Climate change, transport and land use: local challenges of governance

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Abstract

Urban transport today is almost everywhere unsustainable (Banister, 2005). In large part 'unsustainability' comes down to transport's impact on climate change. The urgency and scale of the threat of climate change means that the logic of climate stabilization within the scope of existing technology, as proposed by Pacala and Socolow (2004), needs to be tried. It is relatively easy to imagine a set of mutually reinforcing actions, feasible within existing technology, that would reduce the emissions of greenhouse gas from urban transport by a factor (over a 'business as usual' scenario) sufficient to reduce sectoral emissions to within 'stabilization' limits (briefly outlined in Low et al 2005: 186). But the local challenges for the governance of urban transport within a particular city to deliver such an outcome are considerable and largely unexplored.

As recognized in the Track 12 description, and recently by the UK Stern Review, mitigation and adaptation will not be achieved by the imposition of market rules alone (such as carbon trading regimes) but also require a range of adaptive responses at local level. The purpose of this paper is to outline and discuss some of these local governance challenges within the context of an Australian metropolis. Whilst the Australian setting imposes certain specific contextual parameters, there are also generic lessons to be drawn about issues of governance for mitigation and adaptation.

The paper first sets out a hypothetical set of targets that constitutes a 'climate stabilization wedge' (following Pacala and Socolow) for urban transport. The potential for achieving these targets in the context of Melbourne is then discussed. The paper then considers the question of policy change, and in particular three challenges of governance which will need to be addressed: the intergovernmental challenge, the challenge of path dependence, and the community engagement challenge. In the first case a climate change strategy for transport would need to be realized at all three levels of government (in the Australian federal system), local, state and national. Coordinated policy shifts at each level would be required. In the second case, the inertia and path dependence of existing policy needs to be acknowledged and steps taken to move the underlying institutional structure on to a new path adjusted for climate change (Low, Gleeson and Rush, 2005). Finally the question arises of how the long term interests of a metropolitan community can best find expression in such a way as to influence government.

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Introduction

Climate change is 'the greatest and widest-ranging market failure ever seen' (Stern Review, 2006: p.i Executive Summary). Environmentalists who have been pointing out the dangers of climate change for decades may feel aggrieved that only now that climate change is described in terms of money and markets, do people with the real power to act show signs of waking up to it. Nevertheless the Stern Review must be welcomed as an important sign that 'ecosocialization' is occurring (Low, 2002), but it is necessary to look further into the governance of climate change adaptation. For the real power to act on climate change lies not with consumers, nor with markets – because markets are not actors – and not primarily with businesses, but with governments. Climate change is in fact the greatest *government* failure ever seen.

One thing is clear. The world cannot wait any longer to act. In the 1990s climatologists warned unambiguously that a 60% reduction of greenhouse gas emissions on the 1990 benchmark was necessary to stabilize atmospheric concentrations of greenhouse gases. Since then, according to the Earth Policy Institute, annual gross world product has grown from US$37.1 trillion to US$61.0 trillion (2005 dollars) almost certainly dwarfing improvements in emissions per dollar value of output[1]. So now instead of a 60% reduction, at least a 70% reduction on 1990 is necessary. Stabilizing global emissions at 450 parts per million by 2050, which is arguably a minimum requirement for climate stabilization, would require about an 80% reduction in current emission levels (Bows and Anderson, 2006). Emissions levels vary widely amongst countries. Australian emissions are currently running at about 18 tonnes per capita, while many African countries average less than 0.2 tonnes per capita (World Bank, 2006). So the main focus of emissions reduction must be in the developed world. Each year that passes the task becomes larger, more difficult and more expensive. Climate change, as Stern points out, costs real money!

The purpose of this paper is to take one apparently feasible strategy for emissions stabilization, that of Princeton scientists Pacala and Socolow in a paper published in *Science*, and consider not the technological problems but the institutional problems of implementing it in the context of the Australian metropolitan city of Melbourne.

Stabilizing greenhouse emissions

Pacala and Socolow (2004) propose 'stabilization wedges' to address the climate problem. To paraphrase these authors, the 50 year trajectory (2000-2050) can be represented on a graph with time on the horizontal axis and fossil fuel emissions on the vertical. The space between the line representing *business as usual* emissions (tending upwards) and the line representing desired emissions for stabilization (flattening and then turning down) make a rough triangle: the 'stabilization triangle'. This triangle can be divided into a series of wedges representing mutually reinforcing spheres of action. Options for 'stabilization wedges' proposed by the authors include: improved fuel economy, reduced reliance on cars, more efficient buildings, improved power plant efficiency, substituting natural gas for coal, storage of carbon captured in power plants, hydrogen plants, and synthetic fuel (from coal) plants, nuclear fission, wind electricity, photovoltaic electricity, renewable hydrogen, bio-fuels, forest management, and management of agricultural soils. They point out that all of these options can be employed today (and most are) with known and tried technology, and that, while none is 'a credible candidate for doing the entire job (or even half the job) by itself, the portfolio as a whole is large enough that not every element has to be used' (*ibid*: 968).

Pacala and Socolow focus on technical change. It seems unlikely, however, that technical change alone can be relied upon to produce the desired results without concomitant change in urban life.

[1] See www.earth-policy.org/Indicators/Econ/2006-data.htm#fig1

In the transport policy sector a change will almost certainly be required in existing patterns of urban mobility. Such change can be part of the portfolio approach advocated by these authors, but the policy changes required to produce change in patterns of urban mobility will also require institutional change, which is the main focus of this paper. First, though, we need to consider 'wedges' idea in more detail.

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'Portfolio' thinking suggests that government strategy should not be limited to manipulating the market through emission caps and carbon trading. More active interventions are needed at the city level. The options mentioned above suggest a first sub-division of the task to create an *urban* wedge, an *energy* wedge and an *agricultural* wedge. Of course these wedges interact: for example the global bio-fuel crop will compete for land in some places with the food crop, and bio-fuel policy interacts with transport policy. These interactions are critically important, and in some areas there are greater doubts about the science of emission reduction than about climate change itself: will the proposed action actually reduce CO_2e (equivalent) emissions in one sector (say, vehicle technology) without interfering in other policy goals (e.g. food security) or with emission levels in another sector (electricity production) ? What will be the economic cost (or cost saving) of reduction strategies? A significant fraction of scarce research funds needs to be devoted to answering such questions.

If mobility is considered a good, its extremely skewed distribution throughout the world means that justice demands a fairer distribution. Assuming that the distribution of mobility roughly corresponds with the distribution of GHG emissions, a much larger than 80% reduction in emissions from transport is necessary on the part of the developed world to allow poorer countries to increase their mobility. Moriarty and Honnery (forthcoming) point out that if global car ownership increased from the 2003 value of 114 per 1000 persons to 300 per 1000 in 2030, then CO_2e emissions per passenger kilometre would need to fall 14-fold for a four-fold reduction in global CO_2e emissions.

Let's consider in greater detail one element of an urban stabilization wedge: the urban transport task.

Spheres of Action	**GHG Reduction**	**Reduction Factor (cumulative)**
Travel 'business as usual' (current)	1.0	1.0
Travel demand management Reduce travel demand by 30% (greater use of work from home using communications technology; more efficient logistics etc.)	0.70	0.70
Travel carbon efficiency Shift 30% of journeys to low or non-GHG modes (low carbon public transport, cycling, walking for short journeys)	0.70	$0.70^2 = 0.49$
Vehicle occupancy Increase vehicle occupancy by 30% (more people per vehicle in private and public transport),	0.70	$0.70^3 = 0.34$
Vehicle fuel efficiency Improve fuel efficiency for travel by 30% (use of low powered engines for cars, lightweight cars)	0.70	$0.75^4 = 0.24$
Fuel GHG performance Obtain 30% energy for individual travel from renewable or low carbon sources	0.70	$0.75^5 = 0.17$ (circa 83% reduction)

Figure 1 Options for cumulative reduction of GHG emissions from urban transportation

In the above Figure 1, five spheres of action for a putative 30% reduction in each are combined to produce an overall reduction of around 83% on the *business as usual* trajectory. These factors might in some cases have potential for greater reductions and in some cases less, but in

combination they achieve what would probably be beyond any single policy element. The total reduction of 83% of current emission levels from transport in a developed economy such as Australia is not enough to compensate for growth of mobility in developing nations, so further large scale reductions would be required after 2050.

Let us now consider the actual prospects for change in somewhat greater detail.

Prospects for change

What follows is a somewhat speculative discussion of the potential for change in the elements outlined in the preceding section.

Travel demand management

A thirty per cent reduction in travel looks like a difficult proposition in the light of the continuous *growth* of travel in the developed world over the last fifty years. In Australia total metropolitan[2] road travel by all types of road vehicles has been projected to rise by 41 per cent between 2002 and 2020 (Gargett and Gafney, 2006). However the task may not be impossible given the right mix of policies. A 30% reduction in total kms traveled by road from 2007 means returning to something like the total for 1993, from about 135 billion kms to about 94 billion kms. A 20% reduction means returning to 1998. Was Australia so much worse off then? Comparing Melbourne with European cities shows that Melbournians take 27% more trips per day (all trips by all modes) than the average for seven European cities and 40% more trips than Londoners (see Figure 2). These figures suggest strongly that economic prosperity is not necessarily linked to mobility. It should be possible with the right mix of policies to bring Melbourne nearer the average for prosperous European cities.

Gargett and Gafney (2006) do not consider the problem of climate change at all, or the potential for travel demand management to help solve it. The potential for remote communication to replace at least some of the daily journeys from home to work – a pattern stemming from 19th century factory and 20th century office practices – has scarcely yet been tapped. Improved freight logistics designed to reduce trips instead of reducing storage at depots can also play a role. 'Just in time' delivery systems place a great many more vehicles on the roads at less than full load, and is only really economically viable because the market price of travel is so low. Travel reduction could attain its own momentum once the price of travel is increased to reflect the true costs of global warming.

Cities (2001)	Daily trips per inhabitant	Daily mechanized trips per inhabitant	% of daily trips on foot and by bicycle	% of daily trips by private motorized modes	% of daily trips by public transport
Melbourne	3.72	3.09	18	76	6
Amsterdam	2.9	2.15	51.4	33.9	14.7
Brussels	2.82	2.08	27.5	58.9	13.6
Copenhagen	3	2.44	39	48.9	12.1
Helsinki	3.1	2.41	29	44	27
London	2.65	1.86	31.1	50.2	18.8
Munich	3.2	2.3	37.5	40.6	21.9
Stockholm	2.77	2.07	31.4	47.1	21.6

Figure 2 Mobility and Modal Split in Melbourne and European Cities (Source: UITP, *Mobility in Cities Database* 2001)

[2] Road travel in Australia's large State capital cities.

Travel carbon efficiency

The next element is shifting as much as possible of the remaining travel to zero carbon modes: walking and cycling. Since around half of all journeys in metropolitan Melbourne are of less than five kilometers (according to The Transport Research Centre Victorian Activity and Transport Survey), it seems that a large proportion of these journeys could be made on foot or bicycle provided that well constructed, safe foot and bicycle paths are provided. A comparison of Melbourne with prosperous European cities is again instructive. Melbourne stands out as being very different in modal split, with only 18% of all trips on foot or by bicycle compared with the average for the European cities in Figure 2 of 35.3%. With the right mix of policies, and serious expenditure on walking and cycling – not just for recreation but as a mode of transport – it should be quite possible to achieve more than a 30% increase in trips on foot or by bicycle. In fact a 50% increase would bring Melbourne up to the lowest of the European cities, Brussels.

It has been argued that what makes Melbourne and other Australian cities different from European cities is gross residential density (Newman and Kenworthy, 1989). Australian cities have much lower densities than European cities. But density is likely to bear little causal relationship to the above two factors. The difference is much more likely to be cultural.

The next three elements in the portfolio are closely related. The aim is to maximize the travel possible with a given level of CO_2e emissions (Moriarty and Honnery, forthcoming). These authors expand passenger kilometers per kg CO_2e into the product of the following three factors: The vehicle occupancy rate (pass-km/vehicle-km), the vehicular well-to-wheels (i.e. primary) energy efficiency (vehicle-km/MJ) and the primary energy available per unit of GHG emissions (MJ/kg CO_2 e).

Vehicle occupancy

It seems difficult to increase the vehicle occupancy rate of private cars by very much. Moriarty and Honnery point out that negotiating trips with others greatly reduces the convenience of the private car: 'If, say, car occupancies were permanently required to double to around three persons per car, the nature of car travel, and its perceived benefits, would be profoundly changed. Timing and even destination of trips would have to be negotiated to fit in with the needs of others, often non-family members'.

Increasing the vehicle occupancy rate for public transport is likely to have a much greater effect than for cars. Although Melbourne has an extensive fixed rail system, patronage gains in a fully public transport system will mainly occur on an expanded bus system, given that the road infrastructure is already in place. And as Moriarty and Honnery point out, globally most public transport is currently by bus. They argue that, if applied throughout the OECD, a fivefold improvement in passenger kilometres per kg CO_2e would result from a full shift to public transport compared with a fully car-based transport system. This improvement would result from both the higher occupancy rates possible with public transport and the greater fuel and GHG efficiency of existing public transport compared with existing car fleets. By 2030, it should be possible to raise the fuel efficiency of the OECD public transport fleet by 50 per cent. Combining these factors gives a 7.5-fold GHG efficiency advantage for 2030 public transport compared with existing car travel[3].

[3] Moriarty and Honnery write 'Akerman and Hojer (2006) assume a doubling of fleet efficiency at constant passenger loading is possible for both buses and trains by 2050 in Sweden. Here we assume that worldwide pass-km/MJ can be raised by a factor of 1.5 by 2030 for all public transport systems at constant loadings. For no change in fuel mix, pass-km/kg $CO_{2\ equiv}$ would rise a similar amount. Thus a typical OECD public transport system in 2030 might be 7.5 (i.e. 5x1.5) times as $CO_{2\ equiv}$ efficient as a present fully car-based one'. 750% improvement in fuel efficiency per km travelled equates to a reduction in emissions to 1/7.5 of the starting point.

Vehicle fuel efficiency

Recent European studies suggest that 65% to 80% energy efficiency gains are possible in car performance (Akerman and Hojer, 2006; Ramesohl and Merton, 2006). An even more optimistic report comes from MIT researchers who propose that an improvement is possible of up to 169% (cited in Moriarty and Honnery, forthcoming). These are for new vehicles only, but converting, say, two thirds of the entire Australian car fleet by 2030 seems feasible. Improved energy efficiency of vehicles translates directly into improved greenhouse performance – the less energy used, the less CO_2e emitted, all other things being equal. Even taking the least optimistic figure indicates that at least a 40% reduction could be achieved by converting two thirds of the Australian car fleet over the next 50 years. Improving the fuel efficiency of public transport, particularly the bus fleet, may reduce emissions by another 5%.

Fuel GHG performance

What are the prospects for alternative fuels that can be easily stored and delivered, and emit less CO_2e in combustion per unit of energy than fossil fuels? A variety of fuels have been proposed for this role. Biomass based fuels can be regarded as emission-reducing, though they are not, as is sometimes claimed, carbon neutral. Burning fuel from biomass releases CO_2 into the atmosphere but the growth of biomass for fuel also absorbs CO_2. Such fuels include ethanol and bio-diesel, produced respectively from corn or sugar cane, and rapeseed oil. But these crops compete for agricultural land with food crops, the demand for which will grow as world population grows. Also, just as with food crops, cultivation requires energy and fertilizer, which usually comes from fossil sources, and water which, as the planet warms, will also become more scarce in cropping regions. Some authors argue that the fossil fuel energy inputs required for cultivation are not much less than the energy content of the resulting liquid fuel (Wald, 2007; Reijnders and Huijbrets, 2006). Ethanol made from cellulosic plant matter may give a better net energy return, but is not yet in production. In the USA the production of cellulosic ethanol is only expected to rise from 2.9% of total fuels to 6.5% by 2030 (EIA, 2007).

Then there is electricity to convert directly to traction via electric motors, or to produce hydrogen via electrolysis which can then be burned in the engine. Excitement about the ‘hydrogen fuel cell car’ or the ‘hydrogen economy’ seems to be generated by the fact that burning hydrogen produces no carbon emissions. This neglects the fact that hydrogen has first to be produced using electricity or through fuel cells which usually employ fossil fuel. Hydrogen is a means of storing energy, and in this respect it can be compared with the more traditional electric battery. Moriarty and Honnery report that plug-in hybrid vehicles, using electricity from the grid stored in batteries plus efficient fossil fuelled engines to extend the range of the vehicle, are likely to be four times more greenhouse-efficient than vehicles powered by hydrogen fuel cells with hydrogen produced by electrolysis (Romm and Frank, 2006; Romm, 2006; Van Mierlo, Magetto and Lataire, 2006)

Both private individualized transport (cars) and public transport vehicles can run on electricity produced by renewable energy. Such energy can be produced by sunlight (photo-voltaics), wind or wave power, nuclear energy or coal whose carbon emissions have been captured and prevented from release to the atmosphere. The prospects for a larger proportion of energy being produced in future from renewable sources are difficult to predict, but Moriarty and Honnery point out that, far from increasing, the share of renewable energy in the global energy production total is on track to fall by 2030.

Railways and trams in Melbourne are powered by electricity produced from lignite, or ‘brown coal’ which has the highest CO_2e emissions of any solid fossil fuel. So, perhaps paradoxically in this case, some improvement in emissions can be expected over the next thirty years with the introduction of more efficient power stations and carbon capture and storage. For individualized transport a more hopeful and less distant prospect might be battery or plug-in hybrid vehicles charged from electricity produced and stored in the place of residence from roof mounted photovoltaic arrays. An Australian invention for increasing both efficiency and flexibility of

photovoltaics (sliver cells) was recently reported in Melbourne's broadsheet newspaper, *The Age,* by its economics editor (Colebatch, 2007). Finally there are methods of removing carbon from fossil fuel combustion on the vehicle using plasma technology (Destefani and Siores, 2003). But the principal drawback of these is the difficulty of disposing of the large amounts of solid carbon 'ash' generated.

The general conclusion must be that we do not know yet whether a 30% reduction in emissions will be possible from new and changed fuels in the next 30-50 years. These technologies have to be placed in the realm of the speculative future, not the present.

The foregoing discussion has examined the potential of benign change in transport to reduce greenhouse emissions by the necessary 80% or more in the context of Melbourne, Australia. The discussion has proceeded from the easiest to the most difficult routes to reach this goal. These changes can be achieved through judicious policy shifts, but these policy shifts in turn pose considerable challenges for the governance of transport, and it is to these I now turn.

Governance challenges

Democracy nourishes the popular belief that the primary means of policy change is through the ballot box, following vigorous public debate and pressure group activity. The corollary is that if policy does not change it is because the public does not want change. Political scientists of course have known for many years that policy change and stasis is not that simple. I have argued elsewhere that public policy is determined at least as much by the tacit and structural dimensions of politics as by the 'play of power' (). The particular features of episodic battles over policy do not necessarily reveal much about the institutional rules governing the power play, nor about the belief systems concerning what is relevant and what not, what action will lead to what effect, what actions are within the bounds of political possibility, and what the public and stakeholders want. In moving towards policies directed at targets within the five spheres of action discussed above, the major challenges lie in the institutional dimension of political power.

What happens in Melbourne has to be understood in the wider context of Australia, a federation with a highly dispersed population. Some background is necessary here. There are five large metropolitan, 'primate' port cities, around the coast; from the west: Perth (1.478 million), Adelaide (1.129 million people), Melbourne (3.635 million), Sydney (4.256 million), and Brisbane (1.818 million, but including the adjacent settlement of the Gold Coast, 2.301 million). Canberra (0.325 million), the national capital, was deliberately sited inland between Sydney and Melbourne. Hobart (0.203 million), the capital of the offshore island state of Tasmania, is little more than a large country town. Darwin (0.111 million) is a small port city on the North coast facing Indonesia, and there is a string of small ports northwards up the east coast of Australia from Brisbane. Mining towns such as Broken Hill, Kalgoorlie, and Mount Isa, and tourist towns such as Alice Springs are dotted over the vast inland. The main urban centres (including large rural towns) house about 60 per cent of the population[4].

The mainland state capitals are surrounded, at a distance of up to 150 kilometres by smaller rural towns, and separated from each other by huge areas of sparsely populated agricultural land and, in the case of Perth, by the Nullarbor desert. So distances between cities are long. From Perth to Adelaide is 2725 kilometres (and to Sydney 4110 kilometres) making that city the most geographically isolated in the world. From Adelaide to Melbourne is 728 kilometres, Melbourne to Sydney 963 is kilometres, Melbourne to Canberra is 647 kilometres, and Sydney to Brisbane 1010 kilometres. The siting of what eventually became the State capitals is owed directly to the British colonization and settlement of Australia which initially took place from the sea. Canberra is the only major settlement whose site was chosen by Australians.

[4] Population figures taken from Australian Bureau of Statistics estimates for 2005. http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/80A49E8C

This human geography has three major implications for transport policy. First, there is no real development of polycentric urban regions as in Europe and parts of the USA, which propel demand for new rapid mega-transport land links amongst cities. Secondly, because the main function of the road and rail systems at national level is to link agricultural areas and remote mining centres with the metropolitan ports, the federal transport portfolio has traditionally had a rural bias. In the case of the conservative side of politics, the Minister responsible for transport is traditionally chosen from the National Party (formerly the Country Party, governing in coalition with the Liberal Party). Although the majority of Australia's population lives in large cities, the rural vote remains important and can tip the balance at general elections. This gives the transport portfolio a rather conservative flavour with little interest in emerging issues for the longer term future such as climate change. The third implication of Australia's geography is that major transport infrastructure investments are located within the metropolitan cities and initiated by the State governments responsible for planning and managing urban transport and building infrastructure.

Australia is a post-colonial society inheriting British democratic political institutions adapted for the colonies. The Australian 'State' is a British institutional invention creating self-governing successors to the separate colonies, which before that were governed from Whitehall. The six States, together with two mainland 'Territories' (The Northern Territory and the Australian Capital Territory) somewhat artificially divide up the whole surface of the continent. With the exception of Queensland they have a bicameral Parliament elected by a variety of voting systems, none of which includes the British 'first past the post' system in which the candidate with the largest number of votes in a constituency takes the seat. In some States there are forms of proportional representation, in others preferential voting in which the order of preferences on ballot papers is counted if the candidate with the largest number of votes fails to command an overall majority.

In 1901 the States agreed among themselves, and with the colonial power, to form a national federation called The Commonwealth of Australia with a federal government. Elections for the Commonwealth Government are held every three years, with preferential voting for the House of Representatives (lower house) and proportional representation for the Senate (upper house). It is widely agreed by Australian political analysts that the federal government has steadily enlarged its powers relative to the States with each successive administration. One of the most important federal enlargements was the acquisition after referendum of the power to levy income tax. One of the latest enlargements is the revision of the industrial relations system in Australia under the Commonwealth power to regulate 'corporate affairs', found by the High Court of Australia to be constitutional following challenge by the States. This ruling is widely agreed to have itself greatly enlarged the corporate affairs power. The Territories are still in some minor respects governed by the federal government, but, like the States, they have their own elected parliaments empowered to make laws and deliver services for the benefit of their residents.

Elected *local* governments were instituted by the colonies and therefore predate the States, but then as now local governments were the creature of and subordinate to the central power, then the British colonies, now the State Governments. As in the British constitution, the central power has the constitutional power to dismiss any locally elected Council, or all of them at once (as happened in Victoria in 1993).

The intergovernmental challenge

A major institutional challenge is the articulation and co-ordination of action between levels of government. Figure 3 summarizes the level of government at which different actions will mainly need to be focused.

Sphere of Action	Level of Government
Travel demand management	*Federal*. Fiscal regime aimed at discouraging unnecessary travel and internalising the environmental cost of travel. *State*. Congestion pricing on all main roads.
Travel carbon efficiency	*State* and *Local* working together to improve walking and cycling facilities and introduce high carbon efficiency buses.
Vehicle occupancy	*State*. Improvement of the public transport service system-wide to encourage greater use. Shift of investment priority from roads to public transport. *Federal*. Shift of investment from roads to urban public transport.
Vehicle fuel efficiency	*Federal*. Reforms to fiscal regime to favour energy efficient vehicles.
Fuel GHG performance	*Federal* and *State* working together to create cleaner energy technologies.

Figure 3 Spheres of action and levels of government

Local

Local government is most likely of the three tiers to adopt innovative policies, but also has least power over the five spheres of action. Melbourne City Council has adopted a strong agenda to meet the challenge of climate change, building a new council headquarters at the cutting edge of energy and water saving technology (www), and conducting a far-reaching stakeholder consultation linked to university research to plan its strategies for the next twenty five years (www). The city is also host to the Melbourne Principles for Sustainable Cities developed by the United Nations and ICLEI (http://www.severnsound.ca/Melbourne_Principles.pdf). But the boundaries of the City only include the CBD and a few surrounding residential areas, and the Council's policies are always liable to be checked by the State Government. For instance a recently announced plan by the Council to introduce 'Copenhagen' cycle lanes[5] along one of the main boulevards leading into the City was swiftly vetoed by the State Minister for Roads who is reported to have said: 'People have a right to drive their cars, and they have a right to do it without being impeded upon (sic) … for the purposes of looking after 2000 cyclists'. (Lucas and Millar, 2007)

Because the CBD is also the main commercial centre and seat of Parliament of the State of Victoria, the State Government maintains an interventionist stance, and has at times assumed all planning powers over the City area. Nevertheless Melbourne City Council can act as a focus for innovation amongst inner city councils, and apply pressure on the State Government. The Council has the power to transform the public space of the city from an environment dominated by roads and the facilitation of through traffic to one in which walking, cycling and public transport (tramways) provide the principal means of mobility (along the lines of Europe's 'car-free cities'). Doing so would provide a working model for at least the inner Melbourne group of councils.

[5] Segregated cycle paths located between the footpath and the inside of a line of car parking spaces along a road, designed to provide improved safety for cyclists, especially from opening car doors; allegedly originating in Copenhagen.

State

The State Government of Victoria is charged with responsibility for construction and maintenance of main roads, regulation of road traffic, and provision of public transport for the whole state. Local government's capacity to improve the flow and connectivity of public transport is limited, whilst the State has the statutory power to act comprehensively on the public transport system as a whole for metropolitan Melbourne. Its ability to co-ordinate public transport modes (trains, trams and buses) is, however, restricted by the decision of a neo-liberal administration in the late 1990s to privatize public transport service delivery, resulting in a dual private monopoly over train and tram services (the only case of privatization of public transport in Australia). The State retains ownership and control of the infrastructure while service delivery is the subject of franchise agreements with two private companies owned by French multinationals Veolia Environnement (Connex[6]) and Transdev (Yarra Trams: Transdev in joint ventureship with Australian company Transfield Services). This form of private-public partnership appears to reduce the capacity for innovative network planning, which would incorporate, for instance, pulse-timetabling of services where there is lower density of demand (Nielsen, 2005: 89, para 3.2). The State has introduced a state-of-the-art, on-line, user-friendly data base for public transport users to plan their individual journeys, but this data base is not being used to plan the network itself (MetLink). Earlier private-public partnerships on road building projects have introduced electronic tolling of some parts of Melbourne's freeway system, but it is socially unfair and irrational for some road users to be dependent on toll roads while others have free road access. Eventually the State Government will have to introduce a more rational system of road pricing, both to spread the burden more fairly among social groups and to internalize environmental and congestion costs.

The State Government is in a pivotal position in the intergovernmental system and would need to work closely with local governments in Melbourne (all thirty one metropolitan councils) to transform the mobility environment of the metropolis, and with the federal government to transform the fiscal environment affecting transport. Of particular importance is the source of energy for electric public transport (as mentioned above). The State Government is responsible for electricity supply, but the power industry is also now privatized and has every incentive to exploit the potential of cheap energy from brown coal. Only a collaborative federal-state relationship is likely to change Victoria's energy profile to introduce a higher proportion of renewable and clean energy, which would ensure that a modal switch from cars to public transport contributes maximally to greenhouse gas reduction.

Federal

There are many ways in which the federal fiscal structure favours cars and roads over other forms of transport: for instance tax rebates for car use by business travel (more than a dollar per kilometre for large vehicles, nothing for public transport or cycling), subsidies for the use of diesel fuel, and a long standing set of programs of direct expenditure on road infrastructure – with zero for urban public transport systems. Changes in priorities within this structure, without any additional expenditure, could lead to large changes in urban travel behaviour and fuel use, with corresponding reductions in CO_2 emissions. Below I briefly examine the national transport infrastructure program.

The federal (Commonwealth) Government does not directly build infrastructure, rather it provides funding for land transport under various programs in addition to the Goods and Services Tax (GST comparable with VAT in Europe) receipts which are redistributed to the States. It should also be noted that the federal government has, since 1996, taken no part in any form of intervention in urban and regional (land use) development or planning.

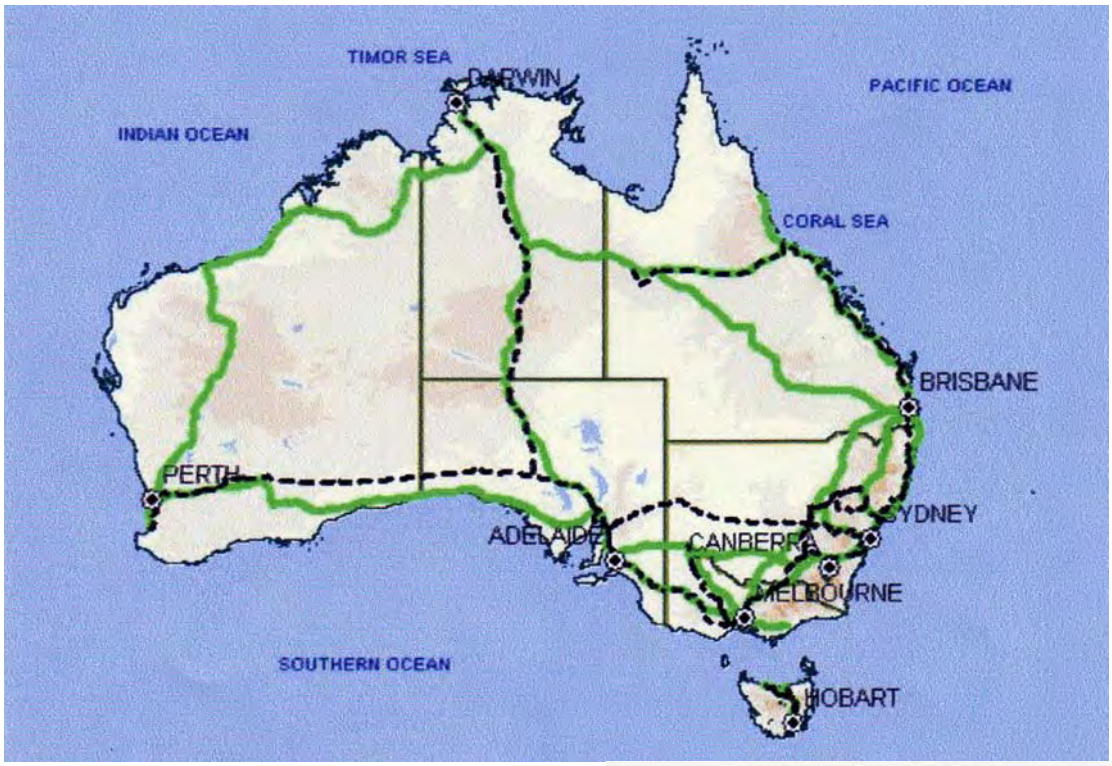
In 2005 the Federal Government enacted new legislation to govern its involvement with land transport: the AusLink (National Land Transport) Act 2005. The first phase of AusLink (AusLink 1) provided funding of AU$9.3 billion over five years for national projects on the AusLink national transport network. The funding was allocated as follows:

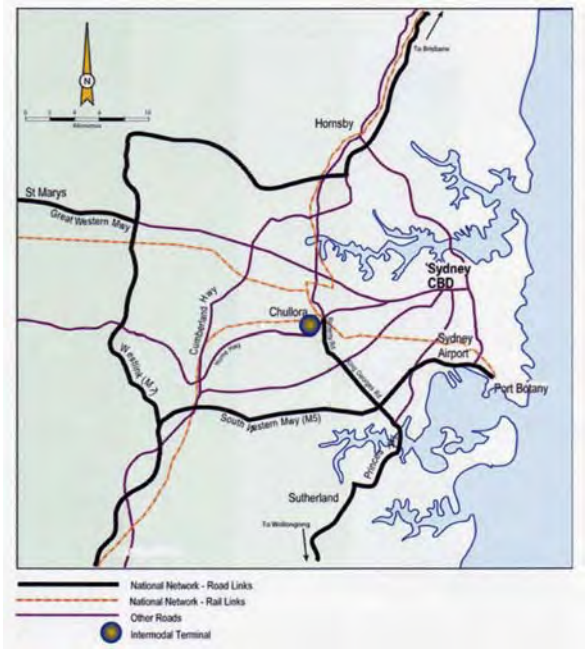
[6] Connex also operates the Stockholm metro in partnership with AB Storstockholm Lokaltrafik.

- AU$7.6 billion for road, rail and inter-modal construction,
- AU$1.5 billion for road maintenance and
- AU$120 million for national rail projects and the upgrading of bridges so that they can bear heavy vehicles.

Funding for AusLink was greatly increased in the 2007 federal budget (May 8th, 2007) which promised a massive AU$22.3 billion to be spent on the second phase of AusLink (AusLink 2) between 2009 and 2014 (Smiles, 2007). This includes AU$19.3 billion going to 'road and rail' infrastructure, and AU$3.2 billion earmarked for local roads grants. Foreshadowed is a major rail improvement program between Melbourne and Brisbane 'to improve access to major ports to ease freight bottlenecks' (ibid.). However the overwhelming emphasis is on road building projects which are already fully programmed in the State road building agencies' plans and can readily be implemented.

AusLink (http://www.auslink.gov.au/ - accessed May 16th 2007) applies to the major road and rail links which are assumed to run in 'corridors' between Canberra, the national capital, and between each state capital. In fact within urban transport systems, where a considerable proportion of the Commonwealth funding is applied, the concept of corridors breaks down since urban transport systems are functional networks. Funding is most needed for metropolitan road and rail network improvements managed by State governments, not road corridors designed by the federal government. What the federal government is thoughtlessly doing in the alleged interests of improving the 'national network' is providing funds for new motorways in Australian cities, particularly in the outer suburbs, thus keeping them car-dependent. An example of the federal intervention in two cities is shown in Figure 4 below.





SYDNEY **MELBOURNE**

Figure 4 Federally funded road building projects in the 'national road network' and its impact in Sydney and Melbourne (The black lines are road projects)

The challenge of path dependence

Federal and State policies are not easy to change. Transport policy, as has been argued elsewhere is subject to inertia which takes the form of path dependence in three dimensions (Low, Gleeson and Rush, 2005). First there is the technical dimension resulting from the imprint on city form of transport infrastructure. Second, there is the institutional dimension resulting from the growth of organizations and institutional arrangements for delivering transport policy. Third there is the discursive dimension resulting from the story lines which shape the public understanding of different aspects of transport policy.

The urban form of metropolitan Melbourne has been, and is still being, shaped physically by transport infrastructure. The low density sprawl of Melbourne's suburbs was first made possible by the construction of the suburban railways, and journey to work patterns still reflect the influence of the radial rail corridors, later reinforced by radial motorways (see Figures 5 and 6). Figure 5 shows the main transport infrastructure of metropolitan Melbourne. Figure 6 shows the distribution over metropolitan Melbourne of the work destinations of the resident population of one statistical local area, using figures from the 2001 national census. It will be noted that despite the radial tendency of the system, a ring road is being constructed to facilitate cross-town travel. There certainly is a demand for cross-town travel but it is already accommodated on high quality, mostly dual carriageway roads with traffic light controlled crossings. The ring road is a motorway-standard road with grade separated interchanges. The eastern section (East Link) is being built as a BOOT (build-own-operate-transfer) toll road. The gap between the northern and eastern sections is formed by the 'green wedge' of the Yarra Valley, a rural area currently protected from urban development. The beginning of construction of the eastern section of the ring road has already led to strident calls from the road lobby to 'close the gap'. The opening of the ring road is forecast to add to traffic congestion at the morning and evening peaks at the city end of the radial Eastern Freeway (shown on the map between Ringwood and the city centre). The ring road will itself have an effect on the distribution of residential and work locations in the city creating an 'edge city' (Garreau) on the urban fringe beyond the reach of the urban rail system, and lengthening vehicle trips.

The technical path dependence of Melbourne's road infrastructure continually provides reasons for building new and better roads to relieve traffic congestion at the inevitable bottlenecks caused by building high quality roads that encourage the use of private vehicles.

Figure not included

Figure 5 Metropolitan Melbourne showing the main features of the transport system

Figure 6 Journey to work from the statistical local area of Maroondah (Central) (Source ABS national census 2001, journey to work)

The institutional dimension of path dependence stems from the history of transport organizations at State Government level. A recent study of the historical development of transport organizations in Melbourne concluded, in sum, that the strength of the roads sector is based on the consolidated structural form of the roads organization, its continuous engagement in the planning process, its access to multiple funding sources, opportunities for it to influence the political agenda, regular chances to share and gather information at a range of forums and its ability to leverage support from other players (Astle, 2007). The weakness of public transport planning stems from the fragmented organizational structure, the disjointed participation in planning forums, greater distance and indirect access to the political agenda, fewer opportunities to network and transfer policy solutions, and limited capacity to engage other players.

The gradual consolidation of all roads related functions over fifty years within a single stable organization (The Victorian Roads Corporation: Vic Roads) enables the roads agency to share knowledge and experience and coordinate policy responses and initiatives. By contrast in the public transport domain, the fragmentation of functions between several organizations in the public and private sectors makes it more difficult to shape the policy agenda. Thus the contrasting structural changes in both sectors seem to be hindering the development of sustainable transport. The consolidation of the roads organization enables it to pursue its own agenda, which is in conflict with urban sustainability, and the fragmentation of the public transport institutions means that there is reduced capacity to compete with the roads program for infrastructure funding. When it comes to infrastructure funding, pedestrian and cycle tracks are merely a poor cousin of roads. Moreover, the ability of the roads organization to dominate land use plans for metropolitan Melbourne has enabled it to pursue a consistent vision for expanding the road network. By contrast, the limited capacity of the public transport institutions to find a voice in the land use planning process has disabled any continuous expansion of the public transport system and (despite the intentions expressed in recent planning documents) prevented its integration with land use regulation and urban development.

Finally the discursive dimension of path dependence reinforces the dominance of the ‘roads plus private vehicles’ solution to the city’s mobility needs. The first quarter of the last century saw a

universally approved drive to position the private vehicle as the only 'modern way of transport' (Davison, with Yelland, 2004). As car ownership grew, patronage of the railways and tramways dropped dramatically. Though the rail lines continued to be serviced, and the tramways were not abolished (as they were in Sydney), the dominant discourse of public transport centred continuously on reducing the level of debt and subsidy. The discourse of roads, on the other hand, was all about the benefits of 'investment'. Despite an unceasing flow of funds to improve the road network, the strong belief was held that this flow was necessary for economic growth. Today the main story is that building motorways is necessary to facilitate freight movement. The funding to roads was not depicted as a subsidy, and the full costs of a road-based transport system never entered the public accounts. While most of the 'consumption' expenditure on public transport appears in the State budget, the 'consumption' expenditure on private transport is hidden in the private accounts of individuals and firms. What appears in public is (virtuous) 'capital investment' in roads.

These three mutually reinforcing elements of path dependence: the technical or physical, the institutional or organizational, and the discursive, create major barriers to policy change to facilitate the behavioural shifts proposed above: reducing travel demand, shifting mobility to low or no emission modes of transport, and an enhanced role for public transport leading to increased vehicle occupancy. Though the above analysis is focused on the State government, it is to be expected that similar institutional and discursive path dependencies exist at federal level.

The challenge of community engagement

If the above agenda for greenhouse gas reduction from urban transport is to be successfully pursued, the details will have to be worked out with the full engagement of the people of metropolitan Melbourne. There are two main issues here. The first is about representation, the second about deliberation. On the first issue, it will already have become clear that there is no metropolitan level of government. Local government in Melbourne is divided into 31 different municipalities (including the City of Melbourne). The State Government of Victoria does not represent metropolitan Melbourne but presides over both the city and its large rural hinterland. Yet the State Government has taken total responsibility for metropolitan planning. This arrangement has the advantage of allowing a single authority to plan the future of the metropolitan city along with the rural fringe into which the urban edge is expanding. However, the State Government must pay attention to the rural vote if it is to retain power and this limits the possibility of a metropolitan politics.

In recent years the Government seems to have driven Melbourne's transport policy from a distinctly rural perspective. The two largest public transport investments have had a non-metropolitan focus: the renewal of the State's regional (non-urban) railway system, and the construction of the new Southern Cross railway station (on the site of the old Spencer Street station) as a terminus for regional and interstate trains. The State has failed to connect Melbourne's outer suburbs to the extensive suburban heavy rail network, and has instead encouraged the building of new motorways (some with federal money) to serve these suburbs.

Partly as a result of the bias towards roads on the part of the State Government, Melbourne is geographically divided between the inner and middle suburbs, well served by rail-based public transport, and the outer suburbs served only by a poor and infrequent bus network, and roads. There is an assumption at State political level that this is what the electorate wants. There is a fear of not continuing to build massive new roads in the outer suburbs, and a belief that low density suburbs cannot be served effectively by public transport. This is a rural political perspective. These rural assumptions are never tested because State elections are mostly fought on other issues. A directly elected metropolitan government would create a political sphere reflecting metropolitan issues such as transport for Melbourne and the city's future development. It has been argued that such a government would compete politically with the State government and would thus be unacceptable to the very agent responsible for its creation, yet there could also be advantages both for Melbourne's position on the world stage (with for instance a directly elected mayor), and for the devolution of power. However such a development would almost

certainly require initiative from the national (federal) level and the abolition of State Government, requiring a constitutional amendment by referendum. Such a change is not at present on the political horizon.

The second issue is about real deliberation. Community consultation (or stakeholder involvement) is today a commonplace requirement written into the procedures for planning, environmental assessment and risk assessment (Flyvbjerg, et al. 2003; Burgman, 2005). But the *forms* of consultation can be observed even while the central *substance* of community engagement is missing or avoided. That central substance is deliberation: the full exposure of alternative positions, and argument over these positions in conditions of 'un-coerced dialogue' (Smith, 2003, following Habermas). Necessarily the outcome of deliberation cannot be determined in advance. Deliberation is supposed to occur, for example, in ideal models of risk assessment and management (see Figure 7, Burgman, 2005: 54). Burgman stresses repeatedly throughout his book the importance of real stakeholder consultation to generate alternative perspectives, arguments, and options for decision, in a process of risk management whose ultimate basis is subjective judgment (see also O'Brien, 2000). Whether this is actually occurring, or whether it did occur in a particular case, is hard to discover. One way of finding out whether this has occurred as portrayed in written documents is to allow the process to be scrutinized in a forensic environment, by cross-examination of witnesses.

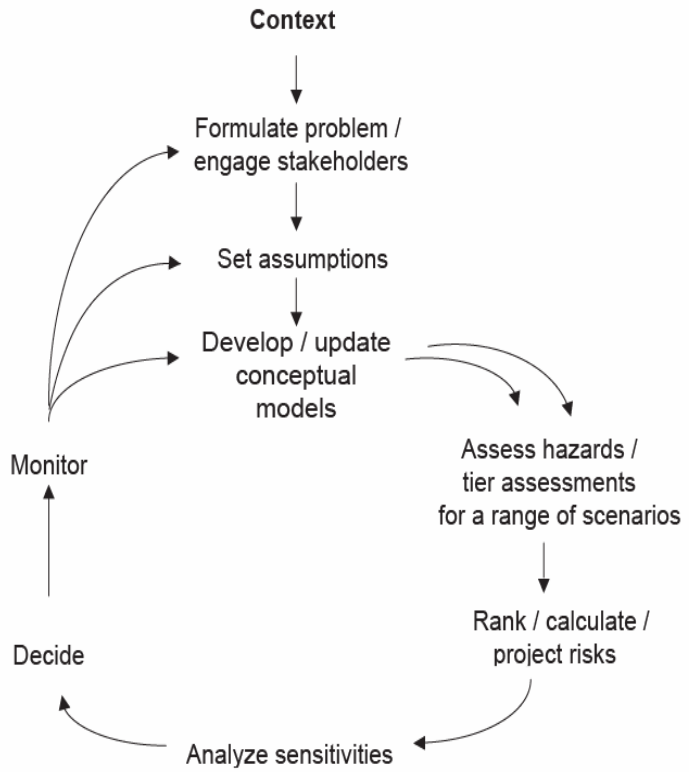


Figure 7. The Risk Management Cycle (Burgman, 2005 Figure 3.3 p. 54)

One example from Melbourne is a proposal by the Port of Melbourne Corporation, a state owned agency, to dredge a deeper channel in Port Phillip Bay to allow larger cargo ships with deeper draught to enter the harbour[7]. The purpose is to maintain the international competitiveness of the

[7] Port Phillip Bay 'is a complex system of interrelated and interdependent physical, chemical and biological processes. It is a large but shallow marine embayment, which has restricted water exchange with the open ocean. Its catchment includes metropolitan Melbourne and parts of the Mornington Peninsula, Werribee, Geelong and the Bellarine peninsula. The bay is a major asset

port to 2035 (PMC, 2007 Executive Summary: ES3). The Channel Deepening project will have an impact not only on the Bay itself but on the urban residential environment around the shores, the commercial and recreational activities associated with the use of the Bay, and the transport system connected with the port. The Port Corporation must produce its own Environmental Effects Statement (EES) which is then subject to a public examination by an appointed expert panel. In 2004, after examination by an expert panel, and following cross-examination of witnesses for the Port Corporation, the EES failed to satisfy the panel and the Minister (State) sent the Port Corporation back to produce a supplementary EES with further scientific investigation. This Supplementary Environmental Effects Statement (SEES) was submitted and published in 2007.

The SEES includes a comprehensive analysis of the risks to various locations and elements of the Bay and its ecosystems. These risks include increased turbidity in the waters and the risk of irreversible death of sea grass which is a key species in the ecosystem supporting fish populations and a colony of penguins. Damage will occur to the deep canyon at the entrance to the Bay through rock falling into it from the dredging operation. Most serious perhaps is the risk to ecosystem and human health from disturbance of severely contaminated sediment near the mouth of the Yarra River where it enters the Bay at the city end, which will have to be dredged and relocated in an underwater dump.

As presented in the SEES, the logic of the risk assessment process can hardly be faulted, nor can the thoroughness with which it was conducted. Yet the entire process rests ultimately on expert experience and judgment. The judgment of risk to ecosystem and human health is really little more than an informed guess buried within a mountainous Environmental Effects report (15,000 pages long) on the science of the conceptual models and the process of analysis. The description of the risk analysis is contained in Technical Appendix 5 to the SEES.

The specialist team ultimately responsible for assessing risks was selected by the project proponent. It consisted of dredging specialists, the authors of the SEES specialist studies, key personnel 'involved in the planning and development of the project', employed by the Port Corporation, and 'other key PoMC personnel'. The expert group seems heavily weighted in favour of proponents of the project. This, coupled with the fact that the whole SEES project costing $114 million is paid for by the proponents, raises the possibility of conscious or unconscious bias. However, the Victorian Government has announced that the panel reviewing the SEES will include no members of the panel which rejected the first EES for the project despite the fact that the members are available. Moreover the Government has also announced that lawyers for the interests opposed to the Channel Deepening project will not be allowed to cross examine witnesses during the panel hearing of the SEES. Such probing is essential to the transparency of the process, and so serious is this ban on cross examination that Mr Chris Canovan, a leading planning lawyer engaged to represent the Port of Melbourne Corporation, is reported to have withdrawn his services (Millar, 2007). Only four weeks will be allowed for the process of examination of the 15,000 page SEES. These actions by the Government do not inspire confidence that the risk assessment process is fair and transparent and that real deliberation has occurred.

Conclusion

In this paper a simple logic of adaptation to the mitigation imperatives of climate change was explored. Change in both technology and human behaviour will be necessary. But while the scale of change should not be underestimated, so also should it not be feared. Adapting to the reality of climate change will not mean the end of the Australian ('Western') lifestyle as we know it. In fact change in urban daily life over the next fifty years need not be any more dramatic than change in urban life over the last fifty – before climate change was perceived as a threat.

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to Victoria, and to Melbourne in particular, as a setting for urban development, shipping, industrial activities, natural resource economic uses, recreation and tourism' (PMC, 2007a: 8.4)

A potential application of adaptation logic to the field of urban transport was outlined, and the likely feasibility of different human and technical elements of change was analyzed. This logic is not yet a strategy, for a strategy would also include the means of creating the institutional pre-conditions and mechanisms necessary to lead and implement change. Following a little scene-setting for the international readership, three institutional challenges were discussed: the intergovernmental challenge, the challenge of path dependence, and the challenge of community engagement. Australia's particular geography and institutional history sets its own problems for change, and the challenges to traditional lines of action and government policy settings are formidable. Major institutional change, change in the culture and structure of governance, must almost certainly precede human and technical change of the type and scale required.

Will it happen? Australia's liberal political system is no doubt flawed in many ways, but it is at base a democracy. When the public begin to feel the effects of climate change, as is already happening through the most severe drought in 100 years, pressure will mount, is already mounting, to force political, and then institutional change. It is for the scientific community to offer genuine paths to adaptation and the hope of weathering the storm to come.

References

Akerman J. and Hojer M. (2006) How much transport can the climate stand?—Sweden on a sustainable path in 2050. *Energy Policy* 2006; 34:1944-1957.

Bows, A and Anderson, K.L. (2006) 'Policy clash: can projected aviation growth be reconciled with the UK Government's 60% reduction target?' *Transport Policy*, 10/1016

Burgman M (2005) *Risks and Decisions for Conservation and Environmental Management*, Cambridge, UK: Cambridge University Press.

Colebatch, T (2007) 'Solar cells wait for their day In the sun' *The Age*, Melbourne, April 30th Business Day p. 2.

Davison, G. with Yelland, S. (2004) *Car Wars: How the car won our hearts and conquered our cities*, Crows Nest (Sydney): Allen and Unwin.

Destefani, C. and Siores, E. (2003) 'Alternative pollution control technologies' in Low, N.P. and Gleeson, B.J. eds. *Making Urban Transport Sustainable*, Basingstoke, UK: Palgrave-Macmillan.

Energy Information Administration (EIA) (2007) Annual energy outlook 2007, US Department of Energy.

Flyvbjerg, B, Bruzelius, N and Rothengatter, W. (2003) *Megaprojects and Risk, An anatomy of ambition*, Cambridge UK: Cambridge University Press

Gargett, D and Gafney, J. (2006) 'Traffic Growth in Australian Cities: Causes, Prevention and Cure' accessed 14/03/2007 at the Australian Government, State of the Environment Report 2006: www.environment.gov.au/soe/2006/publications/drs/indicator/408/index.html

Low, N.P. (2002) 'Ecosocialisation and environmental planning: a Polanyian approach', *Environment and Planning A* 34/1 pp. 43-60.

Low, N.P. (1997) 'What made it happen? mapping the terrain of power in urban development', *Planning Theory*, 17: 88-112.

Low, N.P., Gleeson, B.J. and Rush, E (2005). 'A Multivalent Conception of Path Dependence: The case of transport planning in metropolitan Melbourne, Australia, *Environmental Sciences* 2/4.

Lucas, C. and Millar, R. (2007) 'Minister runs down cycle plan', *The Age*, Melbourne, 3rd March, p.3.

Millar, R. (2007) 'Outrage at dredging probe ban', *The Age*, Melbourne April 23rd p. 3.

Moriarty, P. and Honnery, D (2007) 'Prospects for Green Car Mobility' (forthcoming).

Newman, P.W.G. and Kenworthy, J.R. (1989) *Cities and Automobile Dependence: A sourcebook*, Aldershot, UK: Gower.

Nielsen, G. (2005) *Public Transport – Planning the Networks*, HiTrans Best Practice Guide 2, Norway.

O'Brien, M. (2000) *Making Better Environmental Decisions*, Cambridge Mass. USA: MIT Press.

PMC (Port of Melbourne Corporation) (2007) *Port of Melbourne Corporation Channel Deepening Project, Supplementary Environmental Effects Statement*, *Technical Appendix 5, Channel Deepening Project Risk Assessment for SEES*, Melbourne: Port of Melbourne Corporation.

Pacala, S. and Socolow, R. (2004) 'Stabilization Wedges: Solving the climate problem for the next 50 years with current technologies', *Science* 305, pp. 968-972.

Ramesohl S. and Merten F. (2006) 'Energy system aspects of hydrogen as an alternative fuel in transport.' *Energy Policy*, 34:1251-1259.

Reijnders L, Huijbrets M.A.J.(2006) 'Life cycle greenhouse gas emissions, fossil fuel demand and solar energy conversion efficiency in European bioethanol production for uses'. *Journal of Cleaner Production*, www.doi:10.1016/j.jclepro.2006.05.007

Romm, J. (2006) 'The car and fuel of the future'. *Energy Policy*, 34: 2609-2614.

Romm, J.J., Frank A.A. (2006) 'Hybrid vehicles gain traction'. *Scientific American*, April: 56-63.

Smiles, S. (2007) 'Road to riches bypasses Victoria, State claims', The Age, Melbourne, 'Budget 2007' supplement p.4.

Stern Review on the economics of climate change (2006) HM Treasury and Cabinet Office, London. (2004) 'Stabilization wedges: solving the climate problem for the next 50 years with current technologies', *Science*, 305: 968-972.

Van Mierlo J, Magetto G, Lataire P. (2006) 'Which energy source for road transport in the future? A comparison of battery, hybrid and fuel cell vehicles', *Energy Conversion and Management*. www.doi:10.1016/j.enconman.2006.02.004
Smith, G. (2003). *Deliberative Democracy and the Green Political Theory*. London: Routledge Taylor and Francis Group.
Wald M.L. Is ethanol for the long haul? Scientific American 2007; January: 28-35.
World Bank (2006) *World Development Indicators*, New York, World Bank.