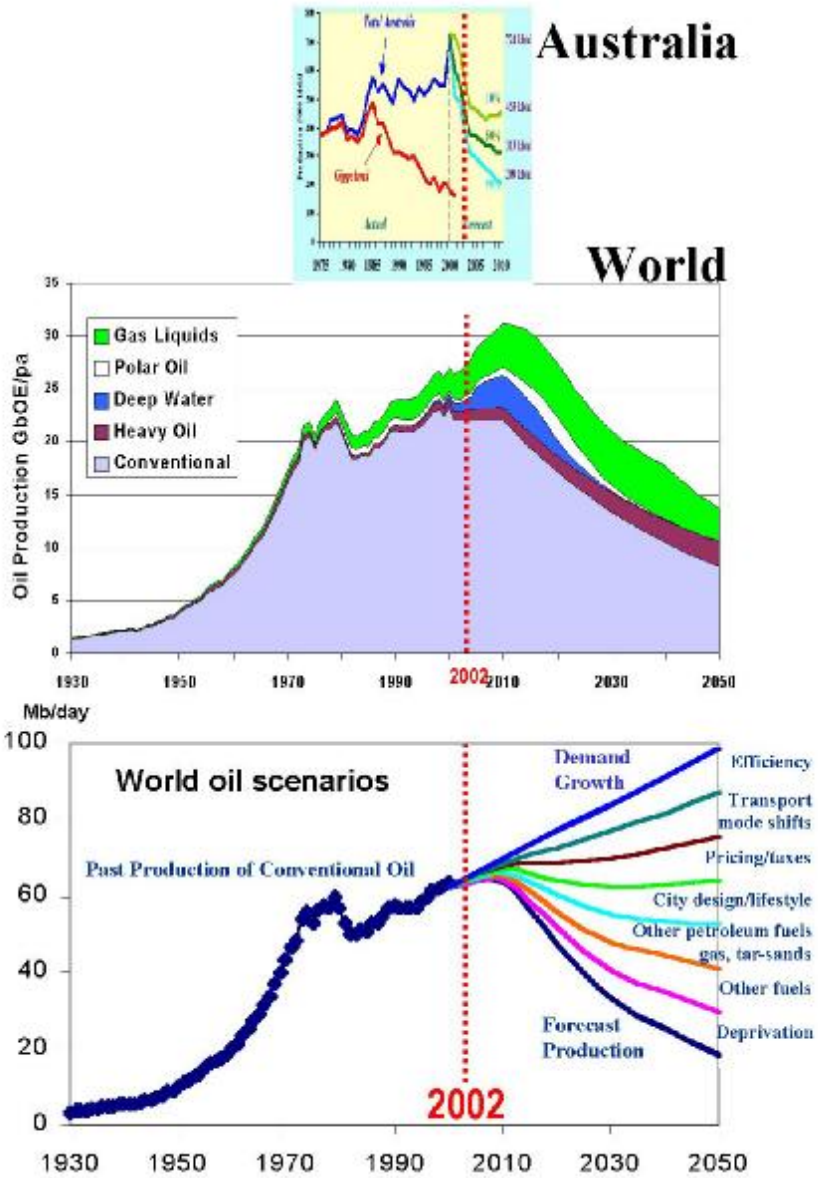
Global Oil Vulnerability and the Australian Situation

A background paper for WA State Sustainability Strategy

Bruce Robinson 30th June 2002



Diagrams showing past Australian and World oil production and future decline predictions. The lowest diagram illustrates one scenario of strategies and adaptations matching the predicted growing gulf between unconstrained demand for petroleum and shrinking supply. Details are in the following text.

As a result of declining domestic production and uncertain world supplies, WA is very vulnerable to "Oil Shocks" in the short term (2 months), medium term (2 years) and long term (within 2 decades).

There is a great deal that can be done to prepare for the likelihood of future oil shocks and hence to ameliorate the effects when (or if) they hit us. Many possible precautions will be "no-regrets" options already justified on equity, environment, health or economic grounds. WA's existing supplies of domestic gas and petroleum coupled with local understanding of oil vulnerability and demand management provide an encouraging opportunity for the state to both forecast and to weather the coming storms better than many other regions.

Recommendations

1. Formation of a broad-based Oil Vulnerability Task Force is recommended to evaluate and communicate details of WA's oil vulnerability, both direct and indirect, and to develop appropriate responses. It will need to catalyse and coordinate industry, government and community approaches to the looming issue of future oil supply uncertainty.

2. Proven cost-effective measures to reduce Perth's automobile dependence should be enhanced or implemented.

(a) The Perth Bicycle Network should be completed and upgraded as a matter of urgency and bicycle networks developed for regional centres.

(b) TravelSmart programs should be implemented to cover the entire Metropolitan area and extended to regional centres.

(c) A skilled and cohesive bicycle transport planning and engineering group should be formed within the Planning and Infrastructure portfolio to promote, plan and coordinate the provision of bicycle facilities in urban areas and to ensure that all new roads and developments and all road modifications in urban areas always make provision for safe and convenient bicycle transport

A 20% reduction in Perth's petrol use can be realistically and rapidly achieved by the combination of TravelSmart programs, the completion of the bicycle network and the provision of Safe Routes to Schools for students to ride bicycles to school or walk

(d) Funding for the provision of any major additional urban roads should be reviewed in the light of the probable decrease in future automobile travel demand as a result of oil vulnerability and of the success of TravelSmart and the provision of non-automobile travel alternatives like better facilities for cycling, walking and public transport.

(e) State motor-vehicle charges such as stamp duty, registration and third-party insurance should be progressively modified in a revenue-neutral or revenue-positive manner to give substantial encouragement to the purchase of small fuel-efficient motor vehicles. A Federal-State initiative for a change from a vehicle-ownership basis for road user charges to a vehicle-use basis would reduce the current subsidies from those people who use their motor vehicles only a little towards those who use them more than average.

Perhaps the most compelling (but still largely unrecognised) evidence of the lack of short-term sustainability in WA is our very serious dependence on rapidly declining petroleum sources. Petroleum is currently essential for transport, agriculture and most facets of WA's community and economic life. Most people have assumed, wrongly, that medium and short-term supplies are assured.

Australian oil production decline

Australia has been shielded from past oil shocks by our domestic oil production from Bass Strait. However, Bass Strait production has been declining since 1985 and until now other fields have filled the production gap. Reliable recent predictions by GeoScience Australia (previously the Australian Geological Survey Organisation) and Woodside indicate that Australia's oil and condensate production will fall substantially in the next decade. This is shown in Figures 1a and 1b.

Figs. 1a and 1b. Australia's liquid fuel production decline began in 2,000.

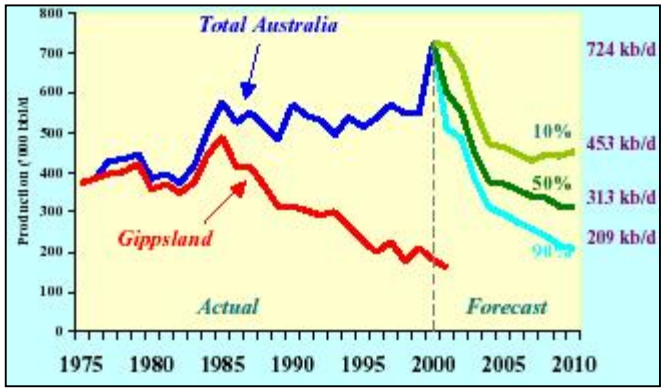


Fig. 1a. Australia's actual and forecast oil and condensate production at 10%, 50% and 90% probabilities. (Akehurst 2002, APPEA 2002)

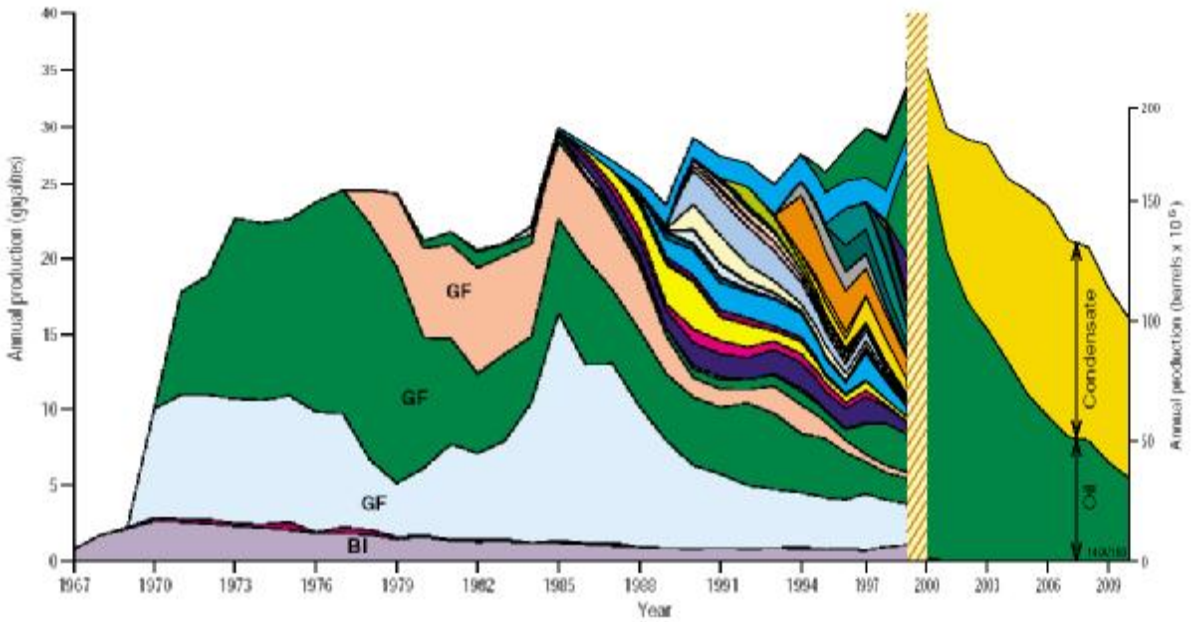


Fig 1b. Expanded version of Fig 1a. **Oil and condensate production profiles of individual Australian fields is shown, and the forecast cumulative production** at 50% probability derived from industry data (Powell 2001, Akehurst 2002). BI denotes Barrow Island; GF denotes giant Gippsland Basin Fields. The original dominance of a few large fields, which are normally found first is shown. An increasing discovery rate of usually progressively smaller fields has been needed to keep production relatively constant. Australia is now using three times as much oil as is being discovered, and this will lead to the forecast production decline as shown in the graph (Akehurst 2002).

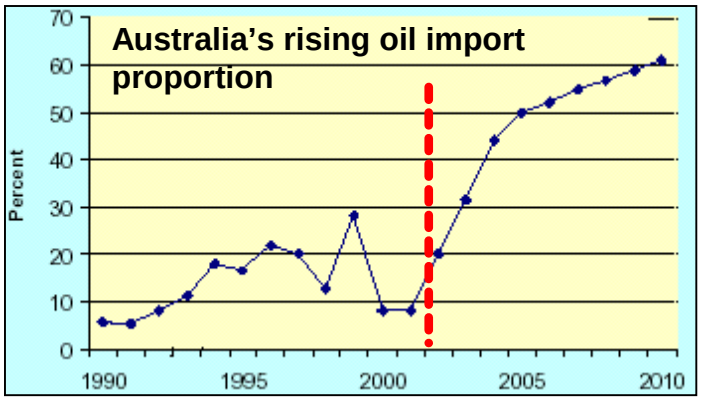


Fig. 2. Australia's rising oil import dependence
The graph shows the percentage of Australia's liquid hydrocarbons demand which has been, and is expected to be, met by imports. Liquid hydrocarbons are defined as crude oil, condensate, naturally occurring LPG and liquid petroleum products. Self-sufficiency is expected to decline from an average of 80-90% over the past decade to less than 40% by 2010 (Akehurst, 2002, APPEA 2002)

Australia's domestic oil production decline is taking place on the timescale predicted for the beginning of the overall world oil production decline. As a result, Australia is becoming increasingly vulnerable to serious oil shortages, in the short term (within a year), in the medium term (within 5 years) and in the long term (within one or at most two decades).

World oil production decline predictions
A world-renown US Geological Survey petroleum geologist, Les Magoon, visited Australia in November 2001 as the Petroleum Exploration Society of Australia's Distinguished Visiting Lecturer. He gave talks around Australia entitled "Are We Running Out of Oil". As reported (Australian Energy News, 2001, Magoon, 2001), he describes the "Big Rollover" as the change from the current world oil buyer's-market to a world seller's-market when global production starts to decline (Fig 3.). Various forecasts put the Rollover date at sometime around 2003, 2007, 2010 or by 2020 at latest.

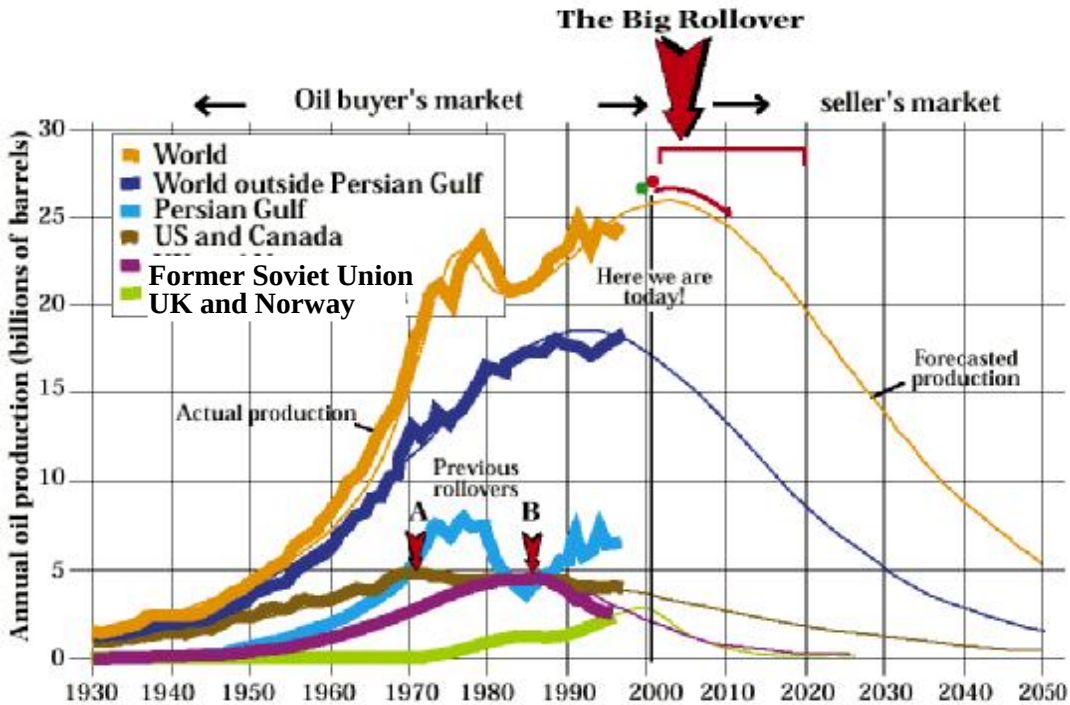


Figure 3. Past and forecast world conventional oil production (from Magoon, USGS 2000, and AEN 2001, after Campbell and Laherrère, 1998) showing the rise and decline of different oil regions. The US and Canada decline started in 1970 (A),

USSR in 1984 (B) and the North Sea in circa 2002. The total world production decline will begin most probably sometime within the next decade. Other petroleum sources, like gas condensates and non-conventional oil will attenuate and postpone the "Big Rollover" from that shown, but not probably not substantially.

First International Workshop on Oil Depletion.

In May 2002, the first International Workshop on Oil Depletion was held at Uppsala University in Sweden by the Association for the Study of Peak Oil, ASPO. The author was the only attendee from the southern hemisphere. Papers and presentations are available at www.isv.uu.se/iwood2002. Oil depletion experts from the US, Europe, Russia and the Middle East gathered to discuss the growing body of evidence that world oil production will reach a peak then decline relatively sharply within a decade or at most two. APSO also released the first edition of its "Statistical Review of World Oil and Gas", a nation-by-nation evaluation of reserves and production rates, based on the most reliable technical data available. The ASPO data differs substantially from that published in oil trade journals, which have very serious commercial and political biases and inconsistencies. Evaluation of non-conventional oil is now included in the current predictions shown in figure 4. Non-conventional oil includes heavy oil (which needs to be heated to flow adequately), oil from deep water (>500 metres) and from polar regions and condensates from natural gas. These sources will in part offset the rate of decline of conventional oil after the "Big Rollover"

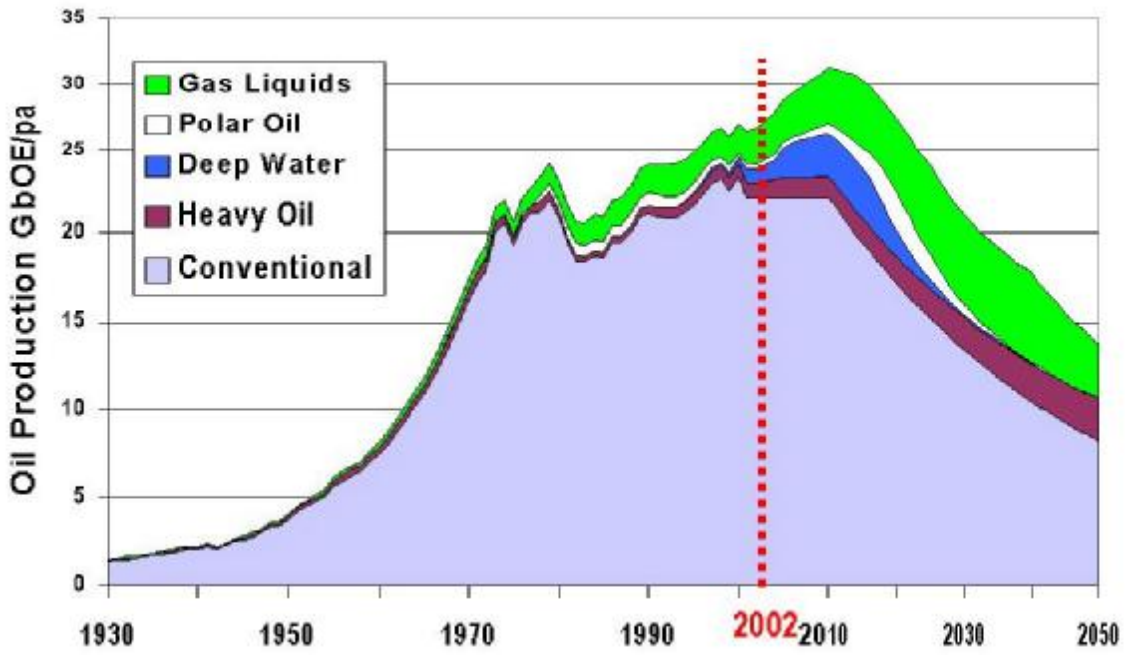


Figure 4: Current forecast of future world oil production, including non-conventional oil, from the Association for the Study of Peak Oil, released at Uppsala, May 2002. (ASPO, 2002)

Presenters at the Uppsala workshop included Matthew Simmons, a prominent energy-sector investment banker from Houston who advises President Bush. He said, *"I have studied the depletion issue intensely for too long now to have any remaining doubts as to the severity of the issue. But I am still amazed at the limited knowledge that exists, even in the U.S. or within our major oil and gas company's senior management about this topic and its dire consequences",* (Simmons, 2002)

Ali Samsam Bakhtiari, of the National Iranian Oil Company, provided a pessimistic view of future oil supply decline and of its effects: -

"Seen from a Middle Eastern perspective, the present global oil situation can be summarised within five major and inescapable trends:

1. *The world's super giant and giant oil fields are dying off;*
2. *There are no more major frontier regions left to explore besides the earth's poles;*
3. *Production of non-conventional crude oil has been initiated at great costs --- in Venezuela's Orinoco belt, Canada's Athabasca tar sands and ultra-deep waters;*
4. *Even OPEC's oil production has its limits;*
5. *No major primary energy rival can possibly take over from oil and gas in the medium term.*

Adding up these five trends, one can envision a global oil crunch at the horizon --- most probably within the present decade....."

"...It would take a number of miracles to thwart such a rational scenario. Now, a single miracle is always a possibility, but a series of simultaneous miracles is not --- for there are limits even to God Almighty's mercifulness". (Samsam Bakhtiari, 2002)

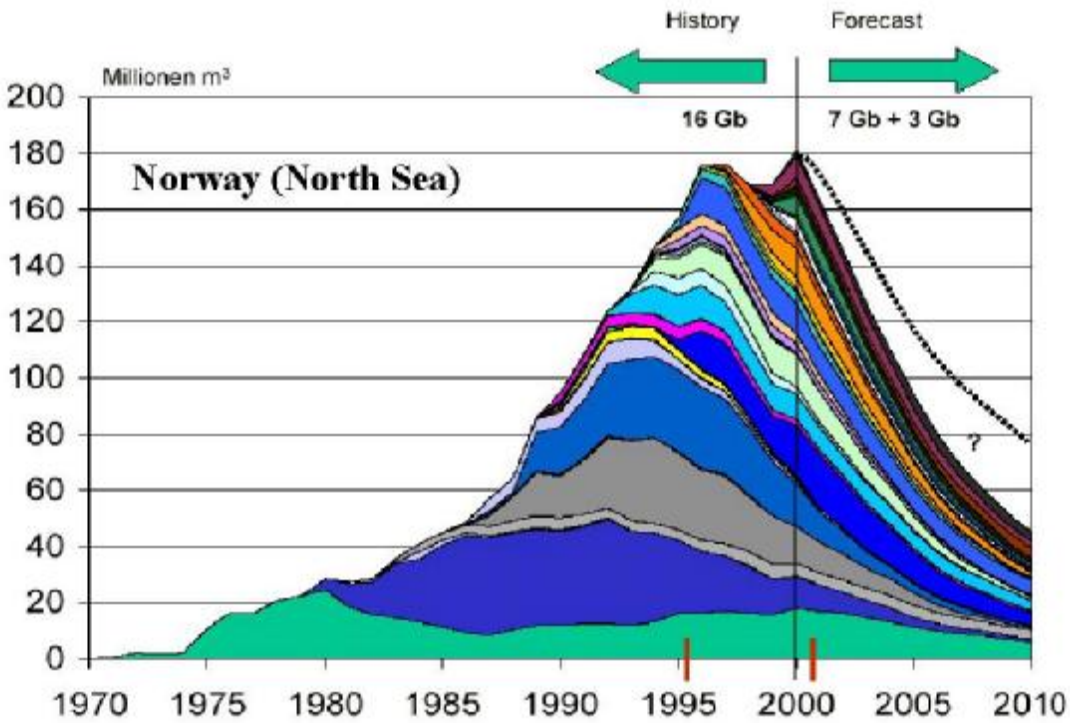


Fig. 5. Typical Oil Depletion Curve. Norway (North Sea). Field by field production curves and forecasts of crude oil (without condensate). The large fields are found first, decline and then ever-smaller fields replace them until overall production starts to drop sharply. UK's North Sea oil production started its final decline in 2000. This is typical in broad terms of what is forecast for all oil provinces. (Zittel, 2001)

As production outside the Persian Gulf declines, (for example, see the Norway depletion forecast in Fig. 5 above.) the balance of oil power will shift more and more towards OPEC. Substantial short-term disruptions and large market-force pressures in the medium-term are quite possible. The permanent decline phase will start once the Middle East production starts falling, probably in about 2010. Physical constraints in addition to market forces and geopolitical factors will then limit oil availability. Rising world demand, for instance from China and India, will add enormous pressures to the oil market. The past oil shocks have been predicted to be mere ripples compared to the changes which will probably occur in the next decade.

The declines in Australian and world oil availability are likely to be much faster than any alternatives can be brought on stream in significant volume and than the necessary structural and efficiency improvements can be made, unless extraordinary measures are taken very soon.

These reliable forecasts of declining domestic production and uncertain world supplies indicate that WA is very vulnerable to "Oil Shocks" in the short term (2 months), medium term (2 years) and long term (within 2 decades).

Short term: ***1 month to 1 year***
Another suddenly-arriving oil crisis, like those from the 1973 oil embargo, the 1979 Iranian revolution or the 1991 Gulf War, is quite possible. Instability from the Israel-Palestine conflict is one current possibility, which could well lead to an oil embargo or disruption of supply from the Middle East. Political change in Saudi Arabia is another. There are other obvious scenarios of wars in the Middle East or political uncertainties that might lead to cessation of oil imports for WA's refinery. WA's local reserves of petrol and diesel would be exhausted within a fortnight or two without drastic action to curtail demand.

Medium Term: ***1 year to 1 decade***
There is a probability of a substantial change to the "ground rules" of oil pricing, perhaps similar to that following the 1973 oil embargo. This will become more likely when non-OPEC oil production starts to decline as predicted. For instance the North Sea province is already beginning its steep decline phase, as shown in Fig 5.. When non-OPEC oil production declines, there will be more market power passed to OPEC. A controlled but relatively rapid oil price rise is one scenario. Lack of current investment in production facilities in the Middle East provides another serious barrier to meeting world demand in the medium term.

Long Term: ***Between 1 and 2 decades***
Growing demand in developing countries, increasing world population and continuing high demand from the developed world means global demand is highly likely to exceed the capacity of the world's declining oil fields to supply petroleum. This is the Big Rollover, when a gap opens between increasing demand and dwindling supply. Many forecasts of the date of the Big Rollover fall within the next five or ten years, and the majority prior to 2020. One probable mechanism for keeping demand and supply closer in balance is a world recession, caused by high oil prices, which will suppress demand. This will be, in effect, a symptom of the Rollover and a means of postponing the crunch, but not of avoiding it.

Objective for change:
Creation of an active Oil Vulnerability Task Force.

A very substantial shift in the perceptions of the public, decision-makers and Government authorities is required for any significant steps to be made to reduce our oil vulnerability.

Formation of a broad-based Oil Vulnerability Task Force is recommended to evaluate and communicate details of WA's oil vulnerability, both direct and indirect. It would need to catalyse and coordinate industry, government and community approaches to the issue of future oil supply uncertainty. A necessary first step is to start discussing the topic, to enable the community to get beyond the state of denial now evident in most quarters.

There is a great deal that can be done to prepare for the likelihood of future oil shocks and hence to ameliorate the effects when (or if) they hit us. Many possible precautions will be "no-regrets" options already justified on equity, environment, health, social or economic grounds. WA's existing supplies of domestic gas and petroleum coupled with

local understanding of oil vulnerability and demand management (especially in water use efficiency and TravelSmart) provide an encouraging opportunity for the state to both forecast and to weather the coming storms better than many other regions.

WA, and particularly Perth, has a very high level of automobile dependence. This has been raised in many quarters, but has not yet been seriously challenged. The Premier, Dr Gallop, said *"Western Australians must break their obsession with motorcars"* when promoting the large health benefits of walking for short trips instead of taking the car.

Oil Vulnerability, of course, encompasses much more than transport and other affected industries and community sectors would be included in the Oil Vulnerability Task Force.

However, urban transport (in Perth and many regional centres) is the most profligate area where serious oil conservation measures will be easily and quickly possible, to reduce the competition for scarce supplies in industries without adequate alternatives. The successful record of the TravelSmart program in reducing automobile use with a simple individualised marketing campaign shows that rapid substantial changes are possible by reducing car trips and in travel mode shift towards public transport, cycling and walking.

Strategies for change

1. Communication of the problem. *"Talk about it, talk about it"*

The majority of decision-makers and the community are unaware of (or are in a state of denial about) our oil vulnerability. The US Geological Survey oil expert Les Magoon says it is crucial to "talk about it" as outlined his poster (Magoon, 2000).

Q! Should we do something to prepare for THE BIG ROLLOVER?	*A!* Just like preparing for the Y2K BUG…. talk about it, talk about it, and talk about it! Then real solutions will come forth from very creative people in science and technology, in business and politics, in city, state, and Federal governments, and in our other institutions. We all are the stakeholders! *We need to make plans before the oil shortage occurs. We can turn a lose-lose situation into a win-win situation if we start now.*
Q!. What good is talk?•	*A!* As someone once said, you can't solve a problem till you know you have one.•
Q! What should we do to prepare for THE BIG ROLLOVER?•	*A!* Hang on tight, if we don't recognize the problem soon and deal with it, it's going to be quite a ride! (Magoon, 2000)

The Oil Vulnerability Task Force's first rôle needs to be one of communicating the details of our oil depletion vulnerability to the community, industry groups, professional bodies, government agencies and other peak bodies and decision-makers, both directly and via the media.

It is apparent that many people show considerable inertia and reluctance in considering sustainability in general, and oil depletion in particular. This means that the task of communicating successfully about oil depletion and oil vulnerability will required a skilled, patient and on-going campaign to provide the community with the information in a form which can be assimilated and considered, without the warning being dismissed as "crying wolf", which is one example of one of the denial mechanisms common when the topic is raised.

2. Communication about potential solutions and their limitations:

It will be important that there be open and informed discussion of the various strategies for reducing our oil vulnerability, their limitations and the input energy, the time required and the costs needed to implement them.

Contrary to many common predictions, it is highly unlikely there will ever be (or should ever be) a single "Magic Bullet" panacea for our oil vulnerability**.** A major aim in reducing oil vulnerability should be to reduce our very high levels of automobile dependency. Some of the possible oil-use reduction and replacement strategies are outlined in Fig 6.

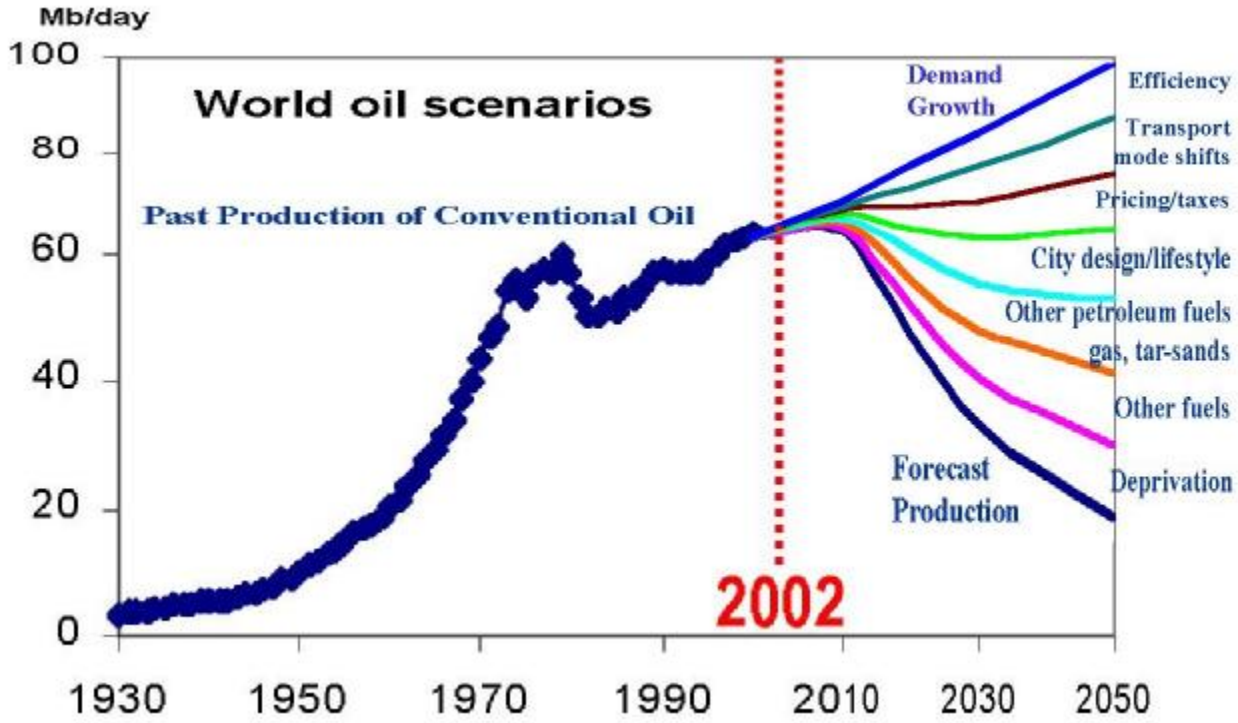


Fig. 6. An adaptation of the scenario outlined by Ron Swenson (Swenson, 1998) of the various mechanisms of bridging the coming gulf between growing current world demand for oil and the forecast decline in the production of conventional oil.

"Sustainability and Cities:- Overcoming Automobile Dependence", (Newman and Kenworthy, 1999) lists Perth as very high in the "automobile dependency" league; the worst Australian capital city for transport energy use per person and CO_2 emission per person. Perth is twice as profligate per person as the average of the European cities studied. The authors outline the economic and social costs our high automobile dependence has already imposed. They also outline strategies successfully used in overseas cities to reduce the need for automobile travel, and hence to reduce our oil vulnerability. Clearly, increasing travel by electric trains, or gas-powered buses, or by bicycles, or by walking reduces our oil vulnerability. Increasing the provision of facilities for these modes of travel instead of expanding high-speed urban road networks will be a simple way of reducing our need for petrol. Freight rationalisation and mode changes from road freight to rail can provide similar reductions in fuel use, especially on long haul routes (Laird et al, 2001).

All alternative fuels to replace petrol and diesel have severe constraints to their introduction. Enormous volumes are required to replace a sizeable proportion of our current liquid fuel usage, and the timescale for their provision in these volumes is very short. It will be very risky indeed to rely on unproven technologies becoming available on such enormous scales within a decade or so, which is the timeframe likely to be required if the Rollover forecasts are accurate. There are 1.4 million motor vehicles on register in WA, and at $25,000 each, a fleet replacement exercise would need the outlay of $35,000 million, which would be diverted from

other community and Government needs. Currently half the registered motor vehicles are more than ten years old, and 20% more than 20 years old. Normal fleet changeover rates are actually very slow. Half of today's new cars will still be on the roads in 20 years (BTRE, 2002)

For instance, it has taken Australia almost two decades since 1985 to switch from leaded to unleaded petrol (Fig 7), a very much simpler technological change indeed than a conversion to fuel-cell cars, for instance. This change was mandatory for all new cars purchased from 1st January 1986.

Fig. 7. Example of the inevitably slow rate of introduction of new technology into Australia's vehicle fleet. Unleaded and leaded (or LRP) petrol sales, Australia, from 1987 and extrapolated to 2008, (Australian Institute of Petroleum at www.aip.com.au), following mandatory introduction of emission-control engines in new cars in 1986. The introduction of hybrid vehicles and fuel cells is likely be much slower as the technological differences are much greater.

Suggested oil vulnerability reduction measures

Energy Efficiency

WA is very wasteful of energy in general, and of petroleum fuels in particular, and there are a great many measures which can reduce this wastage while either improving or not diminishing our quality of life.

In its submission to the COAG Energy Markets review, BP recommended :-

> **"Achieve a step change in energy efficiency** –
> BP knows from its own experience that significant cost savings are available through greater energy efficiency. **Better energy efficiency is the "low hanging fruit" of the energy challenge."** (BP, 2002)

A BBC news report described Energy Conservation as the Fifth Fuel.

> ***"Most of us still waste fuel on a prodigious scale, and the savings we could make by greater efficiency, and by just switching off, are immense."***

Australia's light-vehicle fleet fuel consumption has not improved since the late 1980s. Vehicles are getting heavier, more powerful and the possible fuel economy advances are not appearing in the overall fleet. Mandatory standards for fleet average fuel consumption, and economic incentives such as sliding scale registration fees to favour fuel-efficient vehicles and penalise gas guzzlers are policy options. The national light fleet average fuel consumption has not dropped below 9 litres/100 km. It is crucial that the average fuel consumption for new vehicles purchased is improved substantially. Significant incentives should be provided for the purchase of fuel-efficient vehicles, and disincentives for the purchase of gas-guzzlers.

> *"The average fuel consumption rate of new passenger vehicles sold each year is a significant factor in determining Australia's transport fuel use and emissions well into the future. This is because passenger vehicles, the largest element of the vehicle fleet, are very long-lived. In fact, about half of new passenger vehicles sold in any one year are still on the road 20 years later."* (BTRE 2002).

Volkswagen in Germany has shown a demonstration vehicle which uses only 1 litre of fuel per 100 km for a two-seater city vehicle. Amory Lovins promotes ultra-lightweight Hypercars, designed to improve dramatically the 1% efficiency of current automobiles (efficiency of the energy required to transport a driver) by a factor of ten or more. Even a moderate change in purchase strategies by consumers and fleet owners will save an enormous amount of fuel over the service lifetime of the vehicles

Transport mode shifts

TravelSmart is WA's individualised marketing programme to encourage people to change from private car travel to other modes. Reductions of circa 14-18% in private car travel kms have been already been achieved without any improvement in the infrastructure of the alternative modes. Public transport use, cycling and walking all increase when people are informed and assisted to make use of the alternate modes. Surveys have shown that the modal shifts obtained by TravelSmart are sustained in the long term. The forecast overall 16% reduction in overall car travel from a Perth-wide TravelSmart programme would save the community a great deal of money, pollution and crashes, and would improve health levels through the increased physical activity of walking or riding to school, or walking to catch the bus or the train. Many of the replaced car trips may be the shorter ones (cold engines are less fuel efficient and much more polluting than those at operating temperature), so the saving in fuel and pollution is likely to be higher than the 16% overall travel reduction estimate. A conservative cost-benefit analysis of TravelSmart shows a 13:1 benefit:cost ratio before considering the advantages of reducing WA's oil vulnerability

Bicycle Transport

It is quite realistic to aim for a change from the current 5% of trips in Perth now undertaken by bicycle to 20% of trips by bicycle within two decades. This would only put Perth towards the middle of the league of current European cities, so it is quite achievable. This will be especially true if petrol prices and petrol availability change substantially. This is a likely outcome of the ongoing depletion of Australia's oil reserves and those of the rest of the word. A substantial proportion of automobile trips in Perth are very short, under 5km, and well within bicycling distance.

Perth has many advantages for bicycle transport over European cities. The simple topography, the good weather and the space available for the provision of bicycle facilities are obvious positive factors. Trips to school are normally within easy bicycle distance, and modern multigeared bicycles are more efficient than traditional short-distance Dutch bicycles, for

instance. Country towns and regional centres in WA have lower traffic densities and shorter trip distances and are generally even better-suited for bicycle transport than is Perth.

Completion of the Perth Bicycle Network

Currently about the same number of people travel each day in WA by bicycle as by bus, in spite of the serious dearth of safe facilities. Implementation of the first stage of the Perth Bicycle Network, started in 1996, has seen a sizeable increase in use of Perth's bicycle paths. Completion of the high-grade bicycle paths along the railway lines from Perth to Armadale, Midland and Fremantle will provide safe links to a lot of employment nodes, schools, beaches, shopping centre and other travel destinations. On current construction timetables, it will take almost a century to complete these paths, although the work required to build cyclepaths along the rail reserves is very simple by transport infrastructure standards. Rapid completion of stages 2 and 3 of the Perth Bicycle Network, and the implementation of Safe Routes to Schools is a simple way of reducing oil vulnerability and improving community health and fitness levels.

Bicycle transport planning and engineering group

Changes to the organisational structure of the previous Department of Transport now being carried forward into the new Department of Planning and Infrastructure resulted in the effective disbandment of the previously successful Bikewest team of planners and engineers which conceived and initiated the Perth Bike Network project. It is essential that a skilled and cohesive bicycle transport planning and engineering group should be formed within the Planning and Infrastructure portfolio. The group would promote, plan and coordinate the provision of bicycle facilities in urban areas and to ensure that all new urban roads and developments and all road modifications in urban areas always make provision for safe and convenient bicycle transport.

Pricing and taxes

Currently there are a range of subsidies and incentives which actually favour increased automobile use. Tariff incentives for the purchase of inefficient heavy urban 4WD vehicles are one anachronism. Articulated heavy vehicles pay less third party insurance than a small family sedan, yet are ten times more likely to be involved in a fatal crash. The high fixed charges for vehicle ownership ensure that those who own small cars driven only infrequently are forced to subsidise those who have large cars and drive them for long distances. Fuel usage and crash rates depend on usage frequency, speed and vehicle mass. Road use charges should reflect these factors far more than they do currently. Coordination of state and Federal responsibilities will be needed to move towards a more rational pricing system for motor-vehicle use which can be used as a tool to reduce substantially WA's oil vulnerability.

Salary packaging policies that includes motor vehicles should be reviewed. 50% of new cars being purchased are fleet purchases where fuel economy is not a major consideration, and half of these vehicles will still be on the road in 20 years time. Fringe benefit taxes which offer incentives to increased motor vehicle use, and which shield the user from the real cost of the vehicle use should be greatly modified to decrease our automobile dependence. Salary packages should favour the purchase of ultra fuel-efficient vehicles and provide sizeable incentives to reduce automobile travel

City design/lifestyle

Improving city form by better urban planning is a demonstrated way of reducing automobile dependence (Newman and Kenworthy, 1999). Provision of better public transport and walking and cycling environments can all reduce our oil vulnerability as well as increasing the liveability of cities and the health of individuals and the community. Given the timeframes involved, it is essential that the probable decline in the availability of petroleum transport fuels be seriously considered in future urban planning and transport planning decisions.

City form can be considered at a range of spatial scales, which in turn have a similar range of temporal scales needed to implement changes, from long-term to short-term.

Macro-scale	Rail and light rail, whole-city planning
Meso-scale	road network changes for non-motorised transport and transit, Individual subdivision layouts, roads and bicycle paths Car-parking policies, bicycle network construction
Micro-scale	footpath and bicyel-path quality and continuity, removal of obstructions, affirmative action towards pedestrians and cyclists to redress decades of discrimination

Other petroleum fuels

As conventional crude oil production declines, it is forecast that alternate petroleum fuels will become available, although predictions indicate these will not be able to fill the gap created by the decline in traditional crude oil production. This is in part due to the increased energy inputs needed to extract, convert and refine the non-conventional petroleum.

Heavy oils from Venezuela, oil from tar-sands in Canada, gas used directly for transport, gas converted to liquid fuels and hydrogen manufactured from natural gas fall into this broad category. Although gas hydrates (methane trapped in ice clathrate compounds) are suggested as an energy source, the methane is dispersed at low concentration and it is most unlikely ever to provide enough energy to match the energy costs of its exploitation (Laherrère, 1999). Existing oil and natural gas resources occur highly concentrated in reservoirs so they can be extracted with low energy inputs. Oil shales are also considered as sources of oil, but again the energy and environmental costs are overwhelming. Mining large quantities of very low-grade rock, heating it to convert the organic matter to petroleum compounds, extracting the oil and disposing of the residue is a complex and inefficient process which also requires enormous resources of capital for plant and maintenance. US and Australian experience has shown that the aspiration of producing oil from organic-rich shales is like a mirage that recedes as one approaches. (Magoon, 2001)

Australia's total natural gas production is currently energy-equivalent to only about 80% of the nation's oil consumption. Hence, to rely entirely on natural gas as a source of replacement fuels will mean either the serious curtailment of existing domestic and export markets for gas or enormous expansion of gas production. The latter will bring forward Australia's Big Rollover in gas and the depletion of our finite reserves of natural gas. Already it is forecast that demand for natural gas in the Eastern States will exceed projected supply within a couple of years (Akehurst, 2002), just as North American natural gas production is forecast soon to fail to meet demand (Simmons, 2002).

Natural gas is the obvious source of alternative transport fuel for WA in the event of the forecast decline in world oil production. It should be used frugally and efficiently to make the best of the long-term buffer it will offer us against the future oil shocks. Exporting natural gas now will disadvantage future generations of WA people when all hydrocarbon reserves are running short.

Other non-petroleum-based fuels

These include: Oil from coal, bio-diesel, hydrogen from nuclear electricity, ethanol from crops, oil-mallee cropping, hydrogen produced from solar energy and coal-fired electricity for battery-powered vehicles. None of these alternatives appear to be able to provide a significant short or medium term alternative to petrol and diesel from petroleum. However, research and development overseas and in Australia will no doubt lead to improvements, so that some of

these alternatives are likely to become available in appreciable volumes within 20 or 30 years. Again, the energy-efficiency of the production of these alternatives will need to be evaluated closely before major commitments are made to using them as alternatives.

Deprivation

The last chilling segment of the Swenson scenario diagram is entitled "Deprivation". In the short term and in the long term, it is likely that some people will miss out on things due to our oil vulnerability. Even today, there are significant numbers of people who are transport disadvantaged. 46% of WA people do not have a driver's licence, and hence are already seriously handicapped in the automobile dependent society. The forecast oil shocks are likely to exacerbate the problems already evident. Scenarios in "FuturePerth" planning have considered $10/litre petrol (in current dollars) within 2-3 decades. If it costs $300 or $400 to fill the tank of the family car, there will be a number of trips forgone, and some deprivation.

It will be essential that Governments consider the mechanisms necessary to ameliorate the social problems that would be caused by future oil shocks. These would include rationing and resource allocation schemes so that fuels are reserved for high-priority purposes in the event of short-term or long-term oil shocks. Fuel for agriculture and transport of food supplies, essential services and important industries should be given priority over urban automobile travel.

Measures to shield the disadvantaged sections of the community should be planned to consider the equity and social justice aspects of what could well be a very serious disruption to community life in the event of substantial oil shocks.

Other suggested steps towards reducing oil vulnerability

(a) Alternative Fuels and Energy Sources Review

A detailed review and analysis of all likely alternative fuels is needed. This should contain realistic estimates of the volumes available in the medium and long terms, constraints to large-scale production (as a proportion of total liquid fuel needs), timescales needed for high-volume production, and the input energy and liquid fuel requirements for the alternative. Many alternatives may actually require more energy input than that contained in the final product. Environmental problems should also be evaluated. Some alternatives, for instance, oil made from heating organic-rich rocks like shale, have enormous requirements for water, for waste disposal and for energy input.

(b) Federal-States review of vehicle efficiency and taxation and pricing regimes

A review, in collaboration with other states and the Commonwealth is needed to make substantial improvements to the financial signals given to intending vehicle purchasers and to vehicle users.

Increasing the efficiency of motor vehicles now being purchased is very important, given the long lifetime of vehicles in the WA fleet, and the enormous cost of replacing them. There were 1.41 million motor vehicles registered in WA in 2000. Replacing the vehicle fleet (at say $25,000 per vehicle) would cost WA $35,000 million. Hence it is crucial that motor vehicles being purchased from now on are as fuel efficient as possible. Lack of Australian-standard fuel-consumption figures in car advertisements is one of many barriers to acceptance of fuel efficiency as a major lever in new-vehicle purchase decisions.

(c). WA Govt vehicle fleet and company car (salary-packaging) review

There should be urgent changes to WA Government and local government salary-packaging practices for the provision of motor vehicles. This is because "company cars" and "free" petrol encourage profligate use of fuel and institutionalise the mindset of automobile dependence. Everyone should feel the marginal cost of driving an extra km or an extra trip. Bulk salary packaging means that participants who are more frugal with car use are in effect subsidising those who use more fuel.

The larger and more inefficient vehicles purchased as part of salary-package options are soon traded on new ones but then stay in the WA vehicle fleet for the next one or two decades till the end of their service life. This long-lasting flow-on effect is an additional reason that there is an urgent need to change fleet vehicle purchase policies.

(d) WA petroleum and gas strategies

Actions within the power of the WA Government should be reviewed. This includes requesting the Australian Transport Council and the Federal Government to conduct reviews of Australia's oil vulnerability status and potential countermeasures and, if need be, to devolve powers to the States to enable them to manage resources more efficiently. A resource depletion tax, and State-based petrol taxes such as existed prior to the 1997 High Court decision would provide WA both the flexibility and the resources to provide infrastructure and to encourage practices that will reduce our oil vulnerability. Provision for a strategic fuel reserve for essential services in the event of severe oil shocks is important. Another priority will be clear and open fuel-rationing and fuel-conservation strategies that can be implemented rapidly at the first stage of a serious oil-crisis.

(e) Oil vulnerability assessment by industry sector

Much of the discussion above focuses (at least implicitly) on private urban transport. However, the oil vulnerability of rural and regional transport, freight and major and minor industry sectors including agriculture, mining, fisheries, forestry and manufacturing must also be addressed. The Oil Vulnerability Task Force should commission sector-by-sector reviews to ascertain the sensitivity (both direct and indirect) of various sectors to oil vulnerability, and the opportunities for reducing petroleum product dependence. The future needs for industry and community sectors faced by serious dislocation from the forecast oil shocks should be considered, with the aim of minimising and ameliorating the short-term and long-term impacts of the oil vulnerability.

(f) Economic benefits and opportunities from WA recognition of world oil vulnerability.

It is likely that as well as the potential problems uncovered by an assessment of WA's oil vulnerability, there will be a number of perhaps very sizeable economic opportunities. If WA goes beyond the state of denial about oil depletion in advance of most other countries there will be advance notice for our industries and community of the opportunities as well as the risks. There will be at least some new growth-industries, encompassing oil-conservation strategies, improved oil exploration and oil-recovery techniques and the new renewable energy technologies needed to fill some of the gulf left when oil supplies dwindle.

If WA sits complacent knowing that Australia has decades of gas, and some dwindling oil, we may miss the bandwagon completely as has happened often before. Oil-conservation is likely to be far more productive and cost-effective in the short term than any attempts to bring on-stream the substitutes upon which many people are pinning their hopes. In the long run, we will need both the alternative energy sources and a much more frugal approach to non-renewable resources. We could well benefit enormously from leading the world in preparing for the oil-shocks to come. Oil-conservation strategies could be a very big export item in future as well as saving us imports of oil on a sharply rising market.

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