.

As noted above, it is not clear that supply will necessarily be forthcoming with existing policy settings given critical risks and uncertainties facing investors. These include:

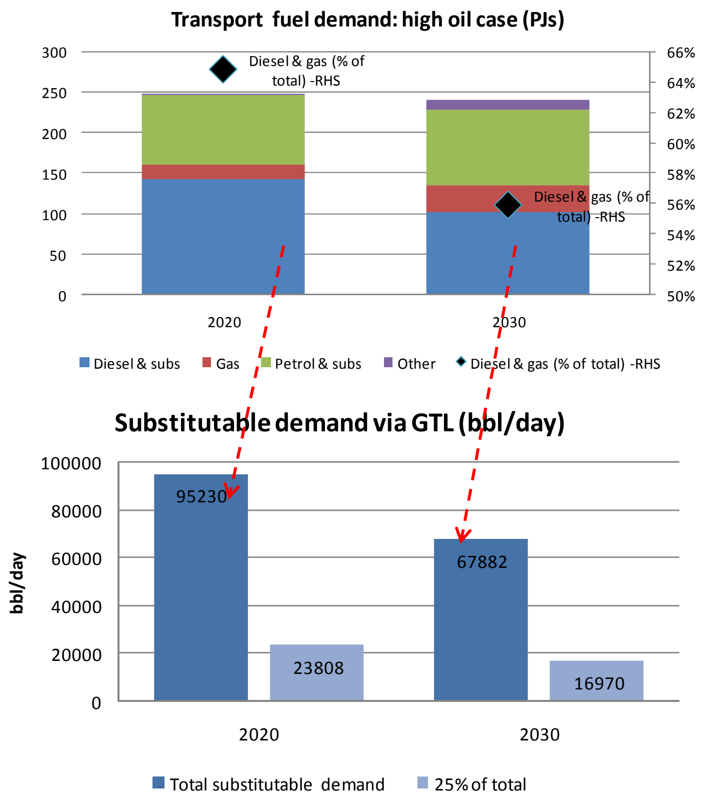
- the oil and gas price outlook (the latter particularly on the east coast of Australia);
- the competition between food and energy markets for critical biofuels inputs;
- the environmental constraints on larger scale biofuels production (and the full cycle greenhouse impacts);
- cost inflation for large capital intense plants (such as GTL/CTL);
- the future cost of carbon; and
- the cost effectiveness of large scale carbon capture and storage technology.

In developing an oil risk mitigation strategy further work is required to evaluate the option value and costs and benefits of government intervention to accelerate non-conventional liquid fuel supplies to Queensland. Options for further analysis and evaluation could include:

- Supporting increased gas/oil exploration development;
- Increasing distillate storage facilities;
- Supporting strategic refinery investment;
- Expanding CNG distribution/refuelling facilities;
- Supporting accelerated GTL investment; and
- Supporting accelerated CTL capacity.

This is clearly not an exhaustive list but, of the options set out above, preliminary analysis suggests in a high oil price environment, Queensland (and NSW) coal seam gas (CSG) could potentially supply some 50-60% of liquid fuel demand in road transport in Queensland comprising diesel and gas (CNG) demand, with diesel supply coming via the Gas to Liquids route (Figure 26)

Figure 26: CNG/GTL substitution potential



The construction of a 25,000 bbl/day GTL plant based on Queensland/NSW CSG would cost some A$3bn (@ AS1=US80 cents). This would reduce Queensland's "import" dependence in transport fuels in 2020 by 15 percentage points, from 80% to 65%. As such, it arguably has a potentially high option value in managing absolute supply shocks to liquid fuel supply.

The level of CSG supply required (55-60 PJ pa over 20 years) would be supportable with current and prospective levels of CSG resources and demand, including significant LNG exports.[25] Further analysis would, however, be required to:

- Validate the supply and cost /economics (including greenhouse/ETS implications) ;
- Frame and evaluate options for providing incentives that would accelerate the build out of GTL capacity as a cost effective risk management option.

These options could include either State and/or Federal assistance in the form of accelerated project clearance, royalty holidays, capital grants or accelerated tax write-offs. More detailed work would be required to understand the full range of costs, benefits and risks and develop a business case.

10. Initial conclusions

a. Preliminary findings

Analysis to date suggests that:

- At a broad macroeconomic level, Queensland's rich resource endowments of gas and coal provide a natural hedge against the oil price outlook that would be consistent with a nearer term plateauing of global oil production. Absent a major global recession, the general upward movement in energy prices would be reflected in improved terms of trade, economic activity and higher government revenue for Queensland;
- Higher prices would likely generate adverse sectoral impacts for industry sectors unable to pass on these higher input prices to downstream markets and/or exposed to end markets that are particularly sensitive to higher oil prices (such as air transport).

For households, initial evidence suggests that such a high oil price environment could combine with other proximate factors (location and low household income) to generate adverse equity impacts that would require consideration in terms of offsetting policy measures.

Detailed modelling of the road transport impacts of high oil price scenarios indicate a major response in terms of reduced oil-based liquid fuel use, delivered primarily via sharply increased fuel efficiency and fuel switching. This response is critically dependent on the underlying model assumptions about both consumer choices and the supply response from providers of alternative fuels and technologies. Further work is required to:

[25] Shell is the leading exponent of GTL technology and has taken a position in a CSG player - Arrow Energy which has 3P reserves of some 3000PJ. This is sufficient for a 50k bbl/day GTL plant operating for 20 years.

- Test and validate these assumptions, particularly those that involve large scale capital investments under conditions of significant uncertainty about future oil and carbon prices;

- Develop and test policy packages in the transport sector for robustness, cost effectiveness and coherence in relation to reducing liquid fuel demand & CO_2 emissions and meeting other policy objectives for the sectors.

Physical supply risks, impacts and mitigation options have not been evaluated via either economic modelling or detailed interaction with critically exposed sectors.

Initial analysis suggests that Queensland's CSG resource provides a significant source of liquid fuel diversification away from conventional oil, both via CNG and GTL. Further work is required to validate/evaluate options in this area compared with a range of other supply side options.

Most of the work to date has been drawn on existing sources of data without the benefit of input from agencies with detailed knowledge of key sectors outside the transport sector and with broader oversight of economic issues/expertise. Interaction with these agencies would assist in generating deeper understanding of sectoral exposures to oil risk and approaches to oil risk mitigation as well as clarify possible risk management objectives in relation to oil price and/or supply risk.