



Observations on greenhouse risks and responses in the transport sector

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Abstract

Climate change has been described by the World Economic Forum as the 'greatest challenge facing humanity this century'. Despite this and major scientific assessments, debate still rages as to how far to go in addressing it.

This paper provides an overview of the key risks. These are severe, likely to increase, and cover economic, social, health, transport, other community systems and nature. Work by the Intergovernmental Panel on Climate Change indicates that a cut of some 60% to 70% in global greenhouse gas emissions may be needed eventually – merely to ensure that atmospheric concentrations do not continue rising further above the pre-industrial age levels.

An overview is presented of options and opportunities for Australia and transport in addressing the challenge. For transport, these include actions in the sector itself, in policy settings, and through external linkages. The paper suggests that a considered, pro-active approach will yield greater benefits than a 'business as usual' approach.

The paper indicates that the challenge for Australian transport policy makers is to implement responses which maximise economic, social and environmental benefits and which are meaningful to all key participants. Scope exists for stronger responses in:

- Demand-side measures – information to promote awareness of transport choices and their effects, and focussed behavioural change programs.
- Demand and supply impacting measures – especially transport charging or pricing systems and emissions trading.
- Urban and transport planning, including resource allocation, focussed management and general implementation.
- Vehicle standards and cleaner power sources.
- Infrastructure design and management supporting urban plans and efficient use, with effective inter-modal connectivity and choices in cleaner modes.

In moving in these directions, actions designed in participation with other sectors – such as land use planning, energy, health and housing agencies, and with industry and communities generally, will yield much greater benefits.

Ultimately transport solutions can be tailored much more effectively to community needs while yielding solutions vital to global climate stability.

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Introduction

This paper presents an overview of climate and allied risks. The risks cover many human and economic systems, transport and other sectors, and natural systems, from global to local community levels. The paper assesses consequences of this globally and for Australia.

It overviews broad options for Australia and transport participants. These span actions in transport itself, government policy settings, investments, and actions in concert with industry and community. Needs in research and approaches to whole of government and community involvements are touched on.

The size of the challenge

The World Economic Forum (2000) has described climate change as the 'greatest challenge facing humanity this century'. Views on matters like this vary but this was the result of a poll of attendees of this major group of business and government leaders. There is also much research setting out the risks involved with climate change. This is referred to in the next section.

The point of the World Economic Forum reference is not to assert that climate is the greatest or the only challenge but to draw attention to these key points:

- An 'invisible force', acting over decades then centuries, could dramatically alter climates and introduce major uncertainties and variations.
- The effects of major changes in climates are likely to be severe – the global population is now over 6 billion and rising and heavily centred near current sources of food and fresh water.
- Economic growth will continue as the major source of emissions growth but if emissions continue rising there is a long-term risk of very severe climate changes, undermining bio-systems and human support systems.

Global risks

The most in-depth assessments of the risks from climate change are those produced under the UN Inter-governmental Panel on Climate Change (IPCC).

The most recent is the 'Third Assessment Report'. It involved inputs by some 2500 senior scientists and reviewers as well as government agencies around the world (Intergovernmental Panel on Climate Change (2001)).

The report surveys the cumulating evidence on climate forcing and its effects, likely impacts on global systems and regions, and options for addressing these. Some of the major findings of 'The Scientific Basis' volume (1) of the report are:

- 'There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities'; and 'human influences will continue to change atmospheric composition throughout the 21st century'.
- 'Global average temperatures and sea level are projected to rise under all IPCC SRES scenarios'. 'The globally averaged surface temperature is projected to increase by 1.4 to 5.8 deg C over 1990 to 2100'.
- Precipitation (is) projected to increase, but in those areas with increases, larger year-to-year variations are very likely. Heat indices are very likely to increase, as are more intense precipitation events.
- Summer continental drying and drought risks are likely to increase over most mid-latitude continental interiors, as are tropical cyclone peak wind speeds and rainfall intensities.

For the upper level of projected temperature rises, impacts upon global systems have not yet been fully assessed. Climate factors in question include ocean currents (2), wind patterns, land hydrology and moisture. Some natural systems affected would be micro-biologies, flora, fauna, ecologies and sea life. There would be potential for increased extinctions and shifts in the location of fresh water, productive cropping and diseases.

- However the impacts might be even more marked – the state of science does not allow full analysis of the risks or any flow-on effects from difficulties in one natural sector or from one generation to others. This suggests that a major intervention in many life support systems is taking place without effective application of precautionary principles.

Some of the most important conclusions of world research are those on the levels of emissions production and absorption. Work by IPCC shows that major cuts in human-sourced emissions will be needed eventually to ensure that atmospheric levels stabilise, at higher levels than today (Inter-governmental Panel on Climate Change (1996), *The Science of Climate Change*, p25).

- Stability at twice pre-industrial-age levels would ultimately require emissions to be less than half current levels; cuts of 60 to 70% appear to be required.

This reduction task can be contrasted with the recent record of global emissions – over the past 5 decades since 1950, there has been a 4-fold increase in global emissions from fossil fuel use (Marland, Boden, Andres (2001)).

In addition over the last 2 decades there has been a strong rise in damage caused by weather disasters and in insurance payments for those events. These trends have compounded clear pressures on basic life support systems such as arable land, forests, fresh water and fish populations.

Work over the past decade into human use of and capacity of the earth's bio-systems has led to an estimate that the human footprint (the use of resources and releases of wastes etc to the environment) now exceeds the earth's bio-capacity (Wackernagel et al (2002)). The conclusion is that there is 'evidence that human activities have exceeded the biosphere's capacity since the 1980s'; that 'humanity's load was some 70% of earth's bio-capacity in 1961... but some 120% in 1999'.

- The report states that cropland and energy use are the two major sources of demand on the earth's systems and that energy is the larger and is growing more rapidly. The effects of energy use on the biosphere occur mainly through greenhouse emissions.

Some basic conclusions drawn from these works are:

- Humanity risks unprecedented change in climate this century and after, with impacts threatening many of the world's bio-systems and factors which make present day life appealing – such as cheap fresh water and food, minimal disease exposure and secure urban and coastal living conditions.
- If left unchecked pressures on living standards may emerge through costs of defence of health and basic human support systems, and through needs for relocations and defensive investments in infrastructure for water and food supplies, health, urban systems, transport etc.
- In coming years, realisation of the risks will lead to changes in sentiment in world markets and to stronger actions in most countries aimed at lowering greenhouse emissions and carbon-based energy use.

The latter conclusion is likely to apply almost irrespective of the state of world negotiations such as those over the shape of the Kyoto Protocol.

A majority of nations now support action such as that in the Protocol or with variations. Further, sentiment in communities and industries is shifting and has been so for some years.

- There is a group of major firms with the aim of greater sustainability – the World Business Council for Sustainable Development. There is concern in other quarters such as the Cities for Climate Protection group. Major car companies (such as GMH, Ford, Chrysler, Honda, Toyota) have active programs to produce low-carbon power systems. In Australia many firms are supporting 'triple bottom line' corporate systems and many have accepted obligations such as Greenhouse Challenge agreements.

The broad effects these shifts will have in future are clear. Over time, demand for and financial returns for low-carbon energy will rise relative to those for carbon-intensive systems. The shifts may be steady or there could be abrupt changes as further scientific evidence comes to light.

The key conclusions are – there is a need for responses towards low-carbon-based energy sources of major order, and these responses and demands will become more obvious in world markets and industry policies in future years.

Australian risks

CSIRO has assessed future climate change in Australia and the impacts CSIRO (2001). The report has projections to 2030 and 2070. The main findings are:

- Australia warmed by 0.7 deg C between 1910 and 1999, mostly after 1950. By 2070, average temperatures in Australia could rise by 1 to 6 deg C over most of the continent. Rainfall and evaporation simulations suggest some reductions in soil moisture. Cyclonic wind speeds may rise by 5-20 % by 2100, and the frequency of severe oceanic storm surges may rise.
- These projections may have a range of effects regionally for agriculture, forests and natural systems. Increased water stress is projected especially in southern areas. Vulnerability of wetlands may increase. Pests and diseases may migrate and several human health impacts are projected including increased infection from mosquito borne viruses. Flood damage in coastal communities will increase.

There are also regional studies. Studies for Queensland (such as CSIRO (2002)) point to more intense rainfalls but lower soil moisture, especially inland. This can be interpreted as a higher incidence of drought.

The Australian Greenhouse Office (AGO) is commencing work under the National Greenhouse Strategy (NGS) on adaptation options and systems for improved risk management. This suggests a judgment that there will be some changes in climate systems. This is supported by CSIRO.

There are indications that more severe climate or weather events are occurring. The Great Barrier Reef experienced a very high level of coral bleaching in the past summer. Cyclone Vance 3 years ago was reported at one stage as having the highest wind speeds of any cyclone on the mainland for over a century.

Transport risks

These assessments have implications for agriculture, tourism and the Great Barrier Reef, coastal communities, health, and transport. The direct effects on transport may be less than for agriculture but the risks are tangible.

One study into regional risks for transport (Queensland Transport (2000)) concluded broadly that in Queensland by 2070 there are likely to be significant changes in climate and weather extremes. The risks are more from changes in the nature of extreme events than from steadier changes (such as temperature

and sea level). Cyclones, floods and storm surges, and in combination, carry the risks of much greater damage from flooding, particularly in coastal areas.

- The systems most at risk are in the northern areas and include bridges, road, rail and port facilities in low lying flood prone zones. Systems in coastal communities will face increasing risks (3).

There may be other impacts on transport, from global actions to combat climate risks. Demand for carbon-based energies could be lower than otherwise and impact on freight demand for energy sources. Freight / passenger demand from other affected sectors such as agriculture and tourism could be lower than otherwise also.

Australian responses

National policies are evolving. The Commonwealth Government has ratified the Framework Convention on Climate Change and signed the Kyoto Protocol. It stated in July 2002 that it would not ratify the Protocol. However it has also stated that it supports achievement of the national target for emissions being limited to +8% over 1990 to 2008-12 as specified in the Protocol.

It has conducted studies into alternative abatement responses and projection analyses – including systemic, market-based approaches such as emissions trading. A partnership with the USA on science and technology has been signed. There has been research into the macro-economic effects of abatement and available modelling studies indicate that:

- Participation in the Protocol or similar agreement could reduce GDP growth over 2000 to 2012, but only slightly compared with the substantial levels of growth anticipated (note: modelling to date has not been able to take into account the major effects of climate change itself or the 'external' community and social benefits provided by many greenhouse response measures).

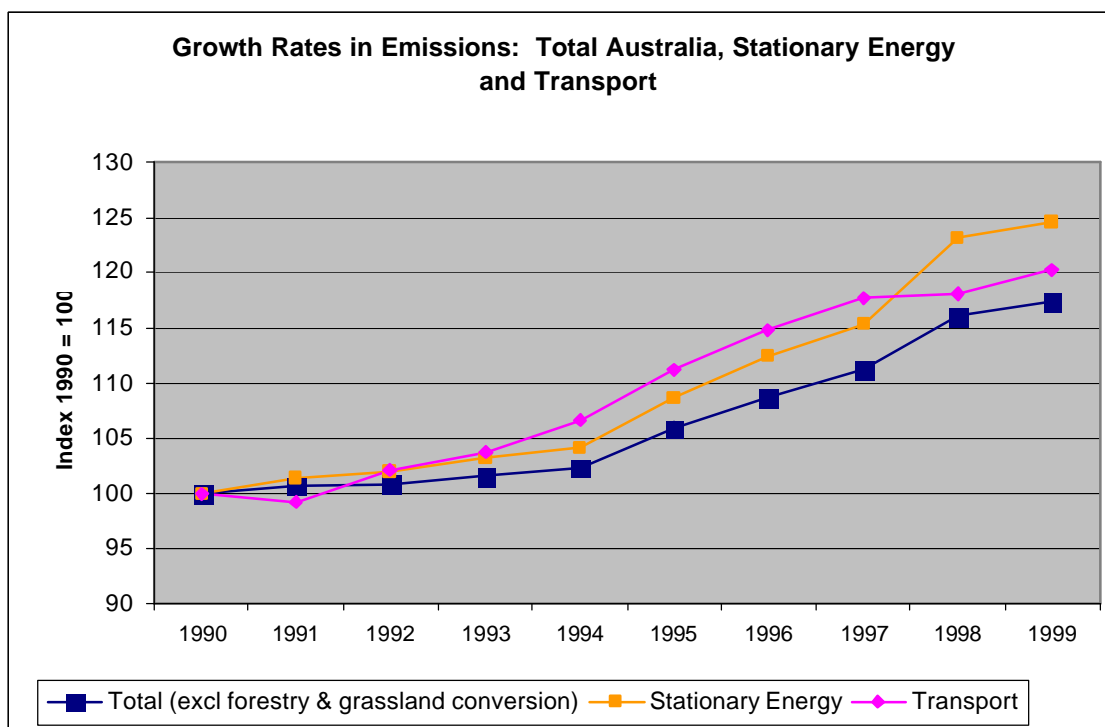
There has been work on implementing the NGS in sectors such as housing, new energy sources, transport and agriculture. State and local governments have been active and there are response strategies in some States.

Overall, the emphasis in Australia now is on least cost abatement – with a focus on adjustments providing abatement at least net cost.

The effect of this on the emissions trend remains to be seen. Transport and stationary energy were the two main sectors with rises in excess of 20% between 1990 and 2000. Stationary energy emissions rose 26.6% over that period and transport emissions rose 24.2% (the annual rate of growth after 1995 exceeded 2% pa).

- Some data for State transport sector emissions is available for 1990 to 1999. This shows varying rates of growth. Victorian transport emissions grew by 12%, while Queensland's emissions rose by 31%.

Graph 1: Greenhouse emissions – total, stationary energy and transport



Source: National Greenhouse Gas Inventory Committee, data to 1999.

From now on a key policy issue will be the shape of the major Australian response effort ahead of the first world Kyoto commitment period, over 2008-12. From recent events and trends, this is likely to be a combination of:

- A national emissions and carbon credits trading system.
- Wider application of voluntary industry and community based measures.
- Efforts to address government programs of industry assistance, investment and taxation which impact on use of carbon-intensive or extensive products; assistance packages for new and emerging industries / value-adding processes, and adjustment packages for some sectors in exposed areas.
- More extensive involvement in sectors where market mechanisms have not been able to allow for 'externalities' (for example urban planning, transport investment and planning, agriculture, housing, energy supply).

- Stronger research into technological and behaviour based response avenues and stronger focus on all the above areas in education and training.

There is no clear sign that comprehensive emission targets for industry would be used, or state or regional targets or major interventions such as taxes or charges. A response is likely which gives strong emphasis to the above list and to net benefits measures. A package approach is likely covering major parts of society and no one major sector is likely to be unaffected.

Stronger actions cannot be ruled out. This will be part dependent however on world market changes and negotiations, and on Australia's assessments in future of its own national interests, and as an overseas trade dependent nation.

Risks and opportunities attach to response decisions. For example, there are risks if responses are too slow, including possible forced changes from world pressures (negotiation, legal, trade avenues). This might entail high adjustment costs, especially if changes in carbon-intensive sectors are delayed.

- The corollary to this may be losses in potential earnings from industries with enhanced prospects in a world seeking to lower carbon intensity.
- There may be lower earnings from newly emerging emissions management and economic systems. These include carbon-credit, trading and Clean Development Mechanism earnings. Australia's long-term strategic position will be affected by the allied decisions taken and by the rates of change.

The current position – transport

There have been some shifts in transport policy in Australia in recent years. Australian Transport Council issued a communique setting out the broad outcomes sought and a framework for action (Australian Transport Council (2001)). This lists strategic priority outcomes for the next 10 years, including:

- Economic development, accessibility, an integrated system, and the environment – the latter including sustainable transport, a national commitment to public transport, and reduced greenhouse emissions.

The Commonwealth government has introduced packages relevant to sustainable development such as the Natural Heritage Trust, Greenhouse Gas Abatement Plan, and tighter standards for motor vehicles and some fuels.

A national strategy has been released for freight / logistics and a broader approach for transport infrastructure funding has been announced (AusLink). This seeks a 'longer-term, participative planning and funding framework ... to ensure development of an integrated national land transport network that can support logistics growth over coming decades'.

The Commonwealth has promoted analysis of response options. A major report was issued in 1996 on transport measures, impacts and benefits and costs (Bureau of Transport and Communications Economics (1996)). This indicated that congestion charging held major promise as an option for emissions abatement and urban and economic management.

Some issues have been further addressed as part of economic evaluation under the transport module of the NGS (Bureau of Transport and Regional Economics (2002)). This report is essential for those addressing transport policy challenges. Some of the main findings are:

- Win-win measures (net community benefits) include – road use or congestion pricing, variable or use based charges for car use, some parking policies and tariff changes to promote use of more fuel-efficient vehicles. These win-win measures would not however achieve the abatement target of the Kyoto Protocol in the case of transport.
- Some measures with positive costs but potentially high abatement include economy-wide carbon taxes or emissions trading. These would ensure that national abatement centres on least-cost areas / sectors in Australia.
- Many other initiatives are available – these need to be assessed case by case for their effects and suitability in the setting in question. Some measures address emissions indirectly, and if they reduce congestion pressures, 'induced traffic' effects may reduce impacts.

Work by the National Transport Secretariat (NTS) has led to an emissions abatement package for urban transport. It has actions at both national and state levels and was approved by ATC in August 2002.

NTS states that transport is not performing well in greenhouse emissions and that to meet Kyoto targets all emitting sectors will be required to take significant action. The package sets 6 major outcome areas and strategic positions (objectives for attainment over the next 5 to 10 years):

- A fully integrated system with timely, reliable, accessible and safe travel.
- Programs to encourage people to take fewer trips by car.
- Transport costs / charges to move from fixed to variable costs bases.
- Significant improvements in emissions efficiency of urban vehicles.
- A national benchmarking system for urban land and transport planning, and planning leading to reduced car trip needs and improved liveability.
- A national transport investment framework implemented across all modes.

The package is the result of significant review and consultation. Application of it in tandem with enhanced urban management would lead to more effective and efficient progress towards sustainable urban regions and reduced transport-greenhouse emissions.

State and local governments have also been more closely addressing the links between development and transport demands. Urban plans have evolved as a result of these reviews, but these efforts may only be beginnings as transport emissions are rising still with no downtrend evident.

Broad options for transport

Described below are 3 broad approaches to greenhouse response which could be considered by transport decision-makers and participants in Australia.

1. A business as usual approach

This might play down the pressures and opportunities discussed in the previous sections. The consequences of this approach might be:

- Transport policies and investments continue along recent lines, with incremental improvements, but without clear focus on achieving gains against all of the key outcome areas.
- Emissions continue to rise.
- Aspirations, demands, and decisions taken externally to transport mount, until a point where major changes are forced on the sector.
- Some large investments under this approach could be wasteful, and the costs of changes would ultimately be high.

2. Graduated change

This would take some account of the issues above, but with a steady, graduated approach to change. The consequences of this might be:

- Transport policies and systems show steady improvements in terms of sustainable development outcomes but with some longstanding weak areas continuing (eg widespread use in urban areas of fuel inefficient cars).
- Emissions growth slows, but emissions by 2010 are much above the national Kyoto Protocol target (+8% growth between 1990 and 2008-12).
- The rate of progress means that the impacts of major external decisions affecting transport are reduced.

- Costs of change for transport – medium to high.

3. A pro-active role

This would take closer account of the issues of sustainable development, and adopt a steady, sustained, focussed approach to change. The consequences of this might be:

- Transport policies and systems show clear improvements in terms of sustainable development. Some longstanding problems are reduced (eg shares of the vehicle market held by fuel and space inefficient cars, weaknesses in logistics).
- Emissions growth slows, is eventually halted, then reversed gradually.
- The clear gains mean that major external decisions taken in pursuit of sustainable development have minor effects on transport.
- Costs of change for transport – low and often offset by efficiency gains.
- The transport sector begins to be seen as a leader in sustainable, efficient planning and development. Ancillary benefits are derived from servicing of new industries and from sales of expertise to other countries.

Response opportunities for transport in Australia

The following are basic mode-oriented avenues for addressing emissions:

- Trip reduction – frequency and length; demand; urban and potentially regional management.
- Use of cleaner modes – selection of modes with low emissions and energy use or low environmental impacts on a whole of life cycle basis.
- Cleaner operations for each mode – through combustion / power systems, fuels and functions such as maintenance, traffic and logistics management.

The scope of these includes urban transport (some 60% of national transport emissions) and regional transport. It also covers access to information, key community services, tourism sites and materials, and both demand and supply considerations and their interplay.

The challenge, especially for policy-makers, is to select from all avenues and instruments in order to arrive at:

- Response measures which maximise the most beneficial measures (with their economic, social and environmental effects), and

- Packages of measures – effective, efficient, acceptable and meaningful to participants at all key parts of the transport chain and from national to local community levels.

With this in mind Table 1 provides a summary of current and potential response measures. The Table sets out an approximate review of the current situation and of the potential by around 2010 for measures to achieve abatement.

The estimates necessarily have a judgmental basis. However close attention has been paid to recent advances in Australia in policy development etc. And allowance has been made for the results of many papers on abatement options over recent years, both with Australia and overseas, including recent OECD literature (OECD (2000), OECD (2001)) and the reports cited above.

The purpose is to provide a broad overview of advances to date, bearing in mind that transport emissions continue to grow. And to provide an overview of advances in future – having regard to potential for emissions abatement and to triple bottom line concepts covering economic, social and environmental factors linked to sustainable development.

Estimates for potential measures in future are based on the assumption of a 'pro-active response role' as discussed above in 'Broad options for transport'.

Some observations are, for advances to date:

- The main advances have been in voluntary measures.
- Regulated standards have been used to an extent – mainly for basic areas of vehicle and fuels systems. There has been no major regulated standards to date covering fuel efficiency or modal choice (in contrast to the energy source targets now applied in the electricity supply sector).
- Some early gains have also been made in urban planning, operations and traffic management (transport systems ongoing management).
- However, all these are still short of providing strong and sustainable abatement visible at the macro level.

Observations for the future are that scope exists for stronger response in:

- Demand-side measures – information provision to promote awareness of transport choices and their effects, and especially focussed behavioural change programs (eg at household and firm levels).
- Demand and supply impact measures – especially transport charging / pricing systems and emissions trading.

- Urban and transport forward planning, resource allocation and general response implementation.
- Vehicle standards and cleaner energy sources and powers. This extends to the fuel cell economy and provision of power from hydrogen and from renewable primary sources such as solar and geothermal.
- Infrastructure quality – systems design and management promoting efficient utilisation, and supporting urban plans, including effective intermodal connectivity and provision of choices for cleaner modes.

Transport opportunities – whole-of-government and community approaches

Transport is largely a derived demand. Passenger and freight demands / trips vary with economic functions such as commerce, education and export trade, with some social, communication and community needs, and with spatial factors (planned or resulting from general development).

Transport activity levels are dynamic and partly outside the control of traditional transport agencies, especially if pricing and regulation are constrained. Technology choices may also be outside their direct influence, especially if determined by national or international forces, which is increasingly the case.

This does not mean that transport agencies and participants cannot influence these variables. Transport agencies have strong capacities to act as 'benign intermediaries' in a range of relevant decision processes.

The role of a government is essentially that of one entity, serving community interests and seeking advances in key outcome areas. A whole of government approach is being increasingly emphasised in countries seeking improved synergies and focus across all portfolios, and better value for taxpayers.

Table 1: Overview of Actual and Potential Transport Sector Response Measures for Emissions Abatement in Australia

0 to 10 scale: 0 zero, 10 maximum, relative to potential application for abatement. Estimates of actual for 2002; **Estimated potential in 2010**

Response Type	Level of Response: 2002, and Potential by 2010			
	National Government	State Government	Local Government, Community Groups	Industry
Demand-side Measures				
Understanding / information	3 9	3 7	3 7	3 7
Awareness and attitude change	2 6	2 6	3 6	3 6
Focused behaviour change	2 5	3 9	2 9	2 7
Demand and Supply Measures				
Voluntary programs and agreements	6 9	3 8	3 8	4 8
Taxes & Charges	3 8	3 8	3 8	
Emissions trading	3 10	3 5	1 3	3 8
Pricing	2 8	2 8	2 8	
Urban forward planning	1 5	4 9	4 9	3 6
Transport systems forward planning	4 8	5 9	5 9	4 8
Transport systems ongoing management	5 8	5 8	5 8	5 8
Supply-side Measures				
R&D: technologies	3 7	3 7	3 6	3 8
Vehicle / fuel standards:				
1. Voluntary	4 8	2 5	2 5	3 8
2. Regulations	5 8	2 4	2 4	
Industry programs:				
1. Voluntary	4 8	2 4	2 4	4 8
2. Regulations	2 5	2 3	2 3	
Compliance programs	3 8	3 8	3 7	3 8
Supply investments:				
1. Vehicle stocks and quality	2 3	2 3	2 3	4 8
2. Infrastructure quantity	5 5	5 5	5 6	5 6
3. Infrastructure quality	4 8	4 8	4 8	4 8

This means that a strategy of closer 'engagement' or participation may be in the interests of many transport agencies, as well as local governments and transport participants. At the state government level, this means for instance:

- Engagement with other agencies responsible for urban and regional planning, funding or investment, the environment, energy, health, housing, information provision, education and industry. Also, closer engagement with major stakeholders, local governments and community organisations.

At the community level, this may mean broader approaches as well, including:

- Engagement with state / local governments, industry, research institutions, clubs, households etc.

The benefits of this approach at the community level may flow from:

- Improved access to government expertise and services, greater confidence in government, improved understanding of transport options / effects, closer involvement in planning (yielding improved designs of communities), and packages of measures tailored to local community conditions with higher levels of efficiency and acceptability

A judgment of this paper is that transport agencies, communities and industry have much more to gain and contribute through the pursuit and refinement of participative approaches.

Future changes

The scope of this paper does not extend to the future of all transport systems or to best practices in various settings over the entire spectrum of:

- Trip reduction, demand, urban, and regional planning and management, individual and group behaviours, transport systems integration, inter-modal logistics, cleaner modes / technologies, cleaner operations for each mode, future power systems, traffic and logistics management, optimal management of systems and communities etc.

However, brief comments are offered. Ultimately there are far-reaching options available to transport managers to assist with the global 60-70% cut in emissions required according to scientific assessment. These include:

- Use of technologies:
 - Harnessing of transport technologies for cleaner energy sources (such as hydrogen, and electric systems from solar, geothermal and other primary

energy sources), lighter vehicles, and advanced mass transit systems (tailored to specific urban markets, volumes and conditions).

- Advanced communications and scheduling systems (based on ITS applications, linked closely to the logistics needs of industry and community), advanced personal movement systems (including electric vehicles, powered bicycles and similar, and short notice hire vehicles).
- Integrated design and management:
 - Design and management of transport systems based on far closer communication, involvement and responsibility links between governments, industry and community levels, and between key portfolio areas (such as transport, environment, industry, energy and land use).
- Urban management:
 - Management, resourcing, performance reporting, and responsibility models providing assurance that community resources are being used to their best effect, that outcomes are appropriate, and that side effects of urban activities are being addressed effectively.
- Triple bottom line:
 - Much closer attention to this approach by governments, firms and the community across Australia.
- Investments:
 - Chosen more in accord with a whole of life cycle approach to energy use (covering greenhouse emissions and other major inputs and outputs), with triple bottom line criteria, and with integrated cross-sectoral regional and urban plans.
- Information and electronic economies:
 - Closer attention to information flows as a means of access to education, ideas, entertainment etc. Attention to emerging trends such as 'de-materialisation' (lighter materials, miniaturisation, lifestyles based more on entertainment and communication systems).
- Transport and communications pricing.
 - Including much improved efficiency and equity.

Conclusions

This paper has overviewed challenges facing the world and Australian transport through greenhouse and climate change.

The main risks are – greenhouse emissions and altered heat balances could change regional climates and bring major variations. The effects could be very severe. The world's population is centred near food and water sources but there could be strong shifts in water supply, cropping and diseases. A key factor is that a cut of 60% to 70% in global emissions may be needed in coming decades to ensure that atmospheric levels do not continue rising.

Studies indicate that Australia is unlikely to escape climate change. A degree of climate change is inevitable according to CSIRO.

Australian strategies on greenhouse are still evolving. Stationary energy emissions rose 27% over 1999-2000 and transport emissions rose 24%.

There are risks and opportunities for Australia. For instance, if mitigation is too slow, risks include forced change from international pressures and earnings losses from sectors with lower carbon intensity. Australia's strategic position may be affected.

Australian transport policy makers have essentially 3 broad approaches: 1. Business as usual, 2. Graduated change, and 3. a Pro-active approach. This paper argues that the pro-active choice is appropriate. This would involve a sustained, focussed approach to change. Benefits of this might include:

- Transport systems improved in terms of triple bottom line results. Key problems reduced, such as the pervasive use of fuel-inefficient vehicles, and logistics. Urban living quality improves.
- Emissions growth slows and eventually reverses. Costs of change are largely offset by efficiency gains. There are benefits from servicing of new industries and from sales of expertise overseas.

The challenge for policy makers is to implement actions to maximise economic, social and environmental benefits and which are effective and meaningful to all key participants. Scope exists for stronger responses in:

- Demand-side measures – information to promote awareness of transport choices and their effects, and focussed behavioural change programs.
- Demand and supply impact measures – especially transport charging or pricing systems and emissions trading.
- Urban / transport forward planning, resource allocation, general implementation and accountability.

- Vehicle standards and cleaner power sources.
- Infrastructure quality – design and management supporting urban plans and efficient utilisation, with effective inter-modal connectivity and choices in cleaner modes.

In moving in these directions, actions designed in participation with other sectors – such as land use planning, energy, health and housing agencies, and with industry and communities generally, will yield greater benefits.

Ultimately transport solutions can be tailored much more effectively to community needs while yielding solutions vital to global climate stability.

Notes

1. The US National Research Council (2001) has broadly supported the IPCC findings. It notes that global warming could well have serious adverse societal and ecological impacts by the end of this century (and after), especially if temperatures approach the upper end of the IPCC projections.
2. Research continues into possible shifts in major ocean currents such as the Gulf Stream and Pacific Ocean systems).
3. Lower rainfall in some areas could reduce weathering losses for roads).

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