SECURING
AUSTRALIA'S
FUTURE

Delivering Sustainable Urban Mobility

PROJECT 8

FINAL REPORT

AUSTRALIAN ACADEMY OF THE HUMANITIES

AUSTRALIAN ACADEMY OF SCIENCE

ACADEMY OF THE SOCIAL SCIENCES IN AUSTRALIA

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING

ACOLA
AUSTRALIAN COUNCIL OF LEARNED ACADEMIES

SECURING AUSTRALIA'S FUTURE

Funded by the Australian Research Council and conducted by the four Learned Academies through the Australian Council of Learned Academies for the Australian Chief Scientist and the Commonwealth Science Council. *Securing Australia's Future* delivers evidence-based research and interdisciplinary findings to support policy development in areas of importance to Australia's future.

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Delivering Sustainable Urban Mobility

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Australian Academy of Science

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Definitions

Accessibility/mobility

Mobility *per se* refers to the movement of people or goods. It recognises both automobile and transit modes, but assumes that movement is an end in itself, rather than a means to an end (Litman 2011). A broader understanding includes accessibility—the ability to reach desired opportunities and needs (in the form of goods, services, activities and destinations). The underlying premise within a human rights perspective is that mobility is not simply about reaching destinations; in the final analysis, it is about accessing opportunities (UN-Habitat).

Australian cities

A city is a large, permanent human settlement. Comparing 'cities' is notoriously difficult since population measures, geographic areas and definitions of administrative or governance structures vary widely. ABS figures[1] show sixteen conurbations in Australia with populations of 100,000 people or more. These include the eight capital cities, as well as Gold Coast-Tweed Heads, Newcastle-Maitland, Sunshine Coast, Wollongong, Geelong, Townsville, Cairns and Toowoomba. Together these account for 78% of the population of Australia.

Monocentric/monofunctional/polycentric cities

The spatial structure of a monocentric city is such that it has a unique centre, often called the Central Business District (CBD), which is the primary (urban) employment hub and therefore the principal destination for (suburban) commuters, travelling on radial routes (Lin *et al.*).

Low density, mono-functional urban development is often colloquially known as 'urban sprawl'. Multifunctional urban land use refers to the combination of different socio-economic functions within the same area (Vreeker *et al.* 2004).

1. ABS 2015, 3218.0 *Regional Population Growth, Australia 2013–14*.

In a polycentric city, additional (usually newer) hubs of employment and other concentrations of opportunities have evolved beyond the traditional city centre, presenting a more complex spatial structure and a wide dispersion of origins and destinations for commuters (Lin *et al*.).

Sustainable urban mobility

This refers to the movement of people and goods within an urban region in a way that delivers the environmental, economic and social dimensions of sustainability. Sustainable urban mobility planning characteristically contributes to the provision of competitive modes of transport, while minimising air pollution (including GHG emissions) and noise pollution, promoting the economic development of the city and being affordable to users and taxpayers.

Transport poverty

Transport poverty describes a situation in which individuals are forced into transport options that are more expensive than they can afford. In the absence of public transport, the population of outer urban and inner-regional areas are obliged to rely on motorcars (often more than one per household).

Urbanisation

This denotes the proportion of a population living in urban as opposed to rural or remote areas. Urbanisation is an accelerating international phenomenon.

Executive summary

Australian cities are vulnerable

Most Australians inhabit cities or metropolitan areas that are currently ranked amongst the most liveable conurbations in the world. Clean air, sunshine, beaches and a generally high quality of life abound. However, these cities demonstrate environmental footprints that are not sustainable. The lack of polycentric planning means that for at least half the population, access to this lifestyle is dependent on the motorcar. For the whole population, road freight is essential. All Australian vehicle transport is heavily dependent on imported liquid petroleum products. A recent Senate Inquiry found clear divisions in evidence on the question of whether Australia's current fuel stockholding arrangements provide adequate fuel security.

Scientific consensus is that high emissions fossil fuel dependence is not sustainable and will inevitably lead to serious social, environmental and economic problems. The Australian transport sector does not rank well on efficiency and this carries significant costs. Energy efficiency has been highlighted, as a component of energy productivity, in a recent Australian Government white paper.

Against this background a business-as-usual approach will not work. As the Australian population continues to increase—and as that population growth is further concentrated in Australia's major cities—so the social inequities, environmental pressures and economic consequences will intensify.

Pressures will increase

Melbourne and Sydney are expected to accommodate populations of more than 7 million people each in this century. As this trend unfolds, a range of sustainability consequences is emerging. In all Australian urban areas, the demand for motorised travel is a significant source of greenhouse gas (GHG) emissions. Air and noise pollution are causes of ill-health while traffic accidents cause death and disability. A sedentary lifestyle, largely devoid of active modes of transport such as walking and cycling, is a major contributor to chronic disease and obesity, even among children.

Appropriate infrastructure and technological innovation are important

Australia has a growing infrastructure deficit and the cost of addressing that deficit is increasing each year. Some aspects of transport systems in major cities are more than a hundred years old. Several cities have grown to extend well beyond the reach of public transport. The standard response to addressing urban mobility issues has been to increase road infrastructure. Unfortunately, this creates a vicious circle: more roads encourage urban 'sprawl', which increases the use of motorcars. Adding roads is not necessarily the solution for the urban mobility challenges of today.

Some aspects of urban mobility challenges will be ameliorated, in the short-term by new road infrastructure; and in the future both by emerging technologies and adaptation. Promising developments are taking place in alternative fuels and new powertrains for vehicles; high-speed data transmission, digital sensors and data analytics. These developments may help to address traffic congestion, greenhouse gas emissions, health and public safety concerns and social inequality, provided policy development is nimble enough to take advantage. In the longer term, reliance on timely changes in social behaviour is not prudent.

An opportunity exists to plan for sustainable urban mobility

Australia has no megacities yet and there is therefore an opportunity in the decade ahead to rethink the growth and development of our major conurbations (both cities and metropolitan areas), before the problems associated with urbanisation become critical. Incremental changes are important and some of these have already begun in Australia. Unfortunately change often takes place on a piecemeal basis and risks collapsing into an approach based on 'picking winners'.

Sustainable urban mobility planning contributes to the movement of people and goods within an urban region in a way that delivers the environmental, economic and social dimensions of sustainability. This is characterised by an integrative approach to the provision of competitive modes of transport; minimising air pollution (including GHG emissions) and noise pollution; promoting the economic development of the city; and being affordable to users and taxpayers.

It is an approach to urban planning that prioritises people rather than any particular mode of transport. It seeks to bring origins and destinations closer together, in order to reduce or avoid the need for travel. When travel is essential, the aim is to provide more environmentally friendly modes of transport. Finally, such planning seeks to improve the energy efficiency of transport modes and vehicle technology.

Establishing a planning philosophy in which the demand for mobility is moderated and the goal of sustainability advanced implies significant planning reforms. In Australia this will mean a far-sighted, transparent planning process. In many cases, responsibility will be vested at the metropolitan level. The aim is to allow all Australian cities (of 100,000 people or more) to play an active role in developing their own sustainable urban mobility plans. But this will ideally take place within a national urban planning framework, to coordinate infrastructure development and thereby maximise efficiency.

Polycentric cities reduce journey distances

Urban planning and design can concentrate on how to bring people and places together. This can be achieved through a focus on accessibility, rather than simply increasing the length of urban transport infrastructure or increasing the movement of people or goods. Other contributory strategies are increased population densities and the development of mixed-use areas in place of rigid zoning.

Such developments also have the potential to make better use of existing transport infrastructure. Careful planning will enhance sustainable urban transport solutions. In Australia, rail transport has an important role to play when travelling longer distances and for certain types of freight. In terms of marginal costs, the motorcar is in many contexts the cheapest and quickest mode of transport for passengers. But until technological innovation intervenes, the motorcar is almost never the most environmentally friendly mode of travel.

European planning: a process not a model

There are important differences between Europe and Australia: land-use policies; the size and shape of cites; the nature and extent of public transport systems; patterns of home ownership; the forms of the built environment; and heritage protocols. These should serve as caveats to the importation of models developed elsewhere. The significance for Australia of the leading role taken by the European Commission (EC) in the field of sustainable urban mobility lies not in the detail but rather in the planning process.

The EC has been steadily committing to sustainable planning for urban mobility since the influence of the Brundtland Report[2], which appeared in 1987 (United Nations World Commission 1987). In recent years, work has been done with a view to "enabling the European Union to provide a central role in realising the greatest potential gains in urban transport sustainability across economic, financial, social and environmental outcomes in the long run, and provide a foundation for raising capabilities across cities in Europe" (Booz & Co 2012).

Integrated and ambitious local mobility plans are the starting point for the comprehensive changes that are needed. These are best located within an environment of strong strategic planning and coordination from national and regional governments able to provide enabling legal frameworks and policies and coordinate transport infrastructure development, thus ensuring efficiency. Through the *Action Plan on Urban Mobility* (2009) and the *European Local Transport Information Service* (ELTIS) established in 2010, the Commission has created opportunities for EU cities and other levels of government to collaborate closely to achieve significant changes in their system. In a *Transport White Paper* of 2011, the EC began to explore the possibility of making urban mobility plans a mandatory approach for cities of a certain size, according to national standards based on EU Guidelines. The paper also proposes linking regional development and cohesion funds to cities and regions with sustainable planning in place (European Commission DGMT 2012). The EC process has strongly informed the sustainable urban mobility planning approach of this report.

2. The report of the group known as the World Commission on Environment and Development, chaired by Gro Harlem Brundtland was released in October 1987. The document coined and defined the term 'sustainable development'.

About this report

This report begins by setting out the urban mobility challenge. Individual chapters then explore specific issues grouped into transport technology; public health, safety and the environment; social issues; and economics. The final chapter seeks to pull those different dimensions together, demonstrating that a paradigm shift in favour of sustainable urban mobility planning can offer a framework in which to address many of the issues raised.

The report takes a holistic, future-seeking approach to planning. It recognises Australians' openness to technological change and the country's willingness to become an early adopter. Several technological developments that provide sufficient evidence to demand both emphasis and encouragement are presented. The report also recognises that to rely on emerging technologies alone to solve the complex challenges of accelerating global urbanisation would be unrealistic.

Intercity transport, whether by road, air or sea, is barely covered in the report. The very serious access problems facing those Australians who live in outer regional and remote parts of the country have been recognised only in passing. The focus here is firmly on urban life. The major cities and extensive metropolitan corridors now house the majority of the Australian population. The shape and form of those settlements are intimately connected with their transport needs.

This report supports public transport modes, including electric rail, powered by clean electricity. It argues for the value of bringing origins and destinations closer together and therefore encourages polycentric urban development, with mixed land-use and multiple modes of transport, as offering the most sustainable options for the future development of Australian cities. High-density urban living (the 'compact city') is not necessarily a solution to the 'low-density mono-functional urban expansion' that still characterises most State-based planning in Australia. There is evidence of a renewed interest in 'urbanism' as a sustainable approach to inner city life, but no evidence of a slowing of what is often called 'urban sprawl'.

Both cities and their transport systems contribute to and are impacted by climate change. As with so many other aspects of sustainable urban life, climate change is not a local issue but a global one. The report casts many issues in an international context, but then sets out to address those as far as possible using Australian data. In developing processes for sustainable urban mobility planning, the European Commission has taken the lead in the last decade. But neither European nor North American models are directly transferable to Australian cities.

The report draws on the expertise of the four Australian Learned Academies and results from an informed discussion amongst experts from diverse fields. Such a wide-ranging interdisciplinary approach is unusual and yet those involved arrived at a large degree of consensus about the nature of the issues and even, to a somewhat lesser extent, about the solutions. The Expert Working Group commissioned technical reports from teams of consultant in the fields of transport technology; social studies; public health and safety; and economics.

Sustainable urban mobility planning contributes to the movement of people and goods within an urban region in a way that delivers the environmental, economic and social dimensions of sustainability.

Key findings

Chapter 1
Cities and people: the urban mobility challenge

- **Australian cities are vulnerable**
  Despite historically successful urban development, Australian patterns of settlement, urban infrastructure and social organisation are vulnerable to increased urbanisation, changing demographics, diminishing resources, climate change and the increased frequency of extreme weather events.
- **Australian urban environmental footprints are not sustainable**
  Australian cities rank high on measures of 'liveability', but they demonstrate environmental footprints that are not sustainable. Sydney's geographic area of 2037 km^2 exceeds that of London (pop. 10.23 mill). Berlin (pop. 4 mill) has a density of 3000 people/km^2 double that of Melbourne. The expansive nature of Australia's largest cities has environmental consequences and implications for transport.

- **Three strategies are key in improving urban sustainability**
  Sustainable urban mobility planning involves the consideration of a three-pronged approach: reduce or avoid travel or the need to travel; shift to more environmentally friendly modes of transport; improve the energy efficiency of transport modes and vehicle technology.
- **Technological innovations are important**
  Increasingly, the use of information and communications technology will facilitate urban management, ranging from data applications for planning and transport management to city policing and the timely allocation of resources and services. Technological innovation is important in helping to mitigate greenhouse gas emissions, reduce trip times and minimise traffic accidents. Technology alone, however, cannot solve the challenges ahead.

Chapter 2
Transport technology: the next 25 years

- **Limited fuel stocks are a major national risk**
  Australia has small and declining fuel stocks, holding no more than three weeks' supply of oil and refined fuels onshore. Australia is consistently the only one of the 28 member countries that fails to meet its International Energy Agency (IEA) 90-day net oil import stockholding level. This might be regarded as a major national risk.
- **Greenhouse gas emissions are growing not declining**
  Australia is one of the world's highest emitters of greenhouse gases per capita. Greenhouse gas emissions from the transport sector are, relatively, particularly high—in some cities three times those of London and still growing. Australia is likely to face international pressure to achieve a dramatic change in order to contribute to the global challenge to limit warming to 2°C.
- **The transport sector is inefficient—this incurs costs**
  The Australian transport sector does not rank well on efficiency against some international measures; transport inefficiencies carry costs. The cost of moving freight by road (over distances of more than 1000 km) are more than double that of rail, while greenhouse gas emissions for road are more than triple those for rail. The average motorcar is parked at home 80% of the time, parked elsewhere 16% of the time and on the move only 4% of the time.
- **Inadequate infrastructure restricts productivity and incurs costs**
  Experiences of transport networks failing to keep pace with demand, water quality standards being uneven, energy costs being too high, telecommunication services being outdated, or freight corridors being neglected are now so common that they necessitate a strategic response (*Australian Infrastructure Audit* 2015). There are quantifiable economic, environmental, public health and safety impacts to the infrastructure deficit.
- **Several key enabling technological innovations are evident**
  Specific technological innovations will help to mitigate some transport challenges. Three examples are: plug-in electric vehicles (PEVs), which will have a direct impact on the sector; high-speed broadband (HSB) which will continue to expand its impact on urban mobility generally; and the 'Internet of Things' (IoT), expected to become a major enabler in the urban mobility sector. The IoT is the network of physical objects embedded with electronic components that allow those objects to be sensed and remotely controlled. 'Objects' range from medical implants through automobiles with built-in sensors to search-and-rescue technology.
- **Policy development needs to be nimble to match rapid change**
  Innovation in transport is moving quickly. Policy often lags behind technological innovation in the transport sector; planning approaches should be nimble enough to take advantage of rapid developments.

Chapter 3
Impacts on the environment, public health and safety

- **The growing, ageing population presents particular urban challenges**
  By 2050, the Australian population is expected to reach 37 million, which will almost double the number of people in Melbourne, Sydney and Perth. All capital cities will have an increasing proportion of older people over the next half-century. This has significant implications for a range of planning and design activities, from housing and transport, to the delivery of human services and the size of local workforces.
- **Inner city living is becoming denser; outer city living risks being marginalised**
  There are two distinct trends occurring across the largest of Australia's cities: one of growth locating at low densities on the urban fringe

and the other of growth consolidating in high-density city centres. A lack of polycentricism in planning leads to low-density residential expansion of cities ('sprawl') and places those in outer urban and inner-regional areas at risk of transport poverty.

- **Transport poverty**
  An increasing number of people are living further away from central business districts and employment hubs. Fringe developments are characterised by low housing and low employment density, limited (if any) mixed-use development and poor access to public transport. Together this increases distances between where people live and where they need to travel for work, shopping, socialising and recreating. In these motorcar dependent neighbourhoods, residents are at risk of transport poverty.

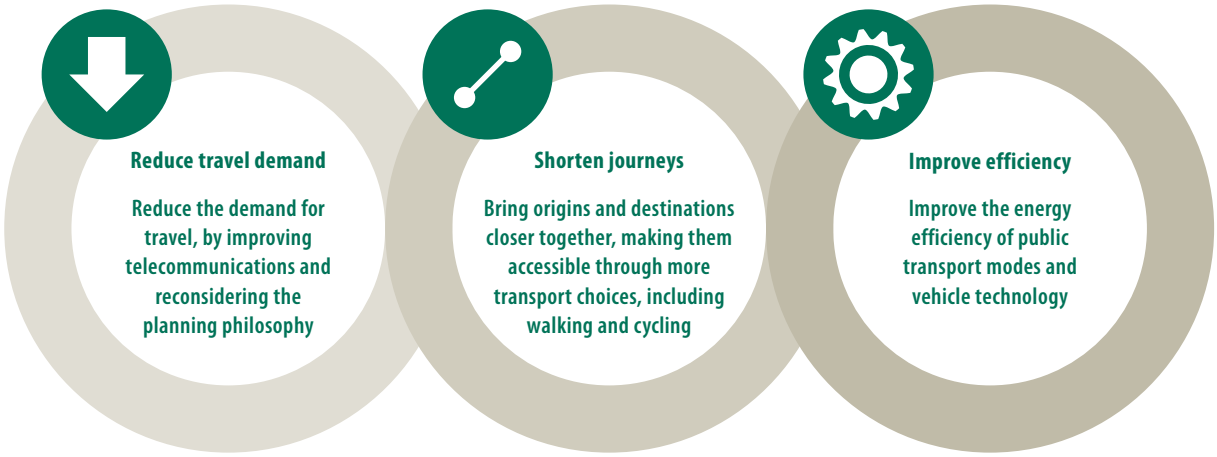
Chapter 4
Barriers and pathways to sustainable urban mobility

- **The cost of urban congestion will increase four-fold in two decades**
  Without investment in additional capacity or demand management innovations for current infrastructure, the economic extent of congestion costs in Australian capital cities is forecast to grow from $13.7 billion in 2011 to around $53.3 billion in 2031 (*State of Australian Cities* 2014–15).
- **The majority of Australian children are no longer actively mobile as commuters**
  More than 60% of children in Australia are now driven to and from school; this constitutes as much as 17% of peak traffic. Chauffeuring of children, during the week and over weekends, contributes significantly to traffic congestion. It also counters the benefits of active modes of transport (walking, cycling, skateboarding, etc.), which increase physical activity and help to prevent obesity.
- **Planning for the origin-destination distance is key to sustainability**
  A transition to more localised patterns of living will help to reduce or avoid the need for travel. Planning for sustainable urban mobility, including shortening the distance between origins and destinations, contributes to this goal.
- **Access to multi-modal transport choices promotes sustainability**
  The availability and frequency of multi-modal transport choices is key to improving accessibility and the ability to benefit from opportunities. Access to opportunities such as education, employment and health care promotes social equity and contributes to economic growth.

Chapter 5
Economic perspectives

- **Economic progress is not evenly distributed**
  Within and between cities, economic progress has not been evenly distributed against a number of economic indicators. Infrastructure plays a key role in improving the productivity of Australia's cities (*State of Australian Cities* 2014–15).
- **Australian cities have a significant infrastructure deficit**
  The available international comparisons suggest that, despite recent increases in government spending and increased private participation, the overall quality of our infrastructure lags behind comparable nations.
- **Infrastructure requires a spend in the order of $350 billion over ten years**
  An Australian infrastructure deficit has built up over the last forty years, estimated in 2014 by the Department of Prime Minister and Cabinet to amount to $100 billion. Further analysis for this report suggests that the national shortfall by 2025 (and the cost of preventing the development of further backlog to that point) requires an infrastructure spend in the order of $350 billion over the next ten years.

Figure 1: Three basic routes to improve efficiency in urban transport



- Integrated planning is essential
  Reforms will be essential to integrate land-use planning and the implementation of sustainable urban mobility principles. Engagement with industry including the design, construction and transport sectors, is necessary.
- Policy reforms and regulation have a role to play
  Among the ways in which policy reforms and regulations can make a difference are three micro-economic examples: improving the way road use is priced; implementing a regulatory regime that will accelerate the reduction of GHG emissions; and planning that reduces the risks of social exclusion.
- Polycentric cities bring people closer to opportunities
  Planning for the development of polycentric cities will help to reduce transport poverty and improve the quality of life for Australians on a more equitable basis. High technology industry nodes and urban renewal projects are examples of polycentricism and take advantage of the employment growth opportunities that middle suburbs and innovation clusters provide.

Chapter 6
Towards sustainable urban mobility

- **Community consultation and active local involvement is essential**
  Engaging communities widely in development and delivery of land use/transport plans and policies is an essential ingredient in social sustainability. In modern liberal democracies a measure of consultation is regarded as a right. A far-sighted, transparent planning process that entails extensive consultation builds individual and community trust.
- **Successful sustainable urban planning often includes action at the metropolitan level**
  Cities that are successfully confronting sustainability challenges often demonstrate a form of cooperative, local representative control over citywide or regional decision-making, described as 'metropolitan governance'. The Port Authority of New York and New Jersey; the Brisbane metropolitan area; the metropolitan region of Nice; the Tennessee Valley Authority and the Greater Toronto Area are diverse examples.
- **A national framework for urban planning ensures that infrastructure investments are maximised**
  There is a growing consensus that broad-scale, multimodal, high-level planning systems are needed (*State of Australian Cities* 2014–15). Integrated planning outcomes will recognise that different parts of the city have different transport tasks and different infrastructure needs. A national approach to planning and managing cities will provide a framework within which cities, regions, metropolitan areas and local governments can develop responses to sustainable mobility challenges in forms appropriate to particular local communities.

1 Cities and people: the urban mobility challenge

Cities can be seen as systems within systems of cities
Brian JL Berry

1.1 Introduction

Rapid urbanisation is a global phenomenon and Australian cities and 'metro' regions are facing the same pressures as other cities in the world. Australian urban areas are characterised by low-density, mono-functional expansion (colloquially known as 'urban sprawl'). The capacity of these areas to withstand the pressures of population expansion and limited modes of mobility provision has finite limits. Public transport and employment hubs are not equitably spread. No forward planning can be complete without consideration of regional and local climate change impacts. In Australia as elsewhere, greenhouse gas emissions demand immediate mitigation strategies. This chapter introduces issues regarding population density, access and mobility. It explores the relationships between city structure, employment and ecological footprint. The role of digital technology and data in city management is presented. Greenhouse gas emissions and the impacts of climate change are discussed in relation to quality of life for all.

1.2 Urbanisation and megacities

Since the mid-twentieth century, the scale and speed of urbanisation has reached unprecedented levels. Two hundred years ago, only 3% of the world's population was urbanised. By 2008, more than half of humanity lived in cities and by 2050 the figure will be 75%. Cities demand infrastructure and this rush to urbanisation has been made possible by a rapid acceleration in the exploitation of resources. It has been estimated (International Geosphere-Biosphere Program 2012) that if the global population increases to add another 3.2 billion people by 2100 and those people are accommodated mostly in 1-million-person cities, then we will need to build a new 1-million-person city every 10 days throughout the twenty-first century.

The centralisation and commercialisation of agriculture; the concentration of water resources; the production of previously unimaginable quantities of energy from fossil fuels; the establishment of national and international transport and communications networks as well as inexorable population growth have all contributed to and will continue to contribute to urbanisation. Continuous extension, fitting and re-fitting of the built landscape are the inevitable results.

One consequence of urbanisation is the rise of the 'megacity'. 'Megacities' are usually defined as metropolitan areas with a population of more than 10 million. In 1950, only New York would have qualified as a megacity. There are now 33 megacities worldwide. Together, the megacities are home to 600 million people, or nearly 10% of the world population. Most megacities are in the northern hemisphere, in Asia, North America and Europe. However, there are 3 in Africa (Cairo, Kinshasa and Lagos) and 3 in South America (Rio de Janeiro, São Paulo and Buenos Aires). Within the next eleven years, it is expected that Asia alone will have another 5 megacities.

Many of the world's cities are facing an unprecedented accessibility crisis. Access to places, activities and services has become increasingly difficult, despite significantly higher levels of urban mobility (Figure 1.1).

1.3 Impacts of urbanisation

The most rapid rates of urbanisation are in developing countries. People are drawn to cities by the promise of easier employment and an improved quality of life. Anthropologists know this as the 'bright lights syndrome'. For many, life in the city has not lived up to the expectations that attracted them in the first place (WHO 1999).

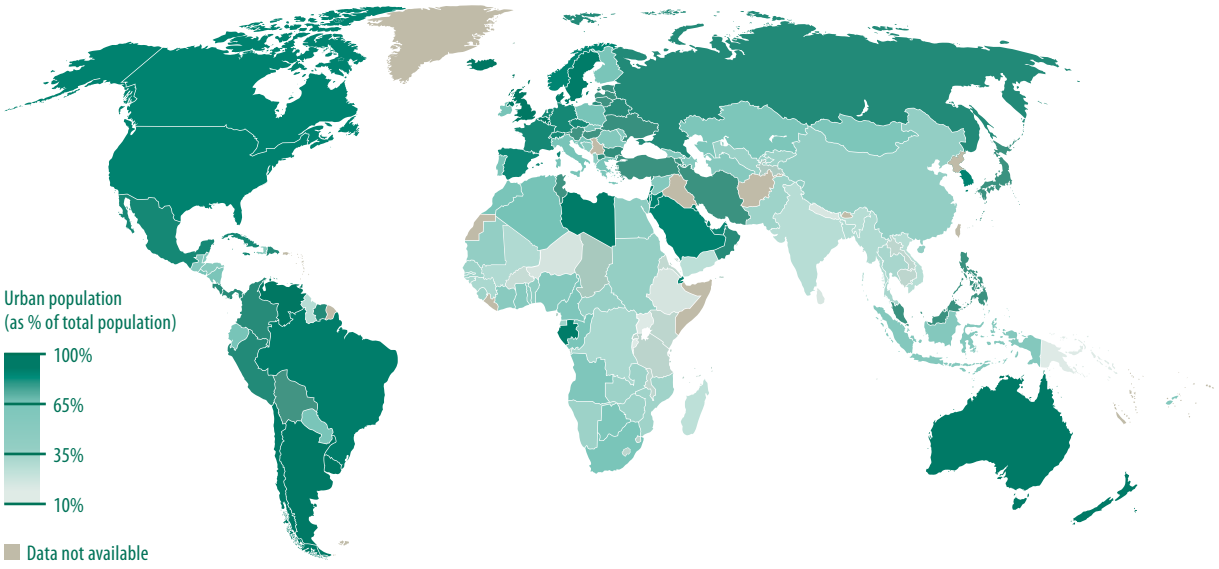
At least 1 billion (or 14%) of the world population lives in shantytowns or informal settlements on the fringes of cities. The number living in shanties and slums is expected to double in the next 15 years. This ongoing shift of people has major consequences, in particular for carbon emissions, water consumption, family life and the rural economies left behind. Urbanisation has provided an escape from rural poverty for many, but also substantial loss of quality of life for others.

Aromar Revi, Director of the Indian Institute for Human Settlements (Revi 2014), has identified the uneven impact of urbanisation as one of six major transitions characteristic of our time. The others are global shifts in demography, health patterns, education, livelihoods and energy.

1.4 Urbanisation in Australia

Settlement in Australia has followed its own rules. Estimates of the Indigenous population prior to European settlement range between 300,000 and 1,250,000. It is agreed that European colonisation had a disastrous effect on the Aboriginal population, through frontier violence and the impact of new diseases (Australian Government Director of National Parks). In June 2001, the Australian Bureau of Statistics estimated the total resident Indigenous population to be 458,520 or 2.2% of the population. Aboriginal

Figure 1.1: World urbanisation in 2005



Source: *UN Human Development Report 2007/08.*

settlement (or at least areas-of-association) would once have been more widespread and diverse than as mapped in 1963, illustrated in Figure 1.2. But Indigenous people, as elsewhere in the world, trod very lightly on the landscape in environmental terms.

Since the eighteenth-century, a different pattern of industrialised settlement has emerged and the 23 million people who live in Australia today are heavily concentrated. 76% of the population now lives on less than 10% of the land (Figure 1.3) (CEDA). Australian cities have some of the highest growth rates in the developed world (Australian Government *State of Australian Cities* 2013).

Australia has no megacities (metropolitan areas of more than 10 million population). Five state capital cities have populations of between 1 and 4M [Adelaide (1.2M), Brisbane (2.1M), Melbourne (3.9M), Perth (1.8M), Sydney (4.0M)], and between them accommodate roughly two-thirds of the population.

The three remaining capital cities [Canberra (0.3M), Darwin (0.13M), Hobart (0.2M)] are much smaller. There are eight other regional cities or metropolitan areas of comparable or greater size [Gold Coast-Tweed Heads (0.59M), Newcastle-Maitland (0.41M), Australian Capital Territory (0.37M), Sunshine Coast (0.29M), Wollongong (0.28M), Geelong (0.18M), Townsville (0.17M) and Cairns (0.14M)] (ABS 2011).

Australia's cities generally show higher private motorcar use relative to public transport use when compared with overseas cities.[1]

Private vehicles provide access to a higher number of jobs than mass transit in Australia's major cities (*State of Australian Cities* 2013).

Urban density and the relationship with the consumption of resources and therefore sustainability is a complex and sometimes divisive topic. For a comprehensive discussion, see Newman, P 2014, 'Density, the Sustainability Multiplier: Some Myths and Truths with Application to Perth', *Australia Sustainability* 6(9).

There are two distinct trends occurring across the largest of Australia's cities: one of growth locating at low densities on the urban fringe and the other of growth consolidating in high-density city centres (*State of Australian Cities* 2014–15). Outside Australia's major cities, population density is very low. Families living in rural and remote parts of Australia face major accessibility challenges. The indices of geographic remoteness used in Figure 1.4 provide a sobering picture of access to services by road.

With 69% of the population living in major cities, the balance is spread across inner regional areas (20%), outer regional areas (9%), remote (1.5%) and very remote (0.8%) areas. In 2009, these figures represented 15.1 million people living in major cities, 4.3 million in inner regional areas, 2.1 million in outer regional areas, 324,000 in remote areas and 174,000 in very remote areas (ABS 2010).

The inner-regional areas are the hinterland that supports the cities and metropolitan areas they surround.

1. For data within Australia, see ABS Car Nation 4102.0, Australian Social Trends, July 2013. For international comparisons, *State of Australian Cities* 2013 draws on Curtis and Scheurer 2012 *Benchmarking Public Transport Accessibility in Australasian Cities* ATRF: "In global terms for mode share, all five cities [Adelaide, Brisbane, Melbourne, Perth, Sydney] can be positioned towards the high-car use, marginal-public transport end of the spectrum; only US cities tend to deliver even more extreme results".

Dharavi, Mumbai CHRONUS

Figure 1.2: Aboriginal reserves as at December 1963

Source: National Library of Australia <http://nla.gov.au/nla.map-vn6104042-e-cd>.

1.5 The 'smart city'

The initial effect of accelerated urbanisation since the Second World War was to draw people together into established cities of ever-increasing size. A renewed and heightened awareness of environmental degradation in the late twentieth-century led to questions regarding the sustainability and even the desirability of these conurbations of millions of people. Social and economic pressures on large and small cities around the world have encouraged a variety of responses.

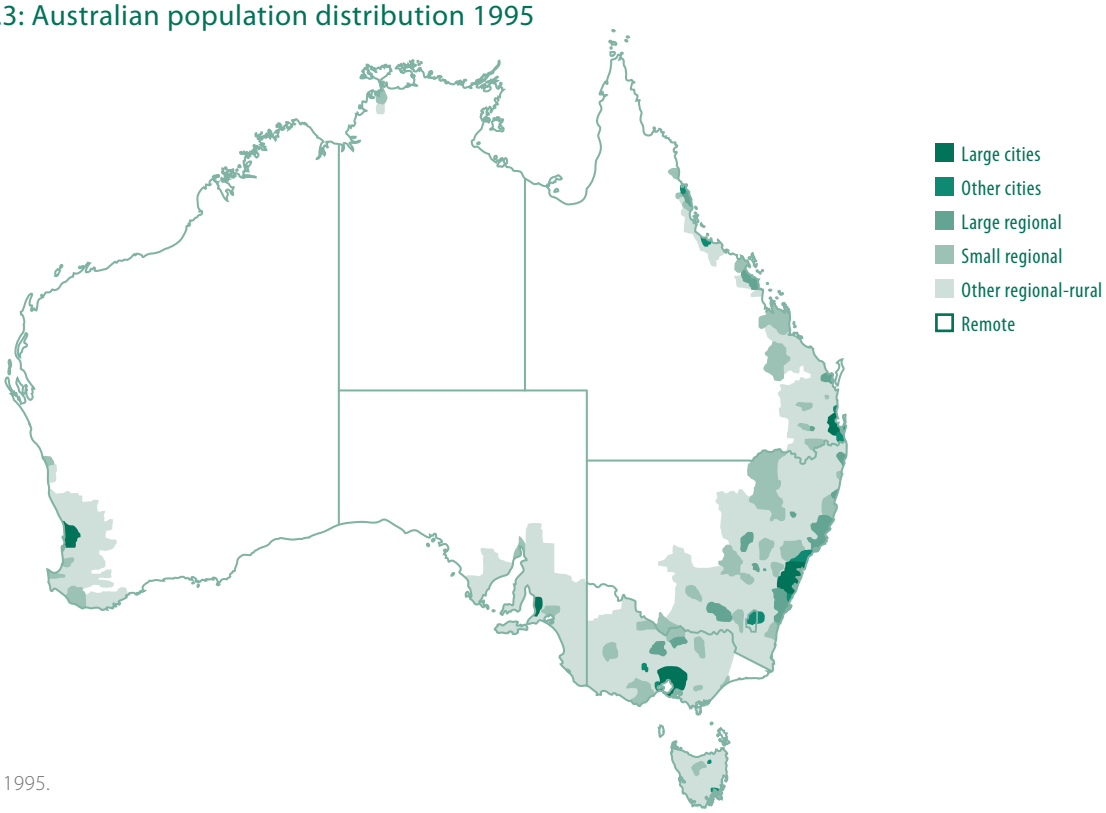
Gleeson, Dodson and Spiller (2010) have shown that decentralisation has a pedigree in Australian urban planning. "The principle of decentralised concentration has long been advocated in Australian planning but rarely implemented with any will and therefore effectiveness. It guided the historical development of Canberra and has informed the planning of cities during periods of active metropolitan planning.

'Corridor planning'—exemplified in the 1968 *Sydney Regional Outline Plan*—provided a sound structural vision for metropolitan development during the 1970s that improved the functioning and equity of our capital cities. This planning legacy has, arguably, been squandered in many of our cities."

In the twenty-first century, digital technology and rapid transit systems are increasingly making a new form of decentralisation feasible. This appears to favour the concept of metropolitan areas, 'metros', of sustainable scale, rather than large cities. A 'metro' comprises one or more urban areas with satellite cities, typically defined by commuting patterns.

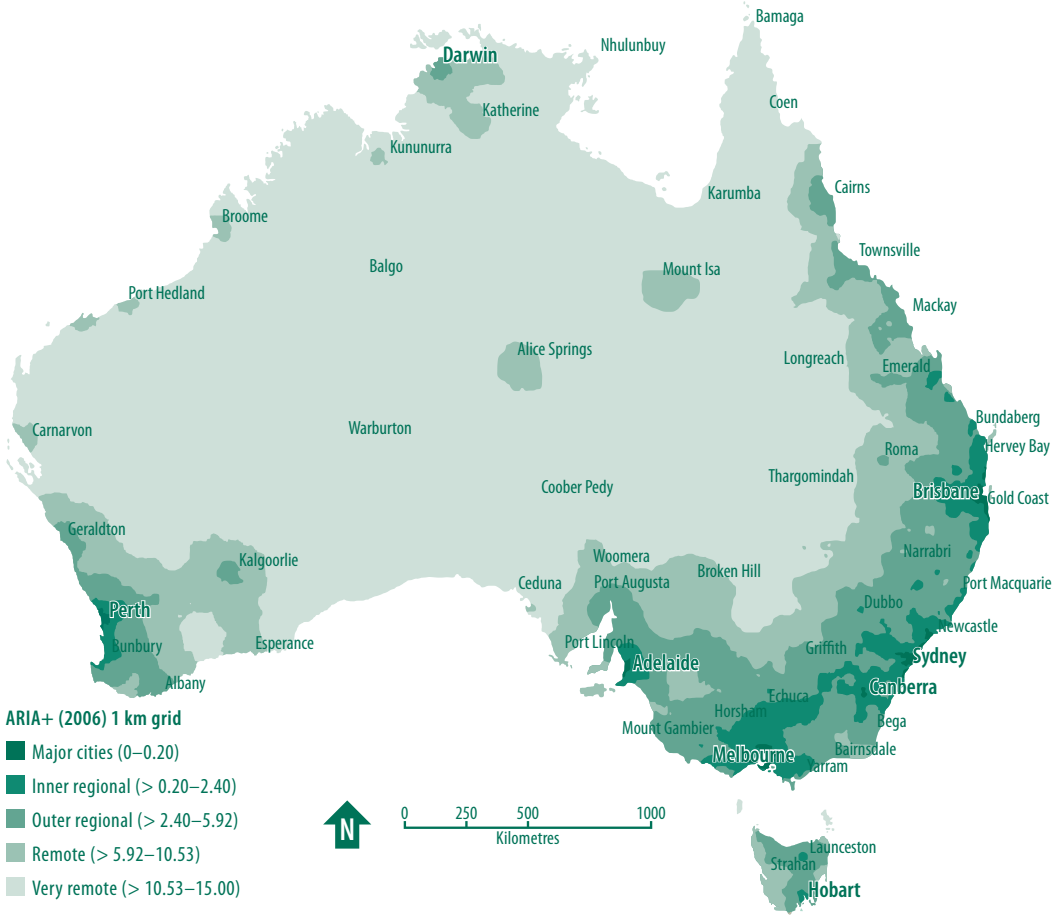
In the digital infrastructure sphere, this encourages more efficient ways of managing the built environment. Ideas that stretch from 'green' buildings, designed to minimise their

Figure 1.3: Australian population distribution 1995



Source: ABS 1995.

Figure 1.4: Accessibility remoteness index 2006



Note: ARIA+ and ARIA++ are indices of remoteness derived from measures of road distance between populated localities and service centres. These road distance measures are then used to generate a remoteness score for any location in Australia.

Data sources: GISCA, The University of Adelaide, GeoScience Australia and Australian Bureau of Statistics.

environmental footprint, to the creation of intelligent transport networks have contributed to the concept of the 'smart' city. The idea has captured people's imagination and many cities are using technology to help manage traffic congestion, to police the streets and to allocate resources and services on the basis of 'real-time' evidence.

'Real-time' data analytics consists of dynamic analysis and reporting, based on data entered into a system less than one minute before the actual time of use. Sensors and cameras placed throughout the urban landscape feed data in real time to one or more computer databases, enabling immediate or near-immediate responses to be triggered. Applications include traffic management on motorways, crime prevention in shopping centres and anti-terrorism surveillance in public spaces.

In Britain, a 2011 survey estimated that there were 1.85 million CCTV cameras operating in the United Kingdom. The report calculated that on a typical day, the average person would be seen by 70 CCTV cameras (CCTV Image Security Newsdesk 2011).

There are many other examples, including the Metropolitan Tokyo Traffic Control Centre; the ATSAC traffic management system in the San Fernando Valley in Los Angeles (Sorensen 2008); and the system used to monitor shipping at the Municipal Port Authority of Rotterdam. In Spain, Santander uses sensors to dim streetlights when they're not required and to signal when rubbish bins need to be emptied. Future applications are likely to include more active transport network monitoring, advanced driver assistance systems and fully autonomous vehicles (New Zealand Government 2014).

These systems make use of relatively straightforward, limited sets of data—sometimes called 'small data'. The anticipated potential of 'big data' is discussed below.

Online retail and tele-working in Australia currently represent less than 10 percent of total retail sales and less than 10 percent of the workforce. But these activities are forecast to grow rapidly and there is no widely accepted estimate of when they will plateau. Both have the ability to change labour markets, retail models, city design and transportation systems (CSIRO 2012).

Digital technology and human behaviour are deeply interlinked. The Internet, personal hotspots and free Wi-Fi make it possible to work at times from a shared desk in a business hub, an airport lounge or from home, in place of a city office. This new flexibility in turn influences the general demand for urban transport.

1.6 'Smart growth' and the 'compact city'

Linked to the concept of the 'smart city', particularly in the United States, is the notion of 'smart growth'. This is an approach to urban planning that focuses on compact, walkable[2] city centres, in order to reduce urban sprawl. Smart growth promotes transit-oriented developments, 'walkability' and bicycle-friendly land use, with a focus on neighbourhoods, including mixed-use development. The advocates of the 'smart growth' land development theory argue that it is an approach that does not oppose urban development but instead encourages appropriate developments, ones that provide for an equitable distribution of costs and benefits, at the street or neighbourhood level.

In Europe and the UK, the term 'compact city' describes broadly similar aims. Again, the intention is to reduce urban 'sprawl', a phenomenon generally agreed to cause high motorcar use (Newman & Kenworthy 1989). The compact city promotes relatively high residential density with mixed land use. It includes an urban layout designed to encourage walking and cycling, low energy consumption and reduced pollution (Dempsey 2010).

2. 'Walkability' has been defined as "...the extent to which walking is readily available as a safe, connected, accessible and pleasant mode of transport" Mayor of London and Transport for London, cited in Abley S 2005 *Walkability Scoping Paper*.

Box 1.1: International competition between cities and new city networks

'Globalisation' refers to the rapid increase since the late twentieth-century in the internationalisation of trade, investment, migration and the exchange of information (IMF 2000). Among the many consequences of globalisation is the emergence of networks of world cities, as well as national and international competition between cities (Derudder *et al*. 2012)

Cities are seen to both cooperate and compete with each other, in order to become clusters or agglomerations of specific products and services, attracting capital investment, building the necessary infrastructure and encouraging the migration of appropriately skilled workers.

Inter-city competition is not limited to the business sector. Cities seek to add international sporting events, cultural attributes and tourist attractions to their portfolios. Despite the somewhat arbitrary nature of various international rankings of cities, this newfound focus on cities as centres of socio-economic importance creates opportunities for aspirant cities such as São Paulo, Incheon, Johannesburg and Mumbai to advance themselves.

New private sector and NGO city networks are emerging that seek to link international communities on the basis of creativity, design, education, environmental activism, religion or resilience. One example describes itself as the "Marketplace of the European Innovation Partnership on Smart Cities and Communities" (Marketplace) and offers a range of 'action clusters' to facilitate inter-city cooperation and exchange. The six clusters established to date include: business models; citizen focus; integrated infrastructures and processes (including open data); policy and regulations/integrated planning; sustainable districts and built environment; and sustainable urban transport.

Paul James, Director of the UN Global Compact Cities Programme, has argued against the view that 'smart cities' are necessarily better or more sustainable cities. James suggests that it is the integration of learning and practice which makes for intelligent and sustainable cities. The 'Circles of Sustainability' is an urban profile process used for assessing sustainability by the UN Global Compact Cities Programme and other global organisations and individual cities (James *et al*. 2015). The method takes the emphasis away from economic growth and suggests that cities should rather be aiming for social sustainability, including cultural resilience, political vibrancy, economic prosperity and ecological adaptation.

1.7 The structure of Australian cities

The major Australian cities can be seen as four-fold structures. At the heart, on the riverbank, is the nineteenth-century inner city, based on a British colonial template, and originally including inner-urban Victorian era neighbourhoods. Beyond this lies a middle-ring of suburbs, built for the most part between the two World Wars and during the immediate post-war era. Both the inner city and the traditional suburbs are comparatively well served by local infrastructure, including libraries, parks, schools and retail precincts. Most of these 'traditional' areas enjoy

Gold Coast, Queensland MARTY.VDH

relatively good public transport, some of which is networked. Some suburbs offer multi-mode transport choices, while others are more heavily dependent on the motorcar.

Some argue, on environmental, economic and social grounds that these older suburbs, often single-story, one dwelling-per-block homes, are unsustainable at current densities (David Lock Associates). However, resistance to change is strong and the traditional suburbs have thus become a battleground in which developers and residents confront one another, through local councils and administrative tribunals.

The ever-increasing pressure for additional housing has seen three broad changes in the post-war era. In the inner cities, urban renewal projects, on waterfronts and across formerly industrial areas, have seen the juxtaposition of heritage-sensitive renovations with often-inappropriate mid-rise or high-rise constructions. In the traditional suburbs, state planners and developers have forced the introduction of mid-rise apartments, particularly along transport corridors. Finally, cities have expanded their boundaries on the fringes, releasing land for new developments. This has led to the construction of entire suburbs that are not served by public transport and therefore completely dependent on the motorcar. Increased house prices, the distance to employment hubs and the cost of fuel have ensured that these fringe developments do little to solve the challenge of affordable housing for all.

Beyond that lie the 'inner-regional' communities that surround Australian cities. These form part of the rural hinterland that supports the cities. Almost all the inner-regional population of more than 4 million rely entirely on the motorcar for accessibility. Many of Australia's multi-car households are found here.

In Australia's larger cities, home renters predominate in the centre while outright homeowners are generally found in the middle suburbs. In the outer suburbs new homes are being purchased—this is the so-called 'mortgage belt', but on the fringes of cities there is also an outer belt of home renters. This outer belt of renters appears to be little studied (*State of Australian Cities 2013*).

Darling Harbour, Sydney ALISTAIR CUNNINGHAM

1.8 Employment hubs

Traditionally, the inner cities (i.e. the central business district and inner-urban neighbourhoods) have been seen as the most important employment hubs, across many sectors. Structural economic changes are strengthening this, but they are also impacting elsewhere in the city. In a study (Stone *et al*. 2014) commissioned by ACOLA for this research project, Stone *et al*. point out: 'the great majority of urban employment is found in the suburbs. In recent years, there has been significant growth in employment in health and education services in suburban locations.'

In another study commissioned for the same purpose (Stanley & Brain 2014), Stanley and Brain point to the increasing importance of parts of the 'forgotten middle suburbs' as places for future employment growth.

Major cities have experienced a large increase in their number of knowledge-intensive jobs—high-skill jobs that demand significant expertise, intellectual effort and innovation. This increase has tended to be concentrated in central areas. While knowledge-intensive jobs account for only a small proportion of all jobs in major cities, they are increasingly important to their productivity and they increase employment opportunities and salaries. The manufacturing and retail sectors, which once drove jobs growth, are now employing a smaller proportion of Australians. An increasing number of people are living further away from city centres while higher-skill, higher-paying jobs, are becoming concentrated in central areas (*State of Australian Cities 2013*).

> "The goal of an urban mobility system, as a public good, is to promote access and not mobility. Mobility is merely one means to the achievement of that larger end. Consequently, policies should reflect the value of access and not the time saved through enhanced mobility systems".
>
> UN-Habitat

1.9 Metropolitan regions in Australia

A 'metro' comprises one or more urban areas with satellite cities, typically defined by commuting patterns. In Australia, metropolitan areas such as Greater Brisbane, Gold Coast-Tweed Heads, Newcastle-Maitland, Canberra-Queanbeyan and Sunshine Coast have already overtaken smaller cities in their population and, in some cases, in their socio-economic significance.

Gleeson, Dodson and Spiller (Gleeson *et al*. 2010) have pointed out that, while Australia may have few remaining metropolitan approaches to planning today, such broad thinking was once more common. Between 1949 and 1985, the Melbourne and Metropolitan Board of Works (MMBW) provided an extensive service that included town planning, the management of parkland, maintenance of metropolitan highways and bridges, foreshore protection and the monitoring of waste discharges. In 1970, the National Capital Development Commission created *Tomorrow's Canberra*, while in the same year the Metropolitan Regional Planning Authority developed a comprehensive corridor plan for metropolitan Perth.

Renewing planning governance in Australia and the potential value of a metropolitan view is an issue that will reappear below.

1.10 Australian cities: high on liveability, large ecological footprint

Liveability indexes are an attempt to measure the broader aspects of cities beyond traditional economic indexes. The *UN-Habitat City Prosperity Index* is an important contribution to objectively measuring cities on an internationally comparable basis. Melbourne, for example, ranks highly on prosperity and quality of life.

Australian cities generally rate high on measures of liveability, but they have environmental footprints[3] that are not sustainable (*UN Human Development Index* 2008). Buenos Aires, for example, is placed only slightly below Australian cities on the liveability index, but with a considerably lighter ecological footprint (2.5 Ha/cap instead of 7.6 Ha/cap) (Newton 2012).

What characterises the five larger Australian cities—and what they share with megacities—is their low-density mono-functional expansion (colloquially known as 'urban sprawl'). Accurate comparisons between conurbations are notoriously difficult: boundary definitions vary and data is drawn from inconsistent sources. There are also very few European cities with populations comparable to the largest Australian cities. Drawing on Demographia World Urban Areas (Demographia 2015) and the City Mayors database (City Mayors), it seems safe to say that both Sydney (pop. 4.03 mill) and Melbourne (pop. 3.9 mill) demonstrate significantly lower population densities than Paris (10.85 mill) or London (10.23 mill). This is despite the fact that Melbourne now boasts a geographical footprint of 2543 km^2, approaching that of Paris, while both it and Sydney's footprint of 2037 km^2 are greater than that of London (Figures 1.5 & 1.6).

The closest population comparison is with Berlin (4 mill). With a population density of 3000 people/km^2 (i.e. double that of Melbourne), the German capital covers an area just over half that of Melbourne.

The expansive nature of Australia's largest cities has consequences for water quality, air quality and ocean cleanliness. And of course, it has major consequences for transport. And perhaps we should remind ourselves that while the trend is overwhelmingly towards urbanisation, we never leave the rural areas behind. The countryside that surrounds our cities (and the people who live there) remain essential as providers of food and other resources, including water catchment, which make urban life possible. The same applies to rivers and oceans. For many cities worldwide, nearby marine, estuarine and fresh water resources are vitally important for fishing.

The liveability of Australia's cities will be affected by how their sustainability is managed. Many cities are making significant progress in introducing vegetation (including small plants, trees, open green spaces and even forests) at various scales across cities—from buildings to districts and metropolitan regions—to reduce the urban heat island (UHI) effect and thereby increase liveability and reduce energy use (*State of Australian Cities 2013*). If the Australian population may double in this century (ABS 2013), cities will have to become a lot smarter about how they develop and learn to think long-term.

1.11 Climate change

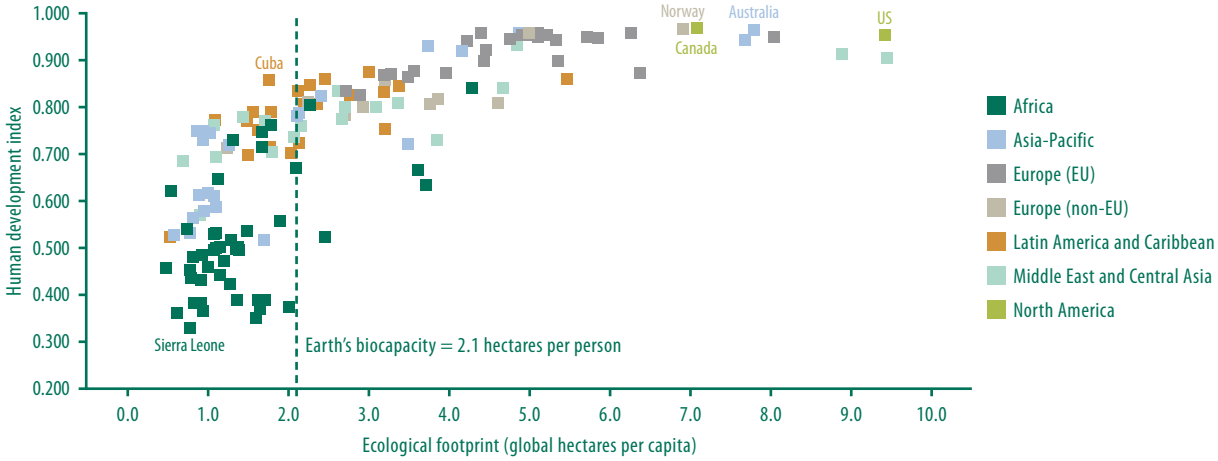
There is a considerable body of academic literature that points to the twin challenges of diminishing resources and climate change.[4] Rapid deforestation, unprecedented loss of biodiversity, the collapse of fish stocks, water scarcity and the pollution of both water and soil all now form part of our ecological understanding.

A study jointly commissioned by the Victorian Department of Transport and the City of Melbourne (City of Melbourne 2009) argues that the capacity of cities to withstand the pressures of population expansion, climate change and outdated modes of operation, particularly, has finite limits. The study followed the disastrous summer of 2009 and concluded that "if we continue to understand, develop and utilise our infrastructure in the traditional ways of the 20th century we are doomed to perpetuate our current problems".

3. A city's ecological footprint is measured in global hectares per capita, the amount of biologically productive land and water available per person on the planet. There were ~12 billion hectares of biologically productive land and water on this planet in 2011 and the international average is 2.7 global hectares per person (*UN Human Development Index* 2008).

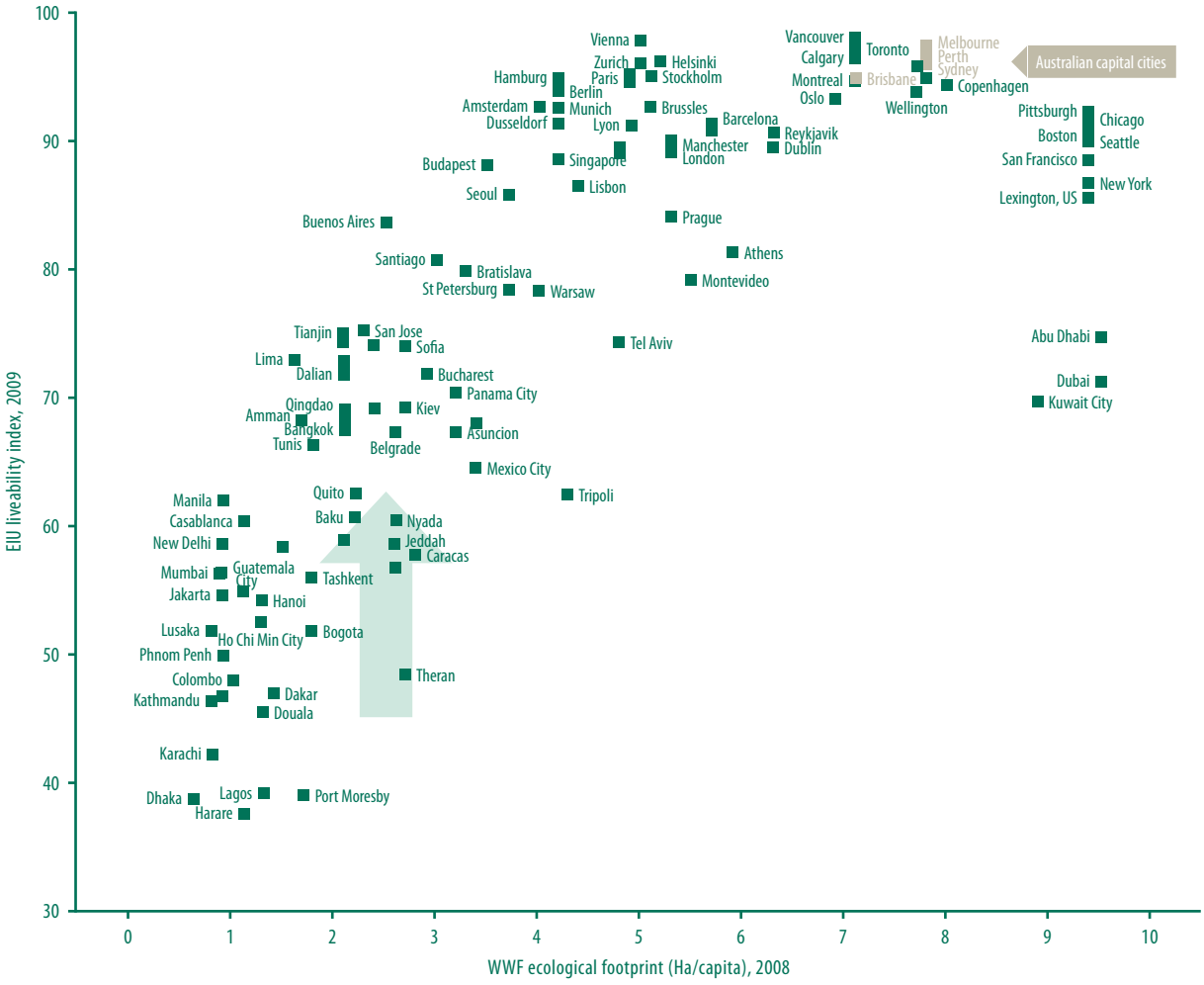
4. Two examples include Grantham, J 2012, 'Be Persuasive. Be Brave. Be Arrested (if necessary)', *Nature*, 14 Nov; and Patz, Frumkin, Holloway, Vimont & Haines 2014, 'Climate Change: Challenges and Opportunities for Global Health', *JAMA*, vol. 312(15), pp. 1565–1580.

Figure 1.5: Human welfare and ecological footprints compared



Source: UN Development Programme and Global Footprint Network. Data sourced from Global Footprint Network 2008 report (2005 data), UN Human Development Index 2007/08.

Figure 1.6: Liveability and ecological footprints



Source: Peter Newton 2012.

In the summer of 2009, Melbourne experienced some of the finite limitations referred to. Early in February, a heat wave led three successive days over 43°C. On 7 February, this was followed by Melbourne's hottest day on record, when the temperature reached 46.4°C in the city centre. The same heat wave created conditions conducive to the so-called 'Black Saturday' bushfires that ensued, the worst in Australian history.

The study serves as an example of how vulnerable urban transport systems and service provision can be. As the temperatures rose in Melbourne, the city experienced a number of failures:

- pressures on the electrical generation and distribution network saw blackouts and failures affect large areas of the city
- fires narrowly missed bringing down the main power distribution network from the Latrobe Valley—an occurrence that would have closed down the whole city
- rail systems designed for cooler conditions overheated and failed, with up to half of the scheduled trips being cancelled.

The Bushfires Royal Commission produced a 'conservative' estimate of the total cost of the Black Saturday bushfires of $4.4 billion. According to the study, "the biggest regret should be the realisation that much of this was avoidable. For example, power generation at its peak could have been better secured and offset by distributed solar power generation fed into the grid from the suburban roofs".

1.12 GHG emissions and targets

Per capita, Australia is one of the world's highest emitters of greenhouse gases. Transport emissions are particularly high, in some cities three times those of London (chartingtransport updated 2015; Stanley & Loader 2008) and growing faster than any other sector except electricity. The transport sector contributes the largest proportion of average household carbon dioxide (CO_2) emissions at almost 42%. Light passenger vehicle use alone accounts for 35% of Australia's average household emissions, by far the largest overall component of the transport sector's emissions (*State of Australian Cities 2013*).

In the UK, an 80% reduction target by 2050 has been legislated (*Climate Change Act* 2008). In the USA, the *American Clean Energy and Security Act* of 2009 includes a reduction of 83% below 2005 levels in 2050. Australia currently has a 2050 target of a 60% cut in emissions. Australia is likely to face international pressure to achieve a dramatic change in the trajectory of its GHG emissions including from the transport sector, in order to contribute to emissions reduction in any way approaching the magnitude required to limit warming to 2°C.[5]

1.13 The role of data in urban management

The past ten years have seen an explosion in data production, including directed categories (e.g. immigration passport control), automated categories (e.g. mobile phones that record and report their own usage) and volunteered categories (particularly social media). The overt use of cameras and sensors by police forces and private security firms is now widespread and familiar. Automated data collection in particular has raised deep concerns amongst those who see this as a new form of covert surveillance.

At a more benign level, data is already used to monitor the movement of vehicles, controlling traffic signals, speed limits and toll charges and administering penalties for violations. But even here, there are real concerns regarding the vulnerability of digital systems to hacking and the danger of technological lock-in, when either malicious or accidental technological failure shuts down a subway system or freezes an airport.

5. Current Australian emissions (<20 tonnes per capita) and 2050 reduction target of 60%, measured against the budget forecast of 1.8 tonnes per capita reducing to 0.33 tonnes per capita by 2050 in Meinhausen, M, Meinhausen, N, Hare, W, Raper, S, Frieler, K, Knutti, R, Frame, D & Allen M 2009, 'Greenhouse gas emission targets for limiting warming to 2°C', *Nature*, vol. 458, pp. 1158–1162.

Box 1.2: Mobility and access

Mobility is our capacity to travel, our potential for movement. Mobility alone is not enough, since without reaching a chosen destination, travel is (usually seen as) pointless. On the other hand, mobility is not always a necessary condition for accessibility. "Mobility is only the means; activities are the end, accessibility is the key" (Handy 1994).

Accessibility is generally accepted to be the potential for social and economic interaction, the ease of reaching our destination of choice and the range of opportunities found there. A focus on accessibility characterises a holistic and integrated approach to sustainable urban mobility. It recognises the links between urban form (including shape, structure, function and demographics) and transportation systems. Land-use planning ensures proximity and compactness, as well as accommodating diverse functions. These mixed-use functions can help to minimise the need for extended travel, enhance economies of agglomeration and encourage non-motorised mobility (UN-Habitat 2013).

In one vision of future cities, information and communication technology (ICT) on a scale previously unimaginable is seen as becoming of central importance in managing and regulating a 'smart city' from a technocratic and technological perspective. 'Big data' refers to large data sets containing a variety of data types: "the vast amount of data that is now being generated and captured in a variety of formats and from a number of disparate sources" (*APS Big Data Strategy Issues 2013*). 'Big data analytics' is the analysis of those data sets to reveal patterns, correlations or market trends. Ownership of data sets can become highly contested, especially when what some would regard as public property is claimed by commercial concerns.

"It is perhaps no surprise that some of the strongest advocates for smart city development are big business (e.g., IBM, CISCO, Microsoft, Intel, Siemens, Oracle, SAP) that, on the one hand, are pushing for the adoption of their new technologies and services by cities and states and, on the other, are seeking deregulation, privatisation and more open economies that enable more efficient capital accumulation" (Kitchin 2014).

An alternative vision of smart cities sees 'big data' as a tool for public good, assisting urban planners to work for socio-economic progress, developing more liveable, secure, functional, competitive and sustainable cities, and promoting the renewal of urban centres as hubs of innovation and work. This is based on the concepts of 'open government data' and 'public sector information' (PSI). A detailed discussion of both concepts is presented in a recent OECD Digital Economy Paper: Assessing government initiatives on public sector information (OECD 2015).

In both visions, what is prioritised is the capture and analysis of data to underpin evidence-based policy development.[6]

[See also 2.9 below for a discussion of data and transport efficiency.]

'Big data' promises a much more sophisticated and wider-scale understanding of the flow of people, vehicles and goods through cities. Planners will have to learn to distinguish between objective data analysis and that on offer for commercial gain. The potential for 'big data' to contribute to sustainable urban mobility requires further research as evidence begins to replace speculation.

The current Australian Parliamentary Inquiry into the role of Smart ICT in the design and planning of Infrastructure is relevant.[7]

6. The politics of 'big data' is beyond the scope of this report. For further discussion of this as-yet-little-researched field, see for example: Peled, Alon. *The Politics of Big Data—a Three-Level Analysis*. Paper presentation at the European Consortium of Political Research (ECPR) General Conference, Bordeaux, France (4–7 September 2013).
7. <www.aph.gov.au/Parliamentary_Business/Committees/House/Infrastructure_and_Communications/Smart_ICT>

1.14 Quality of life for all

Quality of life should not be confused with standard of living. World Health Organisation (WHO) defines quality of life as "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (WHOQOL 1997). The OECD Better Life Initiative is an ongoing research program on measuring wellbeing and progress. The three pillars of this work are material conditions, quality of life and sustainability (OECD).

A report published by ACOLA in July 2013, *Australia's Progress in the Twenty-First Century: Measuring the Progress We Want* (ACOLA 2013) adds a local context to the international literature exploring measures of societal progress that go beyond GDP. The approach is born out of a growing awareness that purely macroeconomic indicators are an incomplete picture of the actual health of our economy, communities, and environment. Economic resources are seen as one of several essentials in people's well-being, in a set that includes health, social interaction, education, jobs, environmental quality, civic engagement, governance, security and free time.

Access and mobility are therefore essential drivers in perceptions of quality of life. The way we shape our cities has a profound influence on our quality of life.

1.15 Key findings

- **Australian cities are vulnerable**
  Despite historically successful urban development, Australian patterns of settlement, urban infrastructure and social organisation are vulnerable to increased urbanisation, changing demographics, diminishing resources, climate change and the increased frequency of extreme weather events.
- **Australian urban environmental footprints are not sustainable**
  Australian cities rank high on measures of 'liveability', but they demonstrate environmental footprints that are not sustainable. Sydney's geographic area of 2037 km^2 exceeds that of London (pop. 10.23 mill). Berlin (pop. 4 mill) has a density of 3000 people/km^2 double that of Melbourne. The expansive nature of Australia's largest cities has environmental consequences and implications for transport.
- **Three strategies are key in improving urban sustainability**
  Sustainable urban mobility planning involves the consideration of a three-step approach: reduce or avoid travel or the need to travel; shift to more environmentally friendly modes of transport; improve the energy efficiency of transport modes and vehicle technology.
- **Technological innovations are important**
  Increasingly, the use of information and communications technology will facilitate urban management, ranging from data applications for planning and transport management to city policing and the timely allocation of resources and services. Technological innovation is important in helping to mitigate greenhouse gas emissions, reduce trip times and minimise traffic accidents. Technology alone however cannot solve the challenges ahead.

2 Transport technology: the next 25 years

2.1 Introduction

The transport sector is the major consumer of non-renewable liquid petroleum fuels. Australia faces an economically and socially important liquid fuel security risk. The production and use of alternative transport fuels are still in their infancy globally but low environmental impact fuels (particularly electricity) are inexorably entering all major transport modes. Australia has underutilised capacity in the national electricity grid, although the carbon intensity of electricity generation in most states and territories is not yet low enough to provide significant GHG emission reductions through use of electric vehicles. 'Real-time' sensing and data analytics are increasingly contributing to improved urban mobility and are becoming more important in urban planning. 'Big data' does not yet offer solutions to sustainable fuel use. Lack of familiarity with rapidly changing transport technologies is a barrier to their inclusion in planning and policy options. The three technological innovations expected to impact substantially on urban mobility are plug-in electric vehicles (PEVs), high-speed

broadband (HSB) and the Internet of Things (IoT). There is a need for sustained and specific policy support to foster rapid uptake in Australia of transport innovations that are available and emerging globally.

2.2 Energy consumption: global

World energy consumption today exceeds 550 exajoules per annum or 500 x 1018 joules. This represents an increase of at least 25% since 1990, or 250% since 1960. Approximately 75% of that consumption is non-renewable fossil fuels (primarily oil, coal and natural gas). The balance comprises biofuel and nuclear power (Our Finite World 2012).

The transport sector globally is a major energy consumer, primarily of oil. Transport was one of the key sectors highlighted in the Kyoto agreement of 1997, aimed at reducing greenhouse gas emissions. By 2012, the transport sector accounted for 27 percent of the world's energy use (EIA data). Transportation continues to be the most rapidly growing sector in terms of energy use, particularly oil. In 2010, transport accounted for over 40% of China's total oil consumption (IEA 2012). The figure is expected to reach 65% by 2035. It follows then that even small changes in the consumption of fuel by the transport sector will impact significantly on global energy requirements.

2.3 Energy consumption: Australia

Australian energy consumption is primarily composed of non-renewable energy resources (coal, oil, gas and related products). This represents 96 per cent of total energy consumption (Singleton & Pender 2014). The remaining 4% of consumption is made up of renewables.

In 2012/13 total Australian net energy consumption amounted to 5884 petaJoules[1]. Of this, 1525 petaJoules (26%) are attributed to the transport sector (Figure 2.1).

2.4 Transport fuels

Australia is a large continent supporting urban and metropolitan areas that are widely separated. Almost 40% of Australia's final energy use is required to support passenger and freight transport, much of it over long distances. Two thirds of this transport is carried by road. Despite significant improvement in the fuel efficiency of motorised transport, road transport still accounts for 74% of the sector's liquid fuel consumption.

Growth in road transport fuel consumption has moderated as vehicle technology improved, but consumption amounts to 1163 petaJoules per annum. The fastest growing factor is air transport, much of it at the expense of international sea freight.

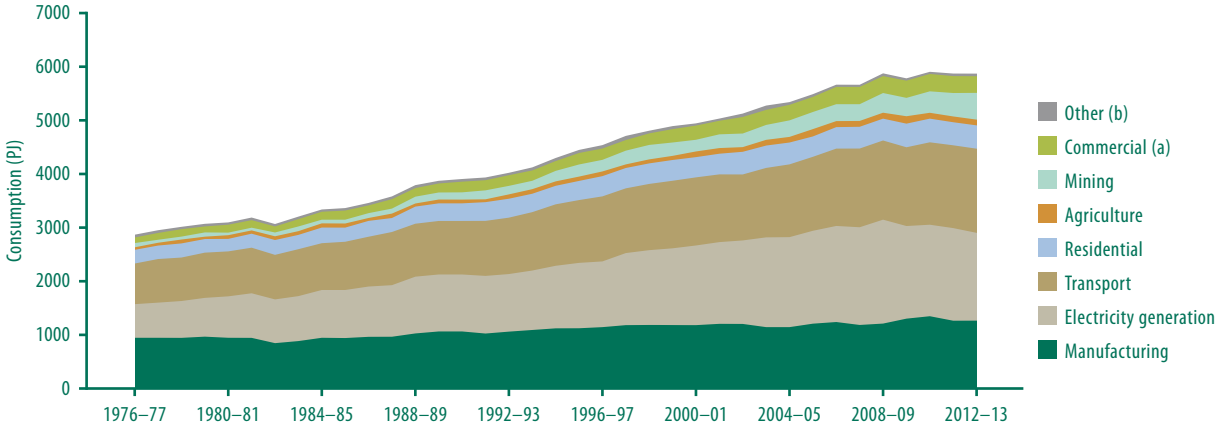
Overall, the demand for liquid transport fuels has risen steadily over the past 12 years (Table 2.1).

In 2013–14, Australia's net import bill for crude oil plus petroleum products was $30.7 billion, or approximately 2% of Australia's gross domestic product (GDP). These net imports have risen in the recent years from $25.0 billion (or approximately 1.7% of GDP) in 2011–12.

Given the geography of the country, patterns of urban settlement, the shape of Australian cities, the relative paucity of rail transport and limited public transport systems, the country is heavily reliant on road transport. At present, private self-directed vehicles are perceived as being fundamental to urban mobility.

It is therefore surprising to find that Australia has small and declining fuel stocks, holding no more than three weeks' worth of oil and refined fuels onshore. The first part of a report published by National Roads and Motorists' Association (NRMA) Motoring & Services in 2013 *Australia's Liquid Fuel Security* highlighted this little known fact. The second part of that report, published in 2014,

Figure 2.1: Australian net energy consumption, by industry



(a) includes ANZSIC Divisions F, G, H, J, K, L, M, N, O, P, Q, R, S and the water supply, sewerage and drainage service industries. (b) includes consumption of lubricants and greases, bitumen and solvents, as well as energy consumption in the gas production and distribution, and construction industries.

Source: BREE 2014, *Australian Energy Statistics*, Table E.

1. 1 petaJoule = 1015 Joules = 23,884 tonnes of oil.

Table 2.1: Energy consumption in the transport sector

Type	1979–80 (PJ)	1989–90 (PJ)	1999–00 (PJ)	2009–10 (PJ)	2010–11 (PJ)	2011–12 (PJ)
Road transport	594.1	792	942	1080.4	1118.2	1163.2
Railway transport	30.9	30.7	29.7	48.4	45.7	45.3
Water transport	97.6	55.7	55.7	67.3	62.2	66.7
Air transport	58.9	103	180.2	243.7	255.6	243.1
Other	3.5	6.2	12.7	25.6	26.6	25.5
Total	**785**	**987.6**	**1220.3**	**1465.4**	**1508.3**	**1543.8**

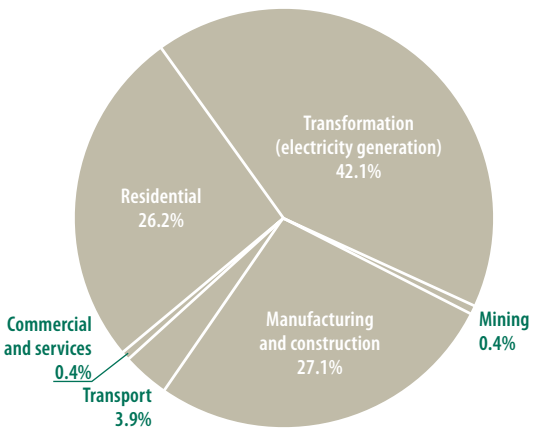
Note: Net energy consumption (defined as total fuel input less energy produced). Source: BREE 2012, *Australian Energy Statistics*; BREE estimation.

noted that the Australian Government has failed to act in mitigation of what might be regarded as a major national risk.

> "There is no public Government policy on maintaining a minimum level of oil refining capacity in Australia. Since 2000, our dependence on imported liquid fuel and oil for transport has grown from around 60% to over 90% of our transport fuel demand. There is no plan to stop our dependency growing to 100% or to halt the further decline of our fuel security."
>
> NRMA 2014

A recent Senate Inquiry found clear divisions in evidence on the question of whether Australia's current fuel stockholding arrangements provide adequate fuel security (Australian Government 2015, The Senate).

Figure 2.2: Renewable energy consumption by sector, 2010–11



Source: BREE 2012, *Australian Energy Statistics*.

2.5 Alternative fuels in Australia

2.5.1 Biofuels

Conventional fuels (petrol, diesel and jet fuel) currently account for 95 per cent of Australia's transport fuel consumption, whilst non-conventional transport fuels (mainly LPG and biofuels) account for the remaining five per cent.

Given Australia's ever-growing dependence on importing refined transport fuels, any increase in the use of alternative fuels and further diversification of the fuel mix in the transport sector will help mitigate some of the risks Australia faces in the importation of conventional fuels. Some alternative transport fuels also assist in lowering emissions from the transport sector.

A commitment to biofuels for motorcars is not a panacea for GHG. Nevertheless, in the medium to long-term, a range of alternative transport fuels may be available, including biofuels, gaseous fuels and synthetic fuels, such as coal-to-liquids, gas-to-liquids, biomass-to-liquids and shale-to-liquids (Figure 2.2).

> "The opportunity exists for Australia to capitalise on its comparative advantages and start laying the foundations now for what might be an industry of significant future value and scale, providing a substantial proportion of Australia's future fuel requirements."
>
> LEK 2014

2.5.2 Electricity

In the US, electric vehicle stocks are expected to rise from close to zero in 2010 to 157 million light trucks and cars by 2050 or 50% of the total US vehicle fleet (ARUP 2015) (Figure 2.3).

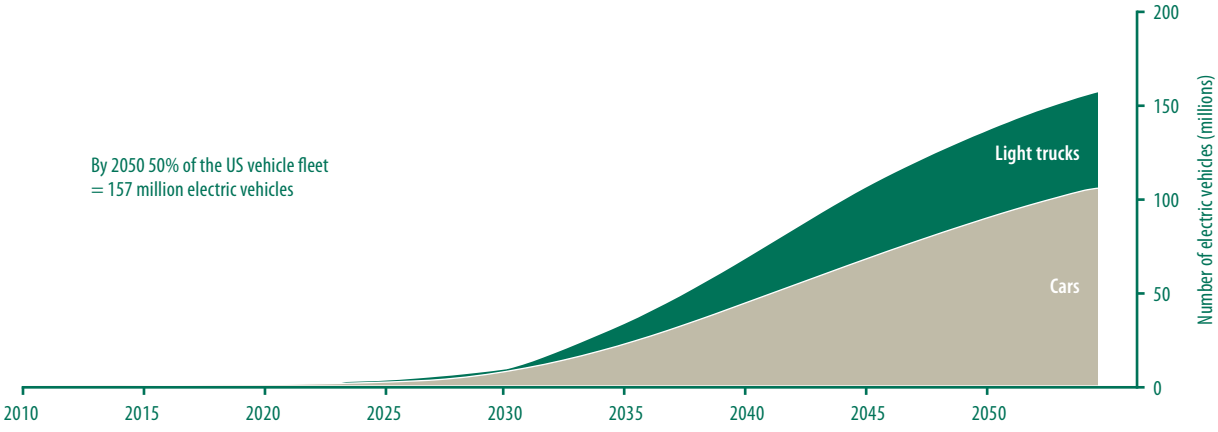
Globally, the rate of market growth has almost doubled each year between 2012 and 2014, after starting from a very low base (National Academy 2015).

The evolution of a charging infrastructure, as well as developments in battery technology and provision for the disposal of waste batteries are all factors that will significantly influence the take up of plug-in electric vehicles (PEVs). However, if upstream emissions from power plants are ignored (and they cannot be at a state or national level), then PEVs can effectively be treated in a local context as zero emission vehicles. Replacing petrol-driven vehicles with PEVs will not, of course, reduce traffic congestion or parking problems (Figure 2.4).

The Australian electricity grid could support the uptake of electric vehicles and further electrification of the rail network. "There is potentially between 7650 megawatts and 8,950 megawatts of surplus capacity across the National Electricity Market in 2014–15. Approximately 90% of this is in New South Wales, Queensland, and Victoria" (AEMO 2014). This represents a 15% surplus capacity over current demand.

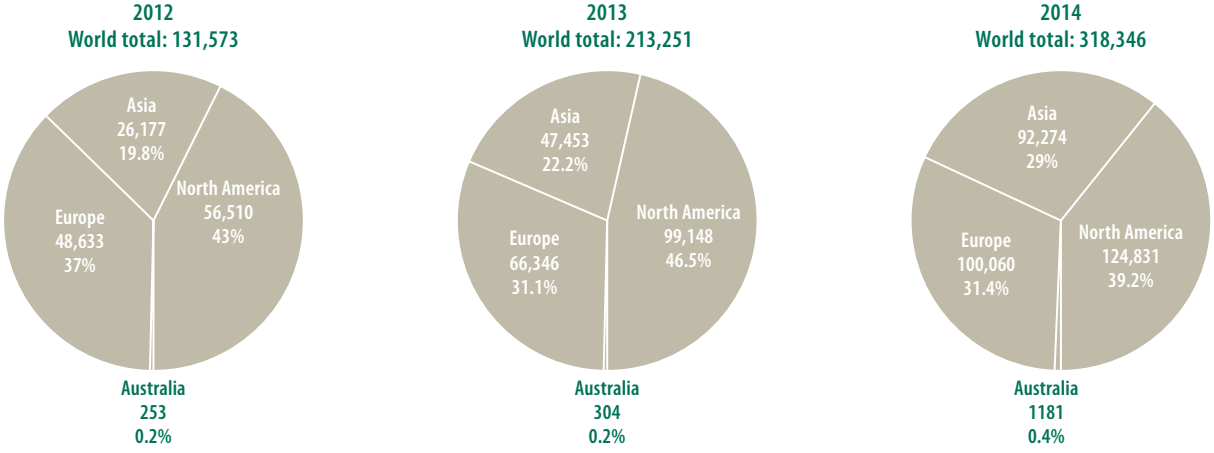
Current research at the Melbourne Energy Institute, University of Melbourne looks at existing network distribution infrastructure and suggests that with an optimal charging policy (informed by electricity market spot price; state of charge of individual batteries; and both present and anticipated network loads) 80% penetration of households by electric vehicles

Figure 2.3: US projected electric vehicle stocks, 2010–50



Source: Rocky Mountain Institute.

Figure 2.4: World plug-in electric vehicle sales in 2012–14



Source: Based on data from Pontes 2015.

could be sustained with current network infrastructure.

The 2012 Western Australian Electric Vehicle Trial demonstrated the suitability of PEVs for Australian urban conditions (Mader & Braünl 2012). The report found that potential EV buyers are reluctant to purchase vehicles in the absence of a substantial public recharging network. International jurisdictions where this problem has been overcome have generally benefitted from government interventions, which have subsidised the availability of EVs and/or underwritten the establishment of public charging facilities.

At the present time, rail systems in all of the major Australian cities are electrified, but only in Queensland are there major electrified routes in non-urban areas. Queensland Rail has about 1000 km of electrified track, including the line from Brisbane to Rockhampton, and the coal routes of central Queensland. The major new, electrified passenger line in recent years has been the Perth-to-Mandurah railway, while some extensions to electrified lines are planned for Melbourne. Victoria and NSW have withdrawn electric locomotives from regional lines over the past two decades. In both cases, this seems to reflect problems with incorporating electric locomotives into a predominantly diesel network, together with low fuel costs.

In many contexts, the most efficient form of rail transport is fully-electrified rail. Where this is powered by electricity generated from renewable sources, rail can be a virtually zero emissions transport mode. Electrified rail in Australia does not fully achieve these potential emissions benefits since it is primarily powered by coal-based electricity and, in some cases, has low loading factors and employs older technologies.

In France, for example, about 80% of electricity is generated from sources that are either sustainable or produce near-zero emissions. There is a nationwide grid of electrified rail transport, with an official objective of complete electrification within 20 years. This provides France with an efficient, low-emissions component of its overall transport system, with rail transport accounting for only 0.63% of all transport's CO_2 emissions (SNCF 2009; CRC for Rail Innovation 2009).

2.6 Transport efficiency and infrastructure

Energy efficiency rankings are dependent on the measures used and local conditions. Even when exactly the same measures are in place, comparisons between countries will be affected by a range of factors such as geography, population, weather patterns, economic development, cost and abundance of energy supplies.

In a World Energy Council report of 2010 (World Energy Council 2010), Australia ranks high in energy efficiency across the building sector (Green Star building system), white goods (star rating of appliances), domestic electricity consumption (smart meters in Victoria) and vehicle GHG emissions (Green Vehicle Guide).

However, a recent international scorecard in transport sector efficiency produced a less encouraging result. The report published by the American Council for an Energy-Efficient Economy, found that Australia ranked last for transport efficiency (ACEEE 2014), while on overall energy efficiency across national efforts, buildings, industry and transport, Australia ranked tenth out of 16 major OECD countries. These results are due in part to Australia's reliance on road transport rather than rail.

The evidence is that rail is significantly more energy efficient than road transport in moving both people and freight[2]. Sydney, Melbourne, Brisbane and Perth all need major urban rail upgrades. Rail infrastructure in Melbourne and Sydney dates back to the late nineteenth- and early twentieth-century. The use of public transport has been increasing and the Australian Infrastructure Audit projects that demand for public transport (measured in passenger kilometres travelled) will increase by 89 per cent by 2031.

2. Comparisons of road and rail freight costs are complex. Rail generally has lower line-haul costs than road, especially for large volumes and over longer distance, but pick-up and delivery and rail terminal costs add significantly to the average door-to-door cost of rail, particularly for short-haul freight. Consequently, average rail costs decline with increasing freight volumes and distances, such that rail is lower cost for door-to-door freight hauls above 1000 km (BITRE 2009).

Box 2.1: Motor vehicle use

By June 2012 there were an estimated 16.6 million vehicles registered in Australia (ABS 9208.0, 2012). Passenger vehicles make up 76% of all registered vehicles. Freight vehicles accounted for 19% of all registered vehicles with the remainder (5%) comprising buses, motorcycles and non-freight carrying trucks.

Motor vehicles in Australia travelled an estimated 232,453 million kilometres in 2012.

Consistent with the population distribution, New South Wales had the largest share of total kilometres travelled (28.7%) and the largest number of registered vehicles. The average distance travelled was 14,000 kilometres per vehicle in 2012. Of all vehicle types, articulated trucks had the highest average kilometres (83,000).

Of the total kilometres travelled by passenger vehicles in 2012, 52.7% was for personal and other use. The remaining kilometres travelled by passenger vehicles comprised travel to and from work (27%) and business use (20%).

In 2012, registered motor vehicles in Australia consumed 31,839 million litres of fuel. Of the total fuel consumed by motor vehicles in 2012, 57.3% was petrol and 37.7% was diesel.

Passenger vehicles consumed 18,510 million litres of fuel in 2012, of which 84.8% (15,696 million litres) was petrol. Light commercial vehicles consumed a total of 5526 million litres of fuel. Diesel accounted for 49.7% (2745 million litres) and petrol accounted for 42.8% (2364 million litres). A total of 6,909 million litres of fuel was consumed by rigid and articulated trucks. Diesel was the main fuel type (99.4%) consumed by trucks.

The average rate of fuel consumption for all motor vehicles in 2012 was 13.7 litres per 100 kilometres. Of all vehicle types, articulated trucks had the highest average fuel consumption with 57.7 litres per 100 kilometres.

According to the UK's RAC Foundation, the average car is parked at home for 80% 0f the time, parked elsewhere for 16% of the time and on the move only 4% of the time. (*Spaced Out: Perspectives on Parking Policy* 2012, <www.racfoundation.org>). Further examples from around the world are cited at <www.reinventingparking.org>, which provides an average of 95.8% total parked time for the 84 cities involved in the 1995 UITP Millenium Cities Database.

The oldest Australian motor vehicle census data is from 1955, and it is no surprise to see car ownership rates in Australia have risen considerably since then. Since around 2005, car ownership has continued to rise while car passenger kilometres per capita have fallen. Analysis at chartingtransport.com, which in turn draws on data from the ABS Motor Vehicle Census and the BITRE 2014 Yearbook, shows that all Australian cities demonstrated an increase in car ownership between 2006 and 2011, yet all but two (Adelaide and Canberra) experienced a reduction in car-only mode share of journeys to work. This suggests we are driving cars shorter distances and/or less often. However, the increase in light commercial vehicles, rigid trucks and articulated trucks has outstripped the increase in passenger vehicles over the past five years. Light rigid trucks experienced an increase of 22.5% between 2009 and 2014, while articulated trucks increased in usage by 15.6% over the same period (ABS 9309.0, Motor Vehicle Census, Australia, 31 Jan 2014).

There are already causes for concern that Australian infrastructure networks are not meeting the demands of a high quality first world standard of living. These gaps are in service quality are particularly evident in urban transport. Experiences of transport networks failing to keep pace with demand, water quality standards being uneven, energy costs being too high, telecommunication services being outdated, or freight corridors being neglected are now so common that they necessitate a strategic response (*Australian Infrastructure Audit* 2015).

An Australian Government *Energy White Paper* published in 2015 approaches 'energy efficiency' as an aspect of 'energy productivity' and recommends a national energy productivity plan (Australian Government 2015 *Energy White Paper*). In both cases, the aim is to achieve more using less energy, applying this across the built environment; equipment and appliances; and vehicles.

> "Effective transportation networks deepen markets. They bring consumers closer to more businesses, and they bring workers in contact with more opportunities. These

deeper markets and connections promote competition. They promote greater specialisation by both firms and workers. And they promote innovation and a more dynamic economy. While the Internet has some of these same effects, person-to-person contact remains an essential part of business, education and innovation. Poor transportation makes this contact difficult and hurts our national productivity."

Lowe 2013

There are quantifiable economic, environmental, public health and safety impacts to the infrastructure deficit. These are revisited in the following chapters.

2.7 Freight: rail, road and sea

"Rail is generally the heavy lifter and long distance athlete of Australia's land transport network. While road is better suited for time sensitive, sorter distance freight tasks, rail is able to carry high volumes of goods, further for less cost than road."

State of Regional Australia 2015

Nevertheless, over the past 40 years, the share of rail freight compared to heavy vehicles has steadily declined. The volume of road freight has increased ten fold in that period to a total of 203 billion tonne kilometres. The only exception to this trend is shipments of bulk commodities like coal, iron ore and grain.

"Today, road's national share of non-bulk freight has risen to 83%, but on the eastern seaboard it's around 95%, and as high as 97% on some routes. Rail's share of eastern-seaboard freight was around the 30–40% mark in the early '70s."

Cleary 2014

The Australian road-dependent freight system is carbon-intensive in nature and exposed to oil price rises.

By way of contrast, the United States still boasts one of the most efficient rail systems in the world and profitably moves about 40% of its intercity freight via rail.

There are complex reasons for the dominance of road over rail freight in Australia (Figures 2.5 & 2.6).

"Australia's road freight task has continued to grow with little moderation by competing modes. Over 95 per cent of Australia's road freight is carried in heavy vehicles weighing 4.5 tonnes or more. The B-Double is the most significant heavy vehicle combination accounting for 40 per cent of all freight movement. This is significant given that B-Doubles operate on a restricted road network.

Advances in vehicle technology have allowed freight to be moved on Australia's roads for a relatively low unit cost. The adoption of heavy vehicle reforms should open the door to more high productivity vehicle combinations such as B-Triples, which will allow road to maintain its growth without a matching increase in the numbers of trucks on the roads. Congestion and fuel costs remain key issues for road freight, as does the potential for staff shortages as the current workforce ages."

ACIL Allen 2014

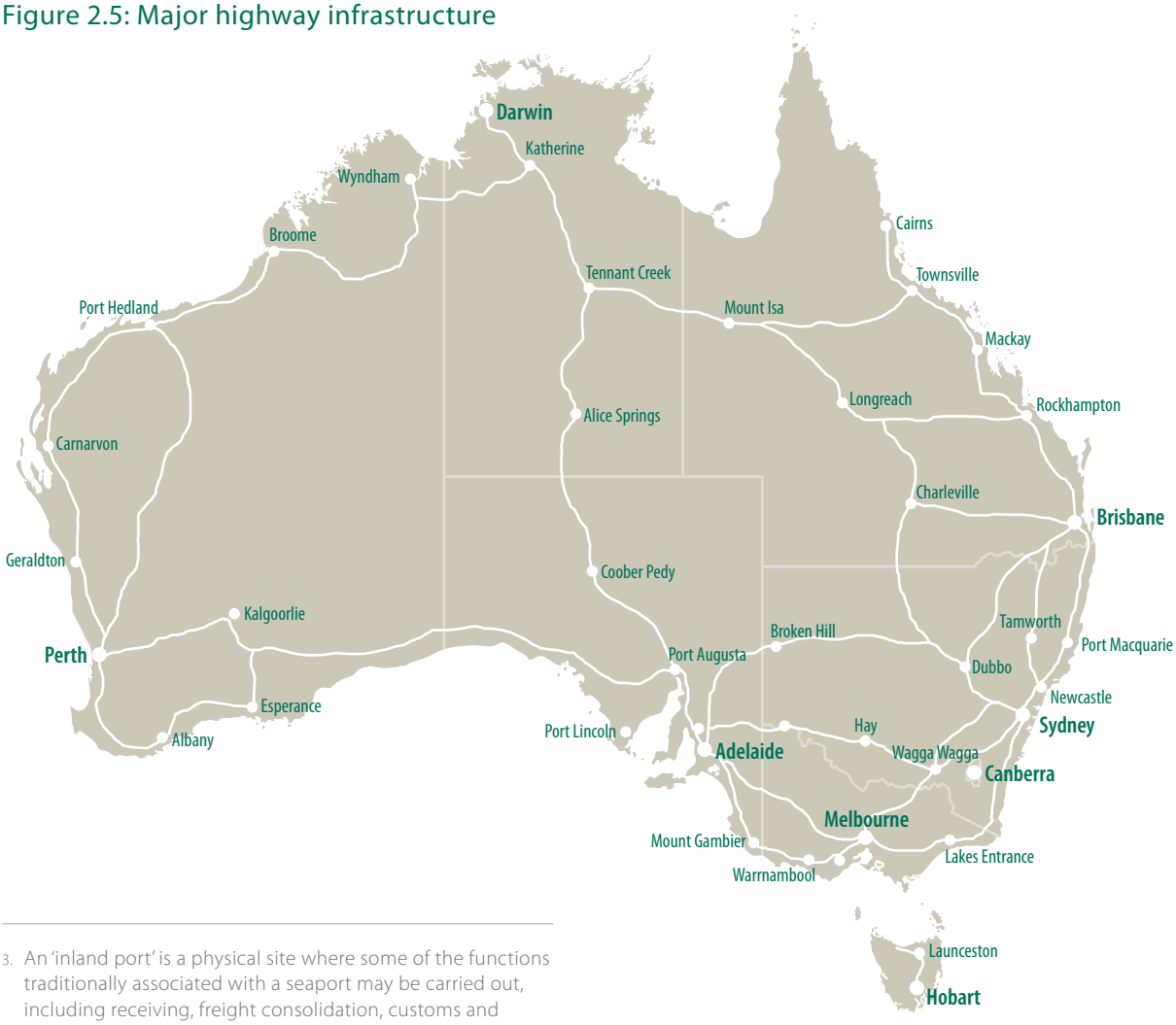
Figures published by the Australian Government's Bureau of Infrastructure, Transport and Regional Economics (BITRE) show that the cost of moving 1 tonne of freight by road over a distance of 1 kilometre (known as cost per tonne kilometre) is 7.5 cents for road, more than double the 3.5 cents for rail. The greenhouse gas emissions for road are more than triple those for rail: 52 grams per tonne kilometre versus 15 (Cleary 2014).

As has been noted elsewhere, road transport is the largest user of final energy, accounting for 74% of the transport sector's liquid fuel consumption. Improvements in fuel efficiency have been made, so that the average growth in road transport fuel consumption has moderated from approximately 3% per annum in the 1980s to 1% growth per annum in the 2000s (Table 2.1 above). Fuel consumption per kilometre does not take into account the costs of rail in time, money and energy, compared with direct point-to-point transportation by road.

Maritime transport remains the backbone of international trade, accounting for over 80% of world cargo by volume. International maritime activity grew strongly in the period between 2000 and 2011. Australia's bulk ports have experienced extraordinary growth in the last decade, with tonnage rising by over 75 per cent. Mining exports account for most of this growth (State of Regional Australia 2015). In Australia, coastal freight declined in the same period from 53 million tonnes (2002–03) to 49.5 million tonnes (2011–12) according to BITRE.

Freight and logistics sectors are evolving in Australia, with a trend away from central locations to the suburban fringe. This is characterised by the development of inter-modal logistics centres (or 'inland ports'), linked to road, rail and air transport[3]. This is coupled with the transfer of containers between different modes of transportation and the processing of international trade, to help relieve congestion at

Figure 2.5: Major highway infrastructure



3. An 'inland port' is a physical site where some of the functions traditionally associated with a seaport may be carried out, including receiving, freight consolidation, customs and quarantine inspections.

traditional maritime ports. Inland ports have new implications for urban planning, to facilitate the intersection of road, rail, air and sea transport.

2.8 Public transport

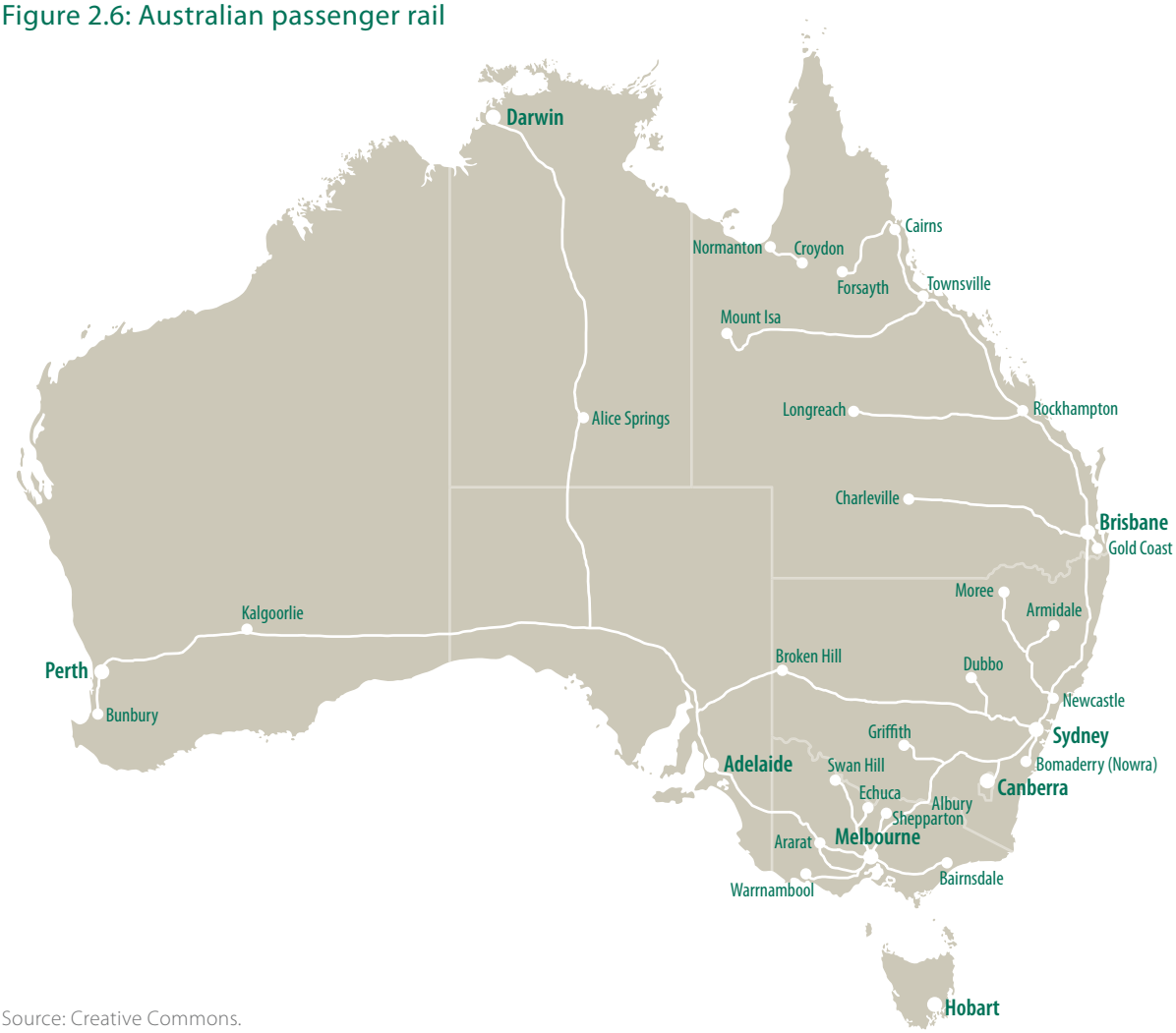
> "An urban area with good public transport is more likely to also have urban spaces conducive to pedestrian access and non-motorized transport. Only public transport developed as a public good can make this happen. Once that is in place, the challenges from private motorized transport are reduced to a point where they are practically solvable."
>
> UN-Habitat

The vast majority of travel is not undertaken for the sake of movement but in order to reach a destination. The backbone of accessibility-based urban mobility is public transport, particularly high-capacity public transport systems that are well integrated in a multi-nodal arrangement (UN-Habitat). The current role of public transport in cities varies widely.

> "In 2001, more than half of all mechanized trips (i.e. excluding walking) in Hong Kong and Eastern European cities…were by public transport, compared to an average of about 25 per cent for Western European cities and less than 10 per cent in the high-income, car-oriented cities of Dubai (United Arab Emirates), Melbourne (Australia) and Chicago (US)."
>
> UN-Habitat

The role of public transport in providing access for commuters in developed economies varies between cities and over time. Government subsidies, privatisation, deregulation of service providers, congestion and restrictions on the use of motorcars can all influence commuter take-up of public transport. Public transport has recently

Figure 2.6: Australian passenger rail



Source: Creative Commons.

Box 2.2: Aviation

This report has confined itself to urban mobility and as such has not aimed to study aviation in any depth. Nevertheless, "easy access to airports is an integral consideration for businesses" (*State of Australian Cities* 2014–15). The increasing congestion of ground transport networks is expected to continue to challenge land access to Australian airports.

Aviation is an integral part of the world economy, accounting for approximately 9% of global GDP, carrying more than two billion passengers and 41 million tonnes of freight each year (Singleton & Pender 2014). Industry forecasts are that aviation will continue to grow at an average rate of approximately 5% for the next 20 years. The implication is that more and more Australians will be seeking access to airports in the years to come.

Both airfreight and passenger movements are increasing at significant rates. International and domestic passenger travel are similarly expected to double by 2030. Airfreight flown into and out of Australia has doubled in the past twenty years. Demand for airport services is expected to approximately double between 2011 and 2031 (*Australian Infrastructure Audit*). Airfreight represents a small fraction of the total by weight but includes 750,000 tonnes of high-value, time-sensitive goods, worth $110 billion during 2011–12.

Increases in both airfreight and passenger movements will continue to test the capacity of airport infrastructure, as well as access to and from airports.

become marginalised in some developed economies. "The declining market share of trips served by public transport is cause for concern since they are the most efficient forms of motorised mobility, particularly for low-income earners" (UN-Habitat).

Public transport in major Australian cities includes trains, trams (Adelaide, Gold Coast, Melbourne), buses and ferries (Brisbane, Perth, Sydney). Shared cars, taxicabs, Über and water taxis are not treated as public transport, though these are sometimes shared on a single journey.

Public transport in Australia's capital cities has been undergoing a resurgence in the last decade. "The factors are many and varied, and include population growth, increasing densities and rising road congestion. However, consumer responses to increased interest rates, increased food prices and increased petrol prices are the main reasons for the recent rapid growth in public transport patronage" (BITRE 2013).

This trend should not be overstated. Figures from DIRD (2014) read with ABS figures (2006 and 2011) indicate that in major Australian cities motorcar use for the journey to work dropped only from 76.3% of the total in 2006 to 74.6% in 2011.

Unsurprisingly, the data shows a greater reliance on private vehicles in inner regional and outer regional areas (State of Regional Australia 2015).

As a minimum, public transport provides a base level of mobility essential to everyday life for many who cannot afford or choose not to own or drive a car for certain trips (*State of Australian Cities* 2014–15). Demand for public transport in the capital cities (measured by passenger kilometres travelled) is set to rise by 55 per cent in Sydney, 121 per cent in Melbourne and an average of 89 per cent across all capital cities (*Australian Infrastructure Audit* 2015).

It is important to note that while all public transport systems are subsidised, private transport systems are as heavily subsidised and possibly even more so. Roads, bridges, tunnels and other civil works involve significant public investment; a high percentage of city parking is provided on public land; and liquid fuels such as diesel and petrol are subsidised in numerous instances.[4]

4. Australian Conservation Foundation 2010, *G20 and fossil fuel subsidies*, <www.acfonline.org.au/sites/default/files/resources/G20_fossil_fuel_subsidies_25-6-10.pdf>.

2.9 The potential role of data in improving efficiencies

The economic benefits of data networks are already widely recognised. In *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, World Bank 2009, Qiang and Rossotto have captured the value of broadband in particular. "Broadband diffusion enables individuals outside boundaries of traditional institutions and hierarchies to innovate to produce content, goods and services." Equally, high-speed broadband (HSB) provides access to individuals who live and work outside traditional geographic boundaries of particular activities. This refers not simply to telecommuting (temporary working outside of the office) but to the capacity for non-metro areas to support different industries, including the high-tech nodes envisaged in Chapter 6 and the innovation clusters referred to in Box 5.1.

HSB has the capacity to support the growth of polycentric cities and to promote urban decentralisation. Its value lies both in data-intensive creative sectors (film, graphics, design) and also remote provision of services such as assistive health technology, reducing the need for travel to metro centres. There is some evidence that HSB makes life in those areas where it is available more attractive to the 'creative class' of knowledge workers (Dutta & Mia 2008).

Despite the deep and widespread penetration of digital networks, little firm evidence is available regarding the successful application of 'big data' per se to improve transport efficiencies or city management. The role of technology in traffic control and other aspects of management have been cited above. CCTV cameras, sensors, actuators (for the electronic control of vehicles), photographs, finger-prints or iris scans, spatial video, LiDAR (laser-based radar), thermal or other kinds of electromagnetic scans of environments are useful tools. They may add to data capture, but in themselves they are not yet applications of 'big data'.

Some of these technologies are more properly understood as belonging to the Internet of Things (IoT). This is the network of physical objects embedded with electronic components that allow those objects to be sensed and remotely controlled. 'Objects' range from medical implants through automobiles with built-in sensors to search-and-rescue technology. A major distinguishing characteristic of IoT components is that they communicate across the network in real time. This is not yet a feature of much big data analytics.

Mobile phone 'apps' such as Über and AirBnB are cited by journalists as obvious benefits for smart cities. How these applications improve transport efficiency has yet to be demonstrated. Ventures such as the intelligent parking systems LAExpressPark, and SFpark have reportedly delivered reduced cruising (motorists contributing to congestion while hunting for parking) and more effective demand-driven revenue collection to the cities of Los Angeles and San Francisco respectively. The first independent studies5 of these innovations may offer more concrete data in due course.

The emerging 'grey' technologies of 'driverless' cars, and use of social media and related applications to develop new ways to use existing car fleets (for example, Über and Bridj) have the potential for far-reaching, but as yet unknown changes in the way we use automobiles in our cities. The proponents are making great claims for the benefits of these new technologies, and sectoral interests such as taxi companies are already calling for protective regulation. Public policy responses will need to steer a path between these competing positions to ensure that new technologies do not undermine existing public transport networks in ways that increase social isolation for vulnerable members of the

5. An early example is Millard-Ball, A, Weinberger, R & Hampshire R 2014, *Is the curb 80% full or 20% empty? Assessing the impacts of San Francisco's parking pricing experiment*, University of California, Santa Cruz.

community, or further entrench existing spatial imbalance in access to alternatives to the car by offering new choices only in already rich inner-urban locations.

Quite apart from the commercial potential of vast amounts of data already held by companies such as Google, Twitter and Facebook, the Australian Government has noted that a successful 'big data' strategy is likely to lead to the delivery of better services, improved efficiency of government operations and open engagement between government agencies NGOs, industry and academia (Australian Government Big Data Strategy 2013).

2.10 Climate change projections and strategic planning

Transport emissions are (after electricity production) the second-largest contributor to GHG. Emissions of GHGs (including carbon dioxide, methane, nitrous oxide and the fluorinated gases) contribute significantly to the warming of the earth. The greenhouse effect, the amount of energy received from the sun, and changes in reflectivity on the earth's surface all contribute to climate change (United States Government).

Australia's per capita CO_2 emissions are nearly twice the OECD average, making the country one of the world's highest emitters per population (World Bank 2015). While transport (particularly motorcars) contributes 14% of GHG emissions, there are also significant emissions involved in motorcar manufacture, as well as fuel extraction, processing and distribution (Figure 2.7).

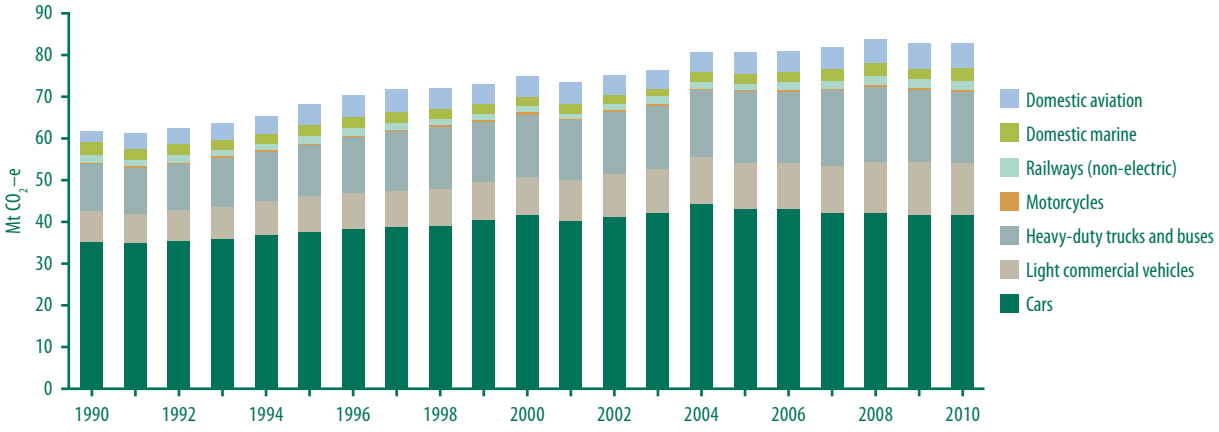
The most recent CSIRO projections for climate change in Australia (CSIRO 2015) report in particular as follows:

- it has become hotter since 1910, with warming across Australia of 0.9°C
- rainfall has increased in northern Australia since the 1970s and decreased in south-east and south-west Australia
- more of Australia's rain has come from heavy falls and there has been more extreme fire weather in southern and eastern Australia since the 1970s
- sea levels have risen by approximately 20cm since 1900.

CSIRO now expresses "very high confidence" that hot days will become more frequent and hotter; that sea levels will rise, oceans will become more acidic, and snow depths will decline. The expectation is that extreme rainfall events across the nation are likely to become more intense, even where annual-average rainfall is projected to decline.

"Climate change caused by anthropogenic GHG emissions is already having, and will increasingly have, serious negative impacts on global human health" (Costello *et al*. 2009). This points to immediate health and environmental imperatives to reduce GHG emissions. Widespread

Figure 2.7: Australian transport emissions



Source: <chartingtransport.com>.

substitution of active modes of transport, replacing motorcar use for short trips in an urban context, could contribute to such a reduction. Unlike other GHG mitigation strategies, this approach has the benefit of increasing physical activity and helping to prevent obesity. This is explored further below.

It is significant that several Australian cities (including Darwin and Melbourne), states (including NSW and Victoria) and state and national government agencies (Sydney Water, Kakadu National Park and others) have prepared their own climate change adaption strategies. Climate change projections fall within strategic planning timeframes and no forward planning can now be complete without such considerations.

2.11 Climate change as a driver of technological change

One of the few things on which there is international agreement in relation to climate change is that achieving deep reductions in greenhouse gas emissions at acceptable social cost will involve far-reaching technological change. There is, however, little agreement regarding the best way to promote appropriate technological change for tackling climate change.

Michael Grubb (Grubb 2004) points out that global emissions are still projected to double by mid-century, while stabilising GHG concentrations demands a radical transformation of energy systems. He distinguishes between a 'technology push' and a 'market pull' approach. The first calls for investment in technological innovation to address the problem, with emissions control to follow once innovation has lowered the cost of GHG limitation. The second approach prioritises regulatory measures, including GHG caps and charges, arguing that profit-seeking business will respond with innovative technological solutions.

Grubb advocates strategic deployment policies as a response to instances where technologies are proven and in principle commercially available, yet still caught in a cycle of small volume and high costs. Strategic deployment policies "support the larger scale deployment of these emergent technologies, in view of the strategic advantages to be gained by building up these industries and 'buying down' the cost curve" (Grubb 2004).

Examples of policies to support renewable energy deployment include feed-in tariffs adopted particularly in continental Europe (these mandate a premium price to be paid for renewable energy, such as electricity generated in Danish wind farms); renewable obligations (also called portfolio standards in the US, requiring utilities to source a percentage of energy from renewable sources); and regulatory requirements (such as the requirement that all Brazilian cars run partly or entirely on ethanol).

2.12 Promoting the swift take-up of new technologies

Substantial research has been done into identifying barriers in the take up of renewable energy technologies. These include:

- lack of awareness of the newest alternative energy technology development
- lack of experience and capability with non-conventional renewable resources (Carls Haffar Jones Morey 2011)
- lack of utility acceptance (Beck & Martinot 2004)
- lack of familiarity with renewable energy technologies on the part of planners and policy advisers
- lack of understanding of the costs and benefits
- uninformed perceptions of increased risk (World Bank 2006).

A recent report published by ACOLA (ACOLA 2014) found that:

- facilitating the creation and growth of innovative firms of all sizes is essential to build Australia's future industries
- unlike most other OECD countries, Australia has a history of frequent changes to assistance measures
- in comparison to other leading countries, direct government support for Australian business R&D is very low.

Since the Brundtland Report of 1987, sustainable urban mobility has moved beyond environmental concerns to include social, economic and institutional considerations. Urban planning is no longer preoccupied with traffic flows and the movement of people and is instead searching for the enhancement of spatial proximity.

"A holistic and integrated approach to urban land-use and transport planning and investment is needed if urban areas are to become socially, environmentally and economically sustainable" (UN-Habitat 2013). These considerations are explored further in the following chapters.

2.13 Key findings

- **Limited fuel stocks are a major national risk**
  Australia has small and declining fuel stocks, holding no more than three weeks' supply of oil and refined fuels onshore. Australia is consistently the only one of the 28 member countries that fails to meet its International Energy Agency (IEA) 90-day net oil import stockholding level. This might be regarded as a major national risk.
- **Greenhouse gas emissions are growing not declining**
  Australia is one of the world's highest emitters of greenhouse gases. Greenhouse gas emissions from the transport sector are particularly high—in some cities three times those of London and still growing. Australia is likely to face international pressure to achieve a dramatic change in order to contribute to the global challenge to limit warming to 2°C.
- **The transport sector is inefficient—this incurs costs**
  The Australian transport sector does not rank well on efficiency against some international measures; transport inefficiencies carry costs. The cost of moving freight by road (over distances of more than 1000 km) are more than double that of rail, while greenhouse gas emissions for road are more than triple those for rail. The average motorcar is parked at home 80% of the time, parked elsewhere 16% of the time and on the move only 4% of the time.

- **Inadequate infrastructure restricts productivity and incurs costs**
  Experiences of transport networks failing to keep pace with demand, water quality standards being uneven, energy costs being too high, telecommunication services being outdated, or freight corridors being neglected are now so common that they necessitate a strategic response (*Australian Infrastructure Audit* 2015). There are quantifiable economic, environmental, public health and safety impacts to the infrastructure deficit.
- **Several key enabling technological innovations are evident**
  Specific technological innovations will help to mitigate some transport challenges. Three examples are: plug-in electric vehicles (PEVs), which will have a direct impact on the sector; high-speed broadband (HSB) which will continue to expand its impact on urban mobility generally; and the 'Internet of Things' (IoT), expected to become a major enabler in the urban mobility sector. The IoT is the network of physical objects embedded with electronic components that allow those objects to be sensed and remotely controlled. 'Objects' range from medical implants through automobiles with built-in sensors to search-and-rescue technology.
- **Policy development needs to be nimble to match rapid change**
  Innovation in transport is moving quickly. Policy often lags behind technological innovation in the transport sector; planning approaches should be nimble enough to take advantage of rapid developments.

Australia has small and declining fuel stocks, holding no more than three weeks' supply of oil and refined fuels onshore.

3 Impacts on the environment, public health and safety

3.1 Introduction

Population increases and demographic changes increase the demand for urban mobility. These developments heighten the significance of urban public health issues including traffic accident injury; noise and air pollution; and chronic diseases. The sedentary life-style, encouraged by inactive modes of transport, exacerbates the problem. The chapter explores the way in which cities act as amplifiers of climate change, creating urban heat islands that impact on public health. The continuous development of adaptation strategies is essential. 'Automobility' and the polarised arguments for and against the motorcar are presented. Sustainable transportation systems promote health and wellbeing. The report proposes policy and funding priorities that will ideally prioritise active modes of transport (walking, cycling) and public transport over private motorcars. Disjunction between land-use and transport planning decisions leads to 'transport poverty', particularly in the outer-city and inner-rural areas.

3.2 Trends, population, ageing

World population is projected to reach 9 billion people by 2050. In Australia, the mid-century figure is expected to be 37 million. This will include almost double the current number of people in Melbourne, Sydney and Perth. Governments everywhere are grappling with how to house, mobilise and feed growing numbers. Given that approximately 90% of Australians live in cities and metropolitan areas, how we approach the expansion of those cities, characterised by new housing developments on the fringe and the density of inner city developments, will have significant health impacts through economic, social and environmental influences.

> "Being a healthy city depends not on current health infrastructure, rather upon a commitment to improve a city's environs and a willingness to forge the necessary connections in political, economic, and social arenas."
>
> WHO Healthy Settings

Transport plays an essential role in economic and social development in our societies. It ensures access to jobs, housing, goods and services and provides for the mobility of people and for the opening up of peripheral and isolated regions. The continuing expansion of transport, heavily dominated by road transport (and private motorcars in particular), must raise serious concerns about the long-term sustainability of present mobility trends.

> "In particular the increasing evidence of the environment and health effects of transport places the need to address effectively transport-related issues at the top of the international political agenda."
>
> WHO THE PEP

In Australia, without regulatory controls or national support for progressive urban planning, the pace of low-density expansion ('sprawl') is likely to accelerate. "Spread-out patterns of growth not only increase the dependence on the private car, but also consume farmland and open space, threaten estuaries and natural habitats, and burden municipal treasuries with the high costs of expanding urban infrastructure and services" (UN-Habitat).

Population increases have to be seen in parallel with the anticipated changes to the composition of that population. Ageing is generally considered to be the most dramatic of those, with notable changes to the age structure of the population projected by the Australian Bureau of Statistics, particularly over the next fifty years.

"As a proportion of the population, the population aged 65 years and over is projected to increase from 14% at 30 June 2012 to between 18.3% (Series A) and 19.4% (Series C) in 2031, 22.4% (Series B) and 24.5% (Series C) in 2061, and 24.6%" (ABS 3222.0, 2013) [in which series A, B and C offer alternative total fertility rates]. This changing age structure will significantly impact on Australian health care and other social services.

The changing composition of the population has important implications for urban planning. "Most of the safety and mobility barriers currently encountered by older adults are a direct product of conventional design practice" (Dumbaugh 2008). Catherine Bridge of UNSW cites difficult access and changes of level, poorly maintained pavements, busy roads with few crossing points, isolated unlit stops, lack of adequate seating, no public toilets and high, steep steps as examples of poor design that will deter and isolate older people.

3.3 Chronic disease and costs

"Globally, the prevalence of chronic diseases is increasing. Currently some 36 million deaths annually are caused by chronic disease" (Lee *et al*. 2012). By international standards, Australians have very high life expectancies. But the country is facing the same increasing prevalence of major chronic diseases, including cardiovascular disease, cancers, diabetes and dementia. The Australian Institute of Health and Welfare reports that the prevalence of preventable cancers is rising, the prevalence of diabetes has more than doubled in recent decades and mental health problems account for 24% of total years lost due to disability or death. Notably, two thirds of Australian adults and around one quarter of Australian children are either overweight or obese, which are risk factors for many chronic diseases.

This is a significant and growing social and economic burden. The total cost of chronic disease in Australia is not known, though health expenditure statistics confirm that it is expensive.

> "Costs for health services for individual chronic conditions in 2004–05 were in excess of $6.5 billion (AIHW), and for condition groups that contain chronic diseases (for example, arthritis in the musculoskeletal group), amounted to well over $13 billion."
>
> Australian Government AIHW 2008

Health care is expensive, and costs are likely to continue to increase, due to medical advancements, the continued growth in

population size and age, and the increasing prevalence of chronic disease. In addition, there are externalities associated with chronic disease, such as additional costs for patients (travel and accommodation), the social and economic burden on carers and families, and lost wages and productivity.

3.4 Cities as amplifiers of climate change

Urbanisation and climate change are converging in dangerous ways. Cities cover less than 2% of the earth's surface, but consume 78% of world energy and produce more than 60% of all carbon dioxide. "Cities are both analogues for and amplifiers of climate change" (Helen Cleugh, CSIRO, at Third Australian Earth System Outlook Conference, Dec 2014).

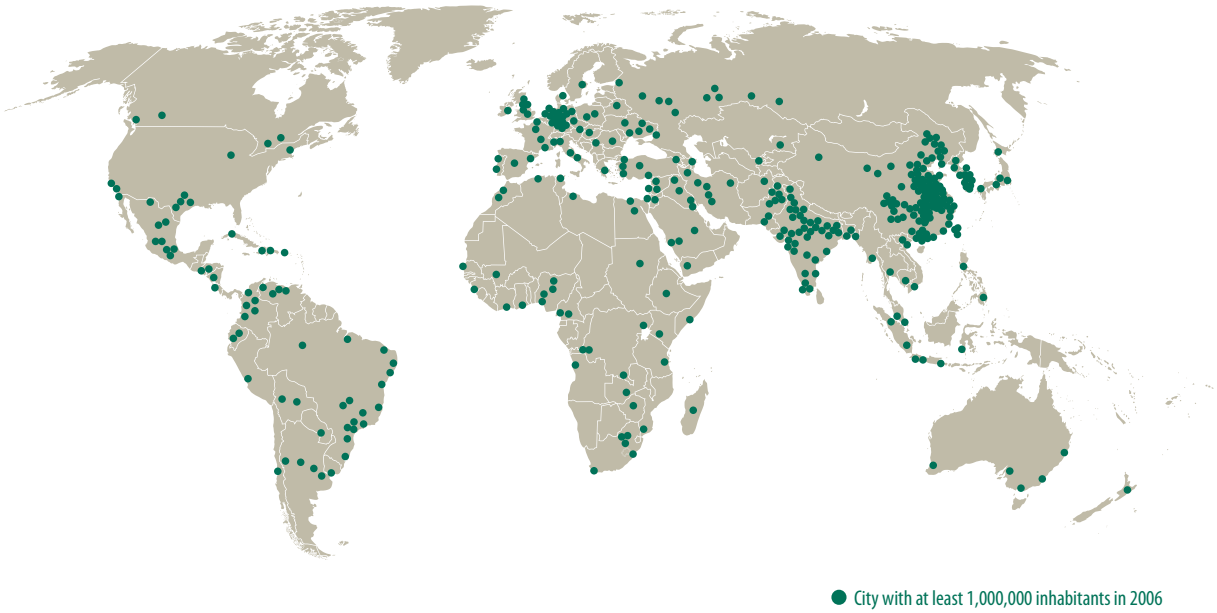
At the same time, cities and towns are themselves vulnerable to climate change. This applies particularly to those cities and towns built on the coast, on the mega-deltas of East Asia and on major estuaries. Figure 3.1 shows cities with populations of 1 million or more. A high proportion of these are coastal cities.

Hundreds of millions of people in urban areas across the world will be affected by rising sea levels, increased precipitation, inland floods, more frequent and stronger cyclones and storms, and periods of more extreme heat and cold. In fact, many major coastal cities with populations of more than 10 million people are already under threat (UN-Habitat). Many diseases are likely to spread and increase in incidence as the climate warms. A growing human population with high rates of interconnectedness is also at risk from newly emergent and exotic diseases for which we have no treatment or immunity (AAS 2014).

In Australia over 85% of the population lives on the coast. The Gold Coast-Tweed Heads metropolitan region (pop. 0.59 million) is such a high-risk area, supporting a high-density, ageing population. "This leaves these communities open to the combined future risks of sea level rise, increased coastal storm activity and coastal erosion. The very real challenge now is to plan, design and construct cities that will minimise harmful emissions—and risks to future communities—but still keep them liveable" (Norman 2014).

Cities though also offer opportunities to develop innovative responses to climate change, including mitigation and adaptation.

Figure 3.1: Cities with populations of 1 million or more



Box 3.1: Urban heat islands

Urban heat islands (UHIs, i.e. populated areas that are significantly hotter than the surrounding areas) are now understood to affect not only the inhabitants, but also monthly rainfall patterns downwind of the city. This phenomenon has been shown to be significant enough to increase the length of growing seasons. UHIs also decrease air quality (by increasing the production of pollutants), decrease water quality and force habitat changes, as warmer waters flow into streams, rivers and oceans. Densely developed, aggregated cities produce stronger urban heat islands than sprawling cities with less development density (NASA 2010 Zhang *et al.*). (This may be a point of tension between the push for higher urban density and the consequent impact on the environment).

The UHI effect may heat cities by an additional 7°C to 9°C in summer.

> "Heat islands not only cause air conditioner and electricity usage to surge, but they also increase the mortality of elderly people and those with pre-existing respiratory and cardiovascular illness. The US Environmental Protection Agency estimates that, between 1979 and 2003, heat exposure has caused more than the number of mortalities resulting from hurricanes, lightning, tornadoes, floods, and earthquakes combined."
>
> NASA 2010 Satellites

Benedicte Dousset (Dousset 2010) has shown that it is the lack of cooling at nighttime, rather than high daytime temperatures, that poses a health risk for vulnerable population groups. Dousset analysed surface temperature images of Paris and showed the spatial distribution of heat-related deaths during a sweltering heat wave in 2003. Some 4800 premature deaths occurred in Paris during the event, and excess mortality across Europe is thought to be about 70,000.

3.5 Adaptation strategies

Since 2010, the National Climate Change Adaptation Research Facility (NCCARF) has been studying the likely impacts of climate change and appropriate adaptation strategies. In the dimension of settlements and infrastructure, challenges identified include: planning for secure infrastructure, including urban water and energy supply and transport systems which can withstand climate change impacts and in particular any changes in the occurrence of extremes; and designing buildings and urban spaces to ensure maximum comfort for minimum energy use in a changing climate (NCCARF). Since the lifetimes of buildings and infrastructure may be between 40 (energy and water systems) and 100 years (bridges and major roads), planning must take into account much longer cycles than is commonly the case.

NCCARF projections include the likelihood of rising average temperatures will lead to more frequent and severe heat waves, made worse in urban areas by heat island effects. Projections for other extremes are less certain: there may be more intense cyclones; cyclone tracks may move further south over Australia; rainfall extremes causing both drought and floods may become more common.

The *National Climate Change Adaptation Research Plan for Settlements and Infrastructure* has identified priority research questions around the following:

- **Planning**: How can urban planning principles, practices and governance be modified to incorporate adaptation?
- **Built environment**: What are the design options and principles, costs and benefits, for adapting new and existing buildings, and how can they be implemented? What are the equity issues; how should they be managed?
- **Coastal communities**: What are the interactions of climate change and sea-level rise with demographic changes, policy and regulatory frameworks?
- **Infrastructure**: What are the vulnerabilities to climate change, including changes in extremes? How should design standards be modified?
- **Cross-cutting issues**: Linking climate change adaptation for settlements and infrastructure with physical, social, economic and institutional factors.

3.6 Well-planned transportation choices

Urban public transport should aim to be a high-quality service. An urban public transport system that is viewed largely as a system for the use of the poor quickly becomes a poor system. If government is seeking to induce car drivers to use public transport, it is important that the alternative be safe, reliable, comfortable and plentiful. A system used by residents from all walks of life is a system that is politically (as well as economically) sustainable (UN-Habitat).

A large body of scientific evidence demonstrates the health benefits of a physically active lifestyle. Most leading chronic diseases share common preventable lifestyle-related risk factors. In Australia, physical inactivity is the fifth most important contributor to the disease burden, with almost 60 per cent of Australians aged 15 years or older being insufficiently active to benefit health.

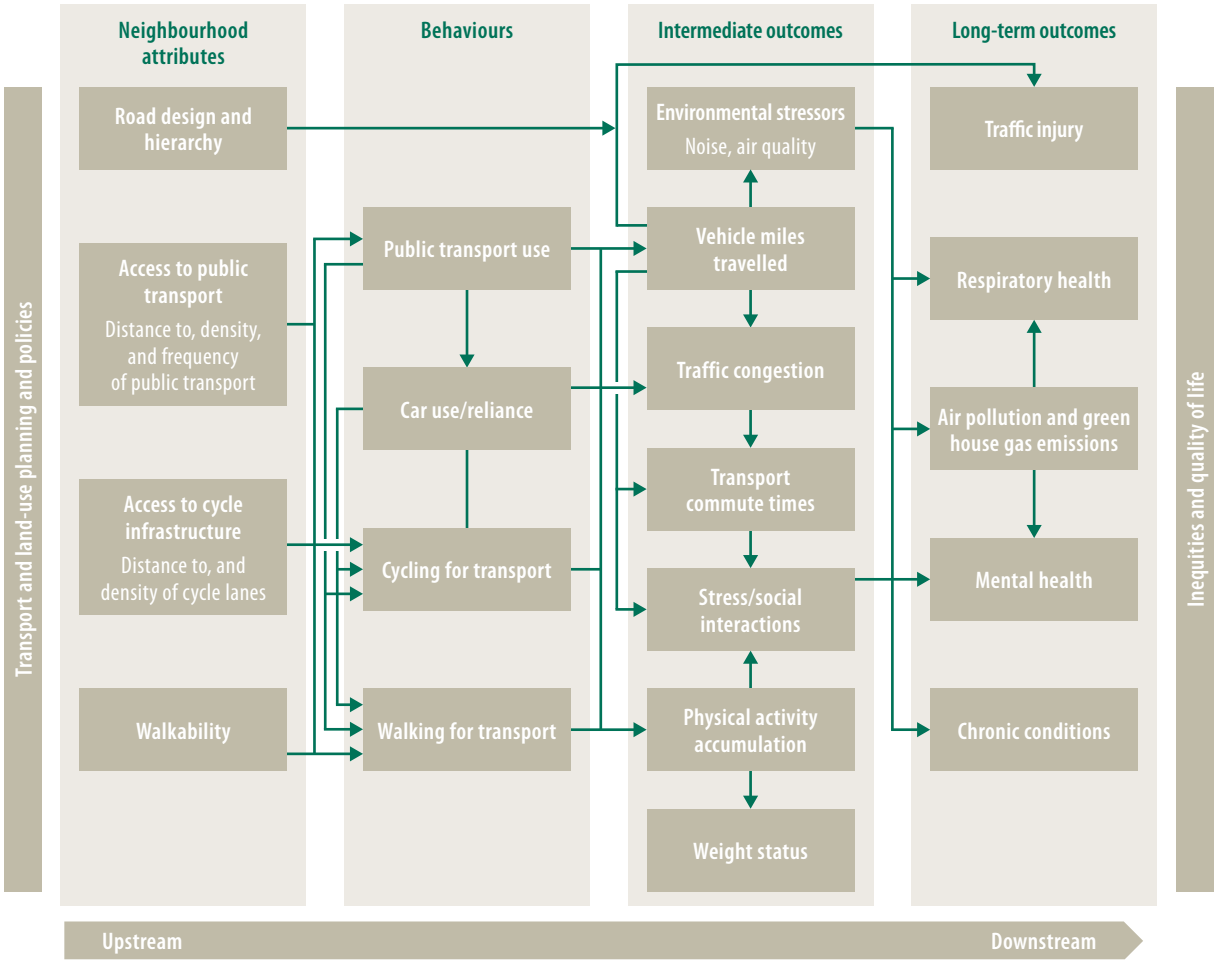
However, another emerging chronic disease risk factor also related to transportation and land-use decisions is sedentary behaviour, including time spent driving. (Owen *et al*. 2014).

In 2008, Medibank Private estimated that the direct and indirect annual cost to the Australian economy of physical inactivity alone was around $13.8 billion. Some transportation choices clearly involve more than individual preference and have significant socio-economic impacts.

Sustainable mobility extends beyond technicalities of increasing speed and improving the effectiveness and efficiency of transport systems, to include demand-oriented measures (e.g. promoting walking and cycling, and reducing the need to travel), with the latter representing a pivotal factor in achieving relevant progress (UN-Habitat).

In a study commissioned by ACOLA for this research project, Giles-Corti, Eagleson and Lowe have hypothesised how transportation choices affect public health. This is summarised in Figure 3.2.

Figure 3.2: Hypothesised pathways through which transportation choices impact health and wellbeing



Source: Giles-Corti *et al*.

The prevalence of obesity is considerably higher in countries such as Australia, where motor vehicle travel dominates. Increasing active forms of transportation (primarily walking and cycling, but also all other human powered forms such as skateboards, etc.) is one way of increasing physical activity. In this context public transport (which generally involves some walking or cycling to stations or stops) can also be treated as a form of active transportation.

A meta-analysis of eight studies concluded that engaging in active transport had a significant protective effect against cardiovascular risk. Similarly, a meta-analysis of 22 cohort studies of adults found that compared with no physical activity, 2.5 hours per week of moderate intensity activity (equivalent to 30 minutes daily on 5 days a week) was associated with a 19% reduction in mortality risk, and 7 hours/week of physical activity (i.e. one hour daily) with a 24% reduced mortality risk. (Woodcock *et al*. 2011).

It is a worrying development that, despite the health benefits of active transport to school, children's active forms of transportation have rapidly declined in most developed countries. Australian studies suggest that only around 20% of secondary students, and between 35–39% of primary school children now use active forms of transport. This is a reduction from an overall figure close to 70% in 1970.

3.7 Cycling and 'walkability'

In pursuit of transport policies reflecting sustainable urban mobility, the promotion of walking and cycling is very important. The bicycle is by far the most energy-efficient means of passenger transport and offers a relatively inexpensive means of improving poorer people's accessibility. There is a distinction to be made between recreational cycling in suburbs and parks and bicycle commuting in motorised traffic. In some developed countries, bicycles are commonly used as a feeder mode to public transport systems. A well-known example is the Netherlands, where bicycles are used for more than 40 per cent of trips in some cities (UN-Habitat).

Australia has generally followed the model provided by the United States, rather than Europe. In North America (and Australia) walking and cycling trips are discouraged by longer trip distances caused by land use policies; the relatively low cost of car ownership and use; and public policies that facilitate driving and make walking and cycling inconvenient, unpleasant; and, above all, unsafe. Despite this, there is some evidence that "rising congestion has also led to an increase in active transport (walking and cycling) in Australian cities…with increasing traffic jams and crowded public transport, residents are returning to walking and cycling where they can" (*State of Australian Cities* 2014–15).

Access to cycling infrastructure is therefore a significant factor in transportation choices, even for cycling enthusiasts. One of the indicators used at the McCaughey VicHealth Centre for Community Wellbeing is access to the Principal Bicycle Network (PBN) within 400 m of residents' homes. In inner Melbourne, levels of access to the PBN are much higher than all the outer areas. Other factors influencing transportation choices for cyclists include secure lockers at stations; dismounted access at footbridges, staircases and other shared zones; as well as secure bicycle parking and showers at work. In contract to road and public transport infrastructure, improvements to active transport networks are relatively cheap and can be made comparatively quickly (*State of Australian Cities* 2014–15).

'Walkability' is a measure of how friendly an area is to walking. Factors that influence walkability include the existence and the quality of footpaths, sidewalks or other pedestrian zones; traffic and road conditions; destination accessibility; lighting and other safety considerations. Giles-Corti *et al*. investigated the reasons for low levels of active transportation to school. Distance to destinations, concerns about traffic safety and a lack of infrastructure to facilitate safety are all contributors (Giles-Corti 2011). This issue is explored further below.

3.8 Revisiting automobility

'Automobility' is a term used in the social sciences to describe not just the use of automobiles as the dominant means of transportation but also a technology deeply embedded within many peoples' everyday lives.

Australia's largest cities were established when the principal means of transport was horse powered. Suburbs developed along tram and train routes, but by the 1950s owning a motorcar had become affordable for many. Manufacturing moved to the suburbs. At this time, Melbourne for example, as Graeme Davison points out, was still recognisable as having developed from the urban map of the late nineteenth-century (Davison 2004).

Since that time, the economy has changed and much of the shine has come off the motorcar as a means of commuting. In the largest cities, 'rush hour' has extended into a series of onerous and frustrating journeys.

Almost two decades ago, Ker and Tranter published a paper titled *A Wish to Wander: Reclaiming Automobility from the Motor Car* (Ker & Tranter 1997). The authors acknowledge that there are numerous models throughout the world for reducing the dominance of the motorcar (including traffic calming, pedestrian streets, charging the full cost of motorcars to owners, etc.). They point though to the enduring affection for motorcars as freedom machines and the difficulty of engendering any enthusiasm for widespread change. Ker and Tranter argue that the 'independence' provided by the motorcar is illusory, since the owner is in fact dependent on a host of others, including the vehicle manufacturer, service and repair industries, an international oil market and an external source of energy.

Davison, on the other hand, distinguishes between 'automobility' (the forms of mobility made possible by self-driven, self-powered vehicles—in which he includes horses and cycles) and 'automobilism' (described as the ideology that privileges such forms of transport and attributes normative superiority to them) (Davison 2015). He makes the point that "the freedoms that many people associate with the car were and are real freedoms."

In contemporary Australia, debates about urban transport quickly become polarised. Those who drive motorcars defend their right to do so in the face of an ideology no less strong: the preference for collective, publicly-owned transport.

'Automobility' is not available to almost half the population, even in western societies. The 'transport disadvantaged' include the young (100% of those under 17); the aged (43% of those over 60 do not have a licence); and women (25% of women over 17 and 60% of those over 60 do not have a licence to drive). Ironically, one of the most hazardous tasks for any pedestrian (but particularly for these groups, as well as many disabled people) is "trying to negotiate the traffic jams around schools at the end of a school day; traffic jams caused by parents trying to compensate for their children's lack of genuine automobility" (Ker & Tranter).

Sustainable mobility is [thus] determined by the degree to which the city as a whole is accessible to all its residents, including low-income earners, the elderly, the young, the disabled, as well as women with children (UN-Habitat).

The suggestion has been raised by several researchers that motorcar use, particularly amongst 'Millennials' (i.e. those born since 1980) is beginning to decline (US PIRG), (Monash University), (Newman & Kenworthy 2011). Against the background of a revival in public transport reported (Mees & Groenhart 2012) in Brisbane, Melbourne, Perth and Sydney between 1996 and 2011, this has led to speculation that the Millenial generation may be making a more than temporary shift away from driving motorcars.

Strong arguments in support of the concept of 'peak car' as a contemporary reality contrast with ongoing forecasts of substantial increase in traffic volumes (Australian Government DIRD 2015). There is a need for further evidence before long-lasting trends can be established.

3.9 Traffic safety

Safety is a crucial aspect of a high-quality urban mobility system. It includes the safety of infrastructures and of the rolling stock, as well as citizens' safety in reaching the system (e.g. walking from home to the bus stop).

Road accidents have become a global pandemic, particularly for younger people. Among young Australians aged 15–24 years, transport accidents are the second most common cause of death after suicide (ABS 2013b).

The annual economic cost of road crashes in Australia is substantial—estimated at $27 billion per annum—and the social impacts are devastating. Since record keeping commenced in 1925, there have been over 180,000 deaths on Australia's roads. However, road trauma levels have declined substantially over the last four decades, despite considerable population growth and a threefold increase in registered motor vehicles. During this period, the number of road deaths per year has fallen from 3798 deaths in 1970 to 1153 in 2014 (Australian Government Infrastructure).

> "Speed is a major factor contributing to traffic fatalities. However, studies consistently show an inverse relationship between levels of density and road traffic mortality…It is plausible that in higher density neighbourhoods trips are shorter and traffic travels at slower speeds."
>
> Frumkin *et al*. 2004

In the five years to 2011, the average number of fatalities from Australian road accidents that involved a truck of more than 4.5 tonnes was 239 a year. This means that trucks are involved in 20% of all road fatalities in Australia even though they make up only 2.5% of the vehicles on the road. The comparable number for rail, including passenger trains, was 34 deaths a year.

BITRE predicts a further 50% rise in the number of trucks on Australian roads over the next 15 years.

A number of neighbourhood features appear to increase the risk of pedestrian injuries, particularly for children. These include:

- high traffic speeds and volumes
- high density of kerb parking
- the number of street crossed during routine travel
- the absence of a park or play area near home
- the presence of cross walks where there are no traffic lights present
- dwelling or population density.

To reduce the risk of crash injury and fatalities, safe pedestrian and cycling environments are required.

3.10 Traffic noise, air pollution and respiratory health

Noise can affect physical and mental health by causing annoyance and/or sleep deprivation. Acute and continual exposure can result in chronic stress, with important health implications (Halpern 1995). Most studies on the impact of noise and mental health relate to airport noise. A review of recent evidence, published in the International Journal of Comparative Psychology (Clark & Stansfeld 2007), found convincing evidence of transport noise generally as impacting on reduced quality of life and wellbeing, as well as impaired child cognition. Nevertheless, the authors did not associate transport noise with serious psychological ill-health.

Evidence from WHO regarding the health effects of traffic-related noise in Europe leads that

organisation to conclude that: "traffic-related noise accounts for over 1 million healthy years of life lost annually to ill health, disability or early death in the western countries in the WHO European Region" (WHO 2011). The report indicates that noise causes or contributes to not only annoyance and sleep disturbance but also heart attacks, learning disabilities and tinnitus. Among environmental factors in Europe, environmental noise leads to a disease burden that is second in magnitude only to that from air pollution. One in three people experiences annoyance during the daytime and one in five has disturbed sleep at night because of noise from roads, railways and airports. This increases the risk of cardiovascular diseases and high blood pressure.

Giles-Corti *et al*. make the point that traffic noise is an area in which the design of buildings and the location of housing and key services such as schools can play an important mitigating role.

Another area in which urban design can intervene to reduce the impact of motor vehicle emissions is air pollution.

Conventional motor transportation reduces air quality and contributes to the risk of respiratory diseases (Riediker *et al*. 2003; Frumkin *et al*. 2004). In Australia, 1% of the burden of disease and injury is attributed to urban air pollution, with 62% of this burden being due to cardio-vascular disease, and the burden increasing with age (Begg *et al*. 2007). Evidence shows that urban air pollution varies by location. People living on or near busy roads are exposed to significantly higher levels of pollutants, including particulate matter, carbon monoxide and nitrogen oxide. Associations between such exposure and various health aspects (particularly asthma) are seen even at the relatively low pollution levels observed in Australia.

3.11 Transport disadvantage/ transport poverty

"Transport difficulties are consistently identified as a factor that restricts Australian families' capacity to access services and participate in activities" (Carbone, Fraser, Ramburuth, & Nelms 2004; Cortis, Katz, & Patulny 2009) (cited in Australian Institute of Family Affairs 2011). These difficulties include limited or no access to public transport, non-family friendly transport options, and not being able to afford—or experiencing stress as a result of—the cost of transport. The phenomenon of transport difficulties is commonly referred to as transport disadvantage (or 'transport poverty') (Wadiwal 2005).

Transport poverty is typically defined as difficulty in accessing transport as a result of cost, availability of services or poor physical accessibility. Access to a multi-modal transportation system is a social determinant of health, which facilitates access to other underlying health determinants, particularly a distributed labour market, education, food, health and social services, as well as opportunities to recreate and socialise (Badland *et al*. 2014).

When land use and transport planning decisions are not integrated, it becomes less likely that transportation infrastructure will link shops and services, as essential components of a liveable community. This can pose considerable threats to the health and wellbeing of residents and creates health inequities.

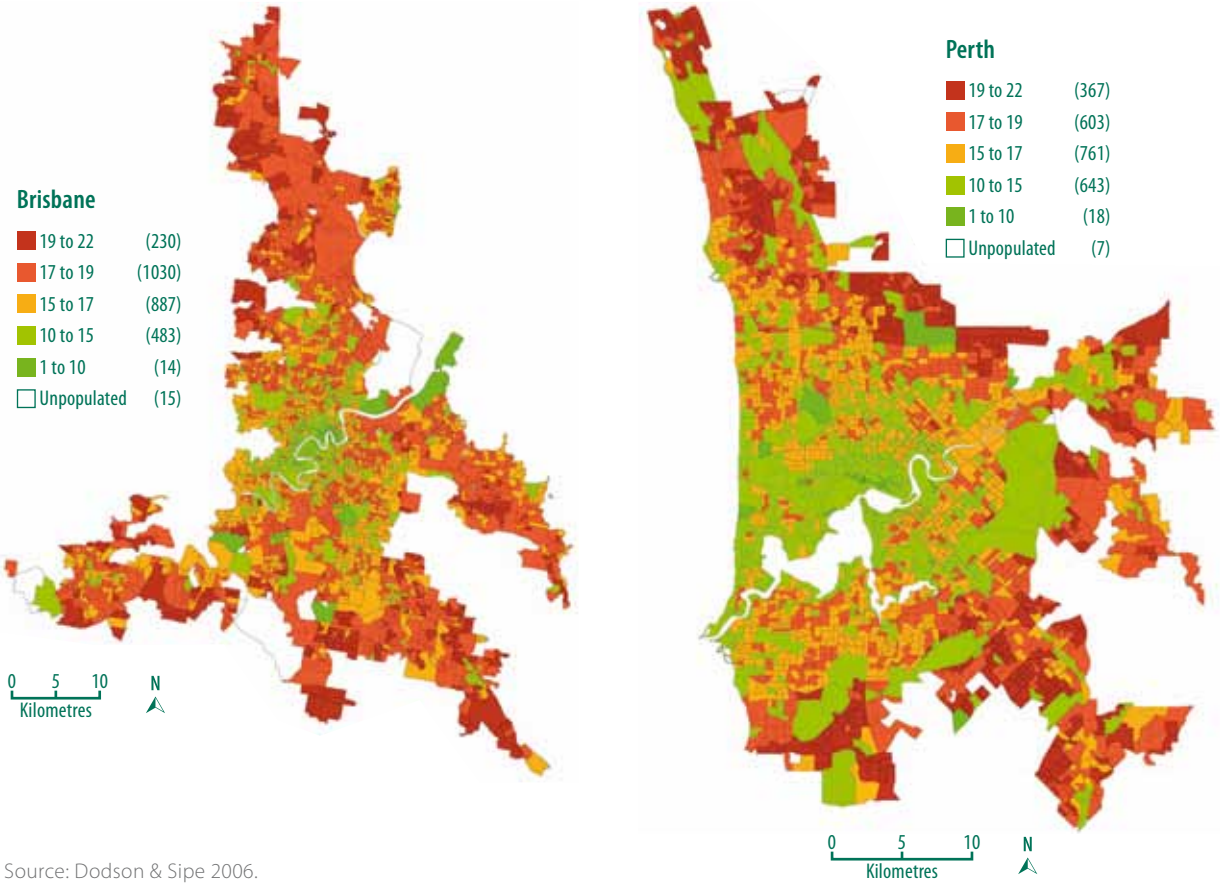
Research suggests that in Australia transport poverty does not only concern difficulty accessing transport but also, in a country that is highly dependent on cars, difficulties associated with maintaining private transport (e.g., financial stress related to the cost of petrol, car insurance, car purchase, maintenance and repairs) (Currie *et al*. 2009). Transport poverty may therefore be defined as "difficulty accessing transport (both public and private transport) and/or difficulties associated with maintaining private transport (i.e. motorcars)" (Australian Institute of Family Affairs 2011).

Since Australia has comparatively high levels of car ownership, difficulties associated with maintaining private transport (e.g., financial stress related to initial cost of purchase, as well ongoing costs such as petrol, insurance, car purchase and maintenance) can be included in the overall definition of transport poverty. Transport disadvantage is experienced by specific sub-groups in the population, for example, families with young children, people with a disability and Indigenous Australians. Transport disadvantage is also common in specific geographical locations such as outer-urban (or 'fringe') areas, rural and remote Australia. "The trend towards spatial groupings of people with the least household wealth pose[s] clear challenges for policy makers" (*State of Australian Cities* 2014–15).

Transport poverty is closely allied to rising living costs (including the cost of a mortgage, the cost of utilities and inflation). Being obliged to rely on motorcars in outer urban and inner-regional areas impacts particularly on lower income groups. "In outer-urban areas transport disadvantage is the result of a range of intersecting factors including poor public transport infrastructure, a higher proportion of low-income households and the need to travel further distances in order to get to places of employment, services and activities" (Australian Institute of Family Affairs 2011).

Rising fuel prices can quickly lead to transport poverty for people with two or more cars who live in areas not served by public transport. This is demonstrated in the 'Vampire' Index, see Figure 3.3 (Vulnerability Assessment for Mortgage, Petrol and Inflation Risks and Expenditure) (Dodson & Sipe 2006).

Figure 3.3: Mortgage and oil vulnerability, Brisbane and Perth



Source: Dodson & Sipe 2006.

Box 3.2: Locational disadvantage and educational opportunities

Locational disadvantage is sometimes described as the 'spatial concentration of poverty (Gronda 2011) and is not limited to developing countries. Examples have been studied in North America, Europe and Australia. Aged public housing stock, low quality housing, limited access to home ownership, high crime rates, reduced participation in broader society, risky behaviour and psychological distress in children and young people can all contribute to a 'ghetto effect' (Good Shepherd Youth & Family 2012).

Bruce Chapman has highlighted the insidious long-term effect of social and economic disadvantage on educational outcomes. "The real prospect is that those residing in parts of large metropolis areas long distances from where tertiary institutions such as universities are, will have relatively low expectations of, and aspirations to, continuing their education to high levels" (Chapman 2015)

To the extent that more limited access to transport; exclusion from the broader community and surrounding areas; and information concerning the opportunities and benefits of achieving high levels of education can be seen to exist, urban transport availability and transport costs have the potential to contribute to educational opportunities and thus lifetime social status (Ryan 2010).

In these circumstances, locational factors may reinforce life-cycle socio-economic status, and thus influence both income distribution and the inter-generational transmission of opportunity and inopportunity. "There is little doubt that inter-generational poverty can be sourced to the transmission of educational outcomes, which in turn are highly likely to have spatial and locational dimensions" (Chapman).

3.12 Key findings

- **The growing, ageing population presents particular urban challenges**
  By 2050, the Australian population is expected to reach 37 million, which will almost double the number of people in Melbourne, Sydney and Perth. All capital cities will have an increasing proportion of older people over the next half-century. This has significant implications for a range of planning and design activities, from housing and transport, to the delivery of human services and the size of local workforces.
- **Inner city living is becoming denser; outer city living risks being marginalised**
  There are two distinct trends occurring across the largest of Australia's cities: one of growth locating at low densities on the urban fringe and the other of growth consolidating in high-density city centres. A lack of polycentricism in planning leads to low-density residential expansion of cities ('sprawl') and places those in outer urban and inner-regional areas at risk of transport poverty.
- **Transport poverty**
  An increasing number of people are living further away from central business districts and employment hubs. Fringe developments are characterised by low housing and low employment density, limited (if any) mixed-use development and poor access to public transport. Together this increases distances between where people live and where they need to travel for work, shopping, socialising and recreating. In these motorcar dependent neighbourhoods, residents are at risk of transport poverty.

4

Barriers and pathways to sustainable urban mobility

Sustainability entails a shift of emphasis from transportation to people and places

UN-Habitat

4.1 Introduction

The scale of reductions in energy consumption required will force a reversal in the mobility trend. Ultimately, mobility is not about reaching destinations but accessing opportunities and needs. More localised patterns of living and working are essential to sustainable cities. Social sustainability rests on equitable access to the whole city, irrespective of gender, age or disability. The motorcar remains a popular form of transport for many Australians, despite the realities of traffic congestion and limited parking. For some Australians, transport choices are so restricted as to make the motorcar their only effective choice, whatever the cost. For many people, certain specific types of travel (e.g. chauffeuring of elderly or disabled friends and family) are also inelastic. The chapter discusses the notion that transport choices are not necessarily driven by rational thought, but by habit, attitude and/or inertia. The argument is

presented that in the inner cities and middle suburbs, the provision of attractive public transport and active transport alternatives based on network planning can be effective in discouraging motorcar use.

4.2 Social sustainability

It has been argued that the scale of reductions in energy use required in order to meet the challenges of climate change is unattainable under any scenario in which we attempt to maintain current levels of mobility, despite whatever technological innovations there might be.

> "Neither vehicle energy efficiency nor alternative fuels looks likely to offer dramatic reductions in either oil use or GHG emissions in particular…For Australia, at best a threefold reduction in passenger GHG emissions might be possible by 2050, but…a 50-fold reduction might be needed…putting our faith in technological fixes for transport problems promises to make maters worse by deflecting attention from the changes really needed."
>
> Moriarty & Honnery 2013

In the absence of technological solutions, the alternatives are social changes. ACOLA commissioned a study (Stone *et al*. 2014) into the social issues surrounding urban mobility. The study suggests a possible scenario in which we are obliged to accept a reversal in the historical trend towards increasing mobility.

> "The Australian city in 50 or 100 years from now is almost certain to be, by comparison, a low-mobility city and so, although this is beyond the scope of contemporary political conversations, we need to begin the transition to more localised patterns of living if we are to maintain the social and economic fabric of a truly sustainable city."
>
> Stone *et al*. 2014

These are probably two extreme cases. The ACOLA study in fact revealed a complexity of what are sometimes contradictory issues (see 4.3 below) that impact on current urban travel patterns. Together, these will continue to influence the scale and scope of the challenge.

Urban transport is socially sustainable when mobility benefits are equally and fairly distributed, with few if any inequalities in access to transport infrastructure and services based on income, social and physical differences (including gender, ethnicity, age or disabilities). Social sustainability is rooted in the principle of accessibility wherein equality exists among all groups in terms of access to basic goods, services and activities—such as work, education, medical care, shopping, socialising—and to enable people to participate in civic life. It recognises the critical importance of mobility and accessibility in fully enjoying human rights (UN-Habitat).

An important aspect of accessibility is the affordability of transport modes. Affordable transportation means that people, including those with low incomes, can afford access to basic services and activities (healthcare, shopping, school, work and social activities) without budget strain. For some urban dwellers, even in Australia, the availability of reliable and affordable public transport services can be the difference between being integrated into the economic and social life of a city or not.

Social sustainability also has gender, age and disability dimensions. A majority of women in many parts of the world are less likely to have access to individual means of transport, be they cars or bikes. In Australia and elsewhere, women often create complex trip chains (Turner & Hamilton 2005)—e.g. taking children to school followed by shopping and other errands—so as to make traditional fixed-route bus services impractical.

4.3 Key trends and drivers

The ACOLA study identified a number of key trends and drivers in current urban travel patterns:

4.3.1 Increasing motorcar use

Growing populations and declining 'levels of service' for public and active transport, together with strong community desire and institutional support for road-based travel have led to a large increase in car use in the last 40 years in all Australian urban centres and in regional towns.

Car dependency is also served by a cultural and commercial system, which promotes the car as a symbol of status and personal freedom. Therefore, many developing countries perceive motorisation as a condition for development. The private car has become a status symbol, depicting affluence and success in life. A number of influential converging factors—such as economic policies that maintain fuel subsidies and planning practices that incentivise suburban residential developments, large malls and retail centres with extensive parking—all play a role in increasing motorisation (UN-Habitat).

The popularity of cars and their centrality to Australian transport is at least one part of why the requirements for them to function as promised are seen as frustrated by Australian cities.

World Bank studies have estimated that traffic congestion lowered the GDP of some cities by 3 to 6%[1]. Motorists in Moscow (pop. 12 million) report an average daily delay of two and a half hours (UN-Habitat 2013). In Mexico City (pop. 21 million), despite an extensive public transport system, which accounts for 70–80% of trips each day, it can take up to four hours for trucks to cross the city (Dablanc & Lozano 2013).

The 2014 ITLS survey reported that 29% of Australians said transport in their local area was worse now than one year ago, up from 24% in the September 2013 quarter. According to the *Australian Infrastructure Audit*, peak hour demand on many urban transport networks significantly exceeds the capacity of those networks. The result is congestion on the nation's roads and overcrowding on parts of the public transport network.

A 2007 BITRE report estimated the 'avoidable' cost of congestion for Australian capital cites totalled approximately $9.4 billion for 2005, with both congestion levels and costs rising strongly. Traffic congestion, in Sydney and Melbourne, is now as thick on weekend mornings as in the traditional weekday peak hour (NSW Bureau of Transport Statistics 2013; VicRoads 2014).

4.3.2 Changes in the spatial distribution of destinations

Car dependency has been further entrenched through the need for longer and more dispersed journeys due to changes in the spatial distribution of employment, retailing, recreational, education and health services destinations in relation to residential locations.

Passenger travel in all Australian capital cities, in both private vehicles and by public transport, increased nine-fold between 1945 and 2010, according to BITRE. In 2013, private vehicles travelled 169 billion passenger kilometres across the capital cities, accounting for 90% of all motorised travel.

Over the last decade, the greatest population growth in Australia has taken place in the outer suburbs of the capital cities, especially Melbourne. Populations in local government areas (LGAs) west, north and south of the city have doubled since 2002. These areas are experiencing some of the highest rates of growth in the country. Sydney has a more even distribution of new housing construction across the urban region. In both cases, the inner cities are also showing rapid growth. In the established middle suburbs, only Blacktown and Parramatta in Sydney and Stirling in Perth have a place among the rapidly growing locations (ABS 2013).

4.3.3 Relative shortness of car trips and saturation

Despite the outer-fringe expansion of cities and our persistent car dependence, a large proportion of all car trips remain short—with origins and destinations in the same or adjacent LGAs. Average trip lengths have increased over time, but are still relatively short at around 7.5 km. The comparable figure for public transport is about 11.5 km travelled per trip, calculated across all the public transit modes. This is roughly twice that typical of the average value at the start of last century (BITRE 2013).

BITRE reports suggest that 'saturation tendencies' (including congestion, travel time, cost) influence the amount of daily travel that people will undertake in Australian cities. This is expected to lead to lower growth in aggregate travel compared with historical trends.

Saturation occurs partly because the amount of additional wealth that people choose to spend on travel is reduced when incomes reach a certain point. In the US, for instance,

1. World Bank studies extend over a considerable period and include for example: Walters, AA 1968, 'The Economics of Road User Charges', *World Bank Staff Occasional Papers*, Number Five, Chapter VII, Washington, DC; The World Bank 1996, *Sustainable Transport: Priorities for Policy Reform*. The World Bank, Washington, DC; World Bank 2002, *Cities on the move, A World Bank transport strategy review*, Washington DC; United Front Publishers and Cairo Traffic Congestion Study, May 2014, <www.worldbank.org/content/dam/Worldbank/TWB-Executive-Note-Eng.pdf>.

households earning US$50,000 per year averaged more kilometres of vehicle travel in 2009 than households with twice as much annual income (UN-Habitat). Moreover, factors such as shrinking city sizes [in specific United States cities such as Cleveland, Dayton, Detroit, New Orleans and St Louis] and lifestyle changes are contributing to levelling off of car ownership and usage in developed countries. Furthermore, increasingly ageing populations further contribute to the stabilisation of motorisation rates.

4.3.4 Modest increases in public transport and active transport use

Continued strength in CBD employment, changes in inner city demographics, fuel price rises and growing environmental awareness have each contributed to recent modest decreases in car-use for work trips and corresponding increases in public and active transport use. In some cities, these mode shifts have occurred with only marginal improvement in 'level of service' for non-car modes.

Public transport usage experienced a decline over two decades but began increasing again in 1996. Between 2006 and 2011, Australia experienced the biggest increase in public transport mode share since 1976 (Mees & Groenhart 2012).

The revival in public transport usage did not include Adelaide, Canberra or Hobart. Increases were seen mostly on rail services. The share of workers commuting by train is now higher than at any time 1976. In Perth, this share is three times as high as 1981[2]. Bus and (in Melbourne and Adelaide) tram travel has not seen the same revival, with usage rates still less than half those of 1976.

The most impressive revival of public transport has taken place in Perth. "A concerted community campaign, backed by skilled planning and budgeting, has revived the city's rail system, which now carries more passengers than Brisbane's" (Mees & Groenhart 2012). One should caution though against inferring that Perth can be a model for older, larger Australian cities, where the opportunities for retrofitting rail are more constrained.

In much of Australia, public transport is not competitive in terms of the time taken, cost and level of flexibility compared to car-based transport. There are geographic areas to which Australian studies point in which car use is 'inelastic'. In these areas, higher fuel costs and/or longer travel times will not influence choice but simply impact on motorists. Residents of car dependent areas have constrained choices to shift travel mode and any increase in travel costs (petrol prices) or times (congestion) will either be paid by them directly or will result in restricted access to employment, education, or other services. Car dependent areas have additional exclusionary effects for people with disabilities (Hine & Mitchell 2001; Rains & Butland 2013).

The bottom line for accessibility is not the hardware; rather it is the quality and efficiency of reaching destinations whose distances are reduced. Equally important is the affordability and inclusiveness in using the provided facilities. Sustainable mobility is thus determined by the degree to which the city as a whole is accessible to all its residents, including low-income earners, the elderly, the young, the disabled, as well as women with children (UN-Habitat).

Walking is reported to have declined since 2006, despite the increase in inner-city population between 2006 and 2011. Mees and Groenhart attribute this decrease to the construction of inner-city precincts such as Docklands and Southbank in Melbourne or the New Acton development in Canberra, which they argue provide poor environments for pedestrians, with wide arterial roads and major barriers to movement on foot.

2. Newman, P, Kenworthy, J & Glazebrook, G 2013, 'Peak Car Use and the Rise of Global Rail: Why This Is Happening and What It Means for Large and Small Cities', *Journal of Transportation Technologies*, vol. 3, pp. 272–287 discusses rail's increasing role compared to cars in an international context, including cities across Asia, Europe, the Middle East and the United States.

Cycling began from a low base in 1976 but increased steadily in all cities except Adelaide. Canberra has an extensive network of off-road cycle paths. Outside of Canberra, despite the enthusiasm within the sector, cycling still accounts for less than 2% of all journeys to work. Constraints are seen to be greater average distances between home and work and perceptions regarding traffic safety. Since 1996, higher inner-city populations, more employment within the city and improvements in cycling infrastructure have seen an increase in cycling as a commuter choice.

In pursuit of transport policies reflecting sustainable mobility, the promotion of walking and cycling is very important.

4.3.5 Slight density gradient away from inner cities

Population density appears in most transport policy debates in Australia. It underpins a belief that no alternatives exist but to support increased allocation of space and infrastructure to the motorcar. The argument is that suburban densities in Australia are too low for public transport to be 'viable' and/or for the design of infrastructure to encourage walking and cycling to be 'worthwhile'.

Despite strong popular belief, the density gradient away from the core of Australian cities is remarkably slight. Densities in most middle and many outer suburban locations have been argued by Paul Mees to be currently high enough to support much improved levels of public transport service. The term 'public transport network planning' is used specifically to describe the intensive coordination of public transport services to achieve a 'network effect'. The 'network effect' that Mees *et al*. describe (Dodson, Mees, Stone & Burke 2011) can lead to "patronage gains beyond those expected by conventional single-route cost-benefit analyses of public transport systems predicated on single-seat journeys because of the high demand elasticities that are unleashed by seamless ubiquitous interconnected networks offering a much wider array of transfer based trips".

There is some evidence that 'public transport network planning' is more important in dispersed urban environments where demand is similarly dispersed. Melbourne's SmartBus system, first introduced as a trial in 2002 may provide the first evidence of the value of network planning.

Mees has shown that density comparisons are typically based on data that are neither consistent nor rigorous. Maps produced for the ABS Social Atlas series take a more consistent approach to comparisons of residential density. The map at Figure 4.1 makes it clear that Melbourne exhibits a very shallow density gradient. Large stretches of middle and outer suburbs in fact show densities suitable for effective and affordable public transport.

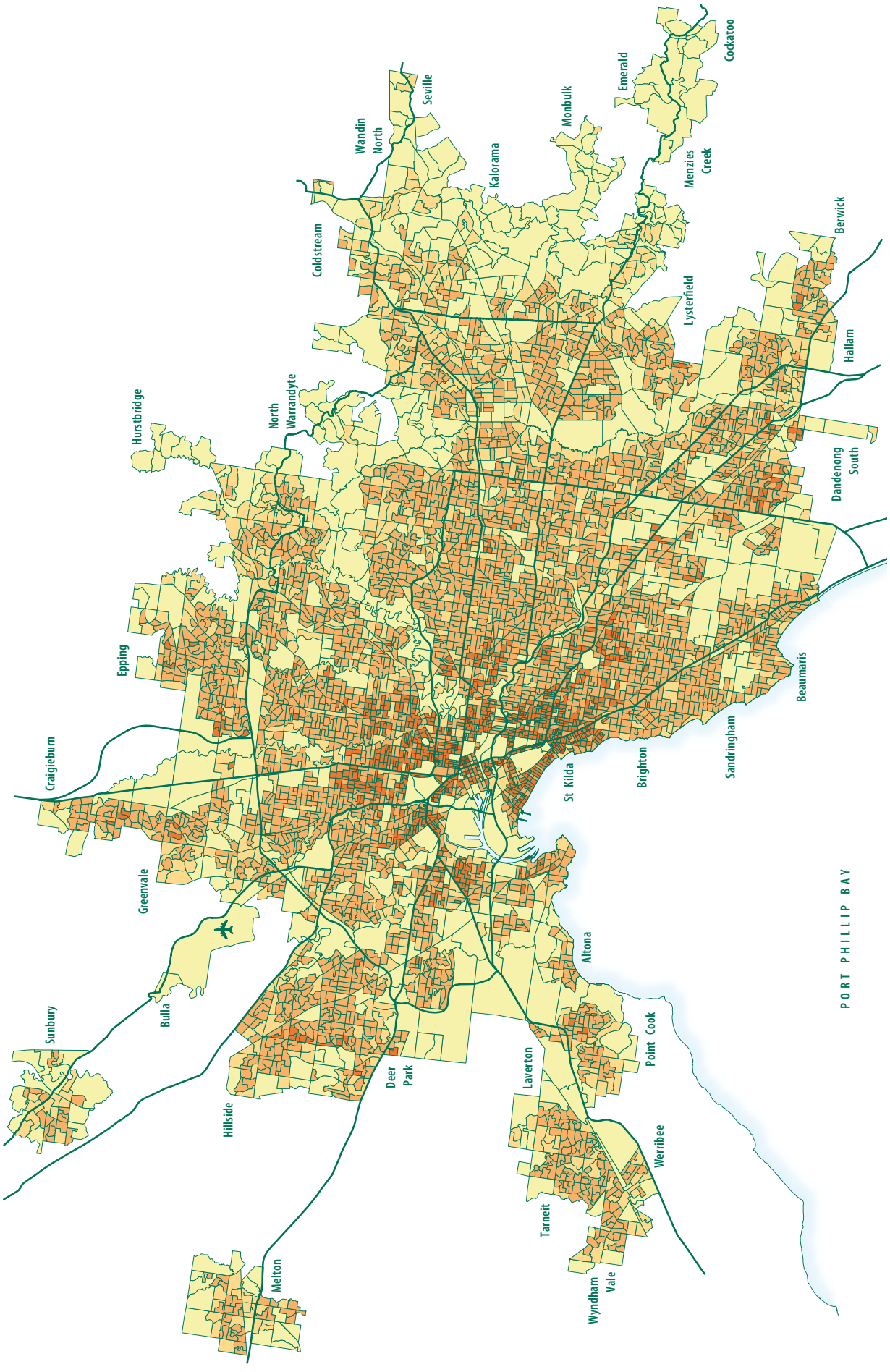
Work by Ewing and Cervero shows that population and job densities are only weakly associated with travel behaviour, once other variables are controlled (Ewing & Cervero 2010).

4.3.6 Growing suburban employment

Economic studies identify jobs in the inner core of capital cities as the 'wealth generators' of the economy. However, the great majority of urban employment is found in the suburbs. In recent years, there has been significant growth in employment in health and education services in suburban locations. Improved planning for the concentration of the locations of public-sector employment of this type provides a clear opportunity to start the necessary 'clustering' of suburban destinations.

Traditionally, centralised employment markets have been prized as the wealth generators of Australian cities. It is a fact that the combined central business districts of Sydney and Melbourne alone (a total area of 7.1 square kilometres) generate almost 10% of the value of goods and services produced in Australia (Kelly *et al*. 2014).

Figure 4.1: Residential densities in Melbourne by urbanised 'collector district'



Source: ABS 2006, *Melbourne: a Social Atlas*, Australian Bureau of Statistics, Canberra, p. 12.

And yet, even in those cities with the largest centralised employment markets (Sydney, Adelaide and Hobart), only about 20% of jobs are located in the CBD and surrounds. In the decade since 2000, much of the jobs growth, particularly in health, social assistance, education and training has been in the suburbs. Few governments or transport authorities made any real attempts to create new public transport services to meet new demands, or to locate jobs and services around transport nodes.

4.3.7 Suburban weekend congestion

Although congestion and travel times remain high during traditional weekday peak periods, suburban congestion is found increasingly over weekends when dispersed travel for multiple purposes is at its greatest.

NSW Bureau of Transport Statistics and VicRoads data shows that weekend travel is an important factor in both Sydney and Melbourne. Weekend peaks are not always as high as the busiest weekdays periods, but they are as long lasting. Studies show that 90% of weekend travel comprises shopping and social and recreational activities. Moriarty and Honnery (Moriarty & Honnery 2013) cite greater affluence, more car ownership and cheap fuel—sometimes by way of employer contributions to fuel costs—as the drivers.

4.3.8 Chauffeuring

Significant numbers (up to 20%) of trips are 'chauffeuring' of children and older people. Up to 17% of peak period travel is attributable to parents taking children to school.

'Chauffeuring' (motorcar travel specifically to carry a passenger, which often implies an empty return trip) is a relatively recent phenomenon for many suburban schoolchildren. The Heart Foundation has reported that more than 60% of Australian children are driven to and from school, a dramatic turnaround from the 1970 level of 16%. The main reason why parents drove their children to and from school was the school was 'too far away' (47%) followed by concern about traffic danger (45%), and the need to go on to another activity after school pickup (33%). Approximately 40% of car trips between 8 am and 9 am and 3 pm and 4 pm are to drop off or pick up school children (Loader 2011).

The 'school rush' has become another measurable component of suburban congestion. The median distances driven between home and school were 2.9 km in urban areas and 4.7 km in rural locations, while 1.6 km was found to be a distance that parents considered walkable

Where parents have a large part of their day taken up with work, voluntary work or simply travelling to and from work, this coupled with their unwillingness to permit children to travel independent of an adult, may simply mean it is easier to drive the child to school regardless of suburban design (Burke *et al*. 2013).

Fear of abduction or sexual attack is another contributor, exacerbated by growing awareness of sexual crimes against children and by reduced social trust. Fear of crime and fear of strangers increases the odds of parents restricting children's mobility, particularly for girls. The perception of risk is a product both of actual incidence and of subjective and cultural assessments of the implications. There is considerable disparity between exposure to risk and how risk is perceived and responded to through social and legal norms. (Burke *et al*. 2013).

Not all chauffeuring involves schoolchildren. An RACV study of people over 65 found that 85% of those surveyed had relied on lifts from others to get around. Buses were available to most of the respondents, but only 45% used them. Sixty-two per cent had access to trains, but these were used by only 22% of respondents (RACV 2006).

4.3.9 Urban fringe growth

A growing imbalance in the choice of sustainable transport modes is exacerbated by population growth and the location, via developer-led housing markets, of most new affordable housing on the urban fringe.

Box 4.1: Changes in attitudes towards the motorcar

The automobile, as a technology that for its effective use requires the sole allocation of up to 30% or more of urban land, is fundamentally inconsistent with the environmental, social and economic rationales for a compact city form in which a constrained amount of public space is available for a multiplicity of purposes. However, habits, convenience, perceptions of safety, and lack of alternatives all create demand for motorised 'self-directed vehicles'.

Many of the factors set out above combine to erode the automobile's 'promise of freedom' and there are emerging changes in public attitudes to car-based mobility from which new political will might be forged.

Australian cities have a strong history of cultural associations catering for the freedoms of cars in urban areas (Davison 2004). The motorcar is often the easier choice because urban areas have been designed to facilitate this impression. Studies show though that many people choose to drive a car even when it takes longer or costs more money. The sense of privacy, comfort and control of the motorcar are frequently shown to outweigh the more utilitarian factors that transport planners may assume will prompt travel decisions.

A 2012 ABS survey on waste management, transport and motor vehicle usage found that other reasons for not using public transport included a preference for the convenience, comfort and privacy of a private motor vehicle (26%). Regular motorcar drivers concede that they would rather drive a car even if it took longer or cost them more money.

Stone *et al*. also cite misconceptions regarding journey times and control in relation to car and public transport use; systematic underestimation of car-related monetary costs; and the importance of self- and identity-relevant consequences in relation to transport policy acceptance.

A Melbourne study (Pandhe & March 2012) shows that often the only reason why people will not drive or own a car is a lack of free parking. Although politically contentious, time spent in traffic has comparatively little deterrent effect on either residential or travel choices as compared to parking.

'Greenfield' development may encompass non-productive land, habitats and/or productive farmland on the urban periphery. Most such development in these areas comprises detached family homes with few 'destinations'. These areas are characterised by limited arterial roads and virtually non-existent local public transport. Typical subdivision layouts require a greater proportion of land area for local roads than in the middle suburbs. Some subdivisions include well-designed infrastructure for walking and cycling, but these are not assembled in a functionally connected way (Carver *et al*. 2013).

Residential and commercial land uses are strictly segregated and lot sizes are uniform. In short, the potential for adaptability does not match that of the middle suburbs While housing is affordable, at least when transport costs are not included, there is currently little elasticity to rising fuel costs as a car is required for almost all trip purposes. Australia has yet to test the limits of this equation as the GFC did in the suburbs of US cities.

4.4 Choices and behavioural factors

Central to the mode shift achieved in exemplar cities and, more modestly, in the inner suburbs of Australian cities is the availability of multiple transport choices that allow citizens to complete a great variety of complex trip patterns without using a private car. This is recognised by European transit agencies and the major car companies, such as BMW, who are engaged in a fierce competition to be first with a 'platform' for a single 'smart-card' that provides access to public transport, bike hire and car share.

Subjective factors frequently outweigh objective measures in determining travel choices. The availability and quality of alternatives modes of transport is a significant factor in determining choices, but not the only one. Personal psychology, social norms, beliefs, habits and fears are equally powerful. Stone *et al*. cite the 'Theory of Planned Behaviour' as a useful framework for predicting 'pro-environmental behaviour'.

Attitudes and perceived behavioural control are important determinants. Habit, inertia and resistance to change are all significant.

There is a sizeable segment of the population for whom 'soft' marketing can be successfully used to encourage a transition in mode choice. A significant obstacle though is those parts of Australian cities where very few, if any, alternatives to the private motorcar currently exist.

4.5 Conclusion

> "The underlying premise within a human rights perspective—is that mobility is not simply about reaching destinations; in the final analysis, it is about accessing opportunities."
>
> UN-Habitat

One of the key planning strategies to more sustainable cities is to reduce the distances between origin and destination. In an idealised form, this would mean clustering both origins and destinations (Walker). We need to begin the transition to more localised patterns of living if we are to maintain the social and economic fabric of sustainable urban life.

There are three ways that the connection between work and homes in major cities could be improved: firstly, by bringing workplaces closer to homes; secondly, by increasing the number of dwellings in areas that have the greatest number of jobs so that people can live closer to work; and thirdly by improving transport links between work and home (*State of Australian Cities* 2013).

The pressures of urbanisation are clearly amplified by the challenge of climate change. Behavioural changes are hard to bring about and take place over 25 years cycles. Certainly most of the generation now entering adulthood has a much better grasp of the sustainability challenge than much of the older generation.

The automobile is fundamentally inconsistent with the environmental, social and economic rationales for a compact city. The point of 'peak

Table 4.1: The state-of-the-art of sustainable urban mobility plans in Europe

Traditional transport plans		Sustainable urban mobility plan
Often short-term perspective without a strategic vision	Strategic level/vision	Including a long-term/strategic vision with a time horizon of 20–30 years
Usually focus on particular city	Geographic scope	Functional city; cooperation of city with neighbouring authorities essential
Limited input from operators and other local partners, not a mandatory characteristic	Level of public involvement	High, citizen and stakeholder involvement an essential characteristic
Not a mandatory consideration	Sustainability	Balancing social equity, environmental quality and economic development
Low, transport and infrastructure focus	Sector integration	Integration of practices and policies between policy sectors (environment, land-use, social inclusion, etc.)
Usually not mandatory to cooperate between authority levels	Institutional cooperation	Integration between authority levels (e.g. district, municipality, agglomeration, region)
Often missing or focusing on broad objectives	Monitoring and evaluation	Focus on the achievement of measurable targets and outcomes (= impacts)
Historic emphasis on road schemes and infrastructure development	Thematic focus	Decisive shift in favour of measures to encourage public transport, walking and cycling and beyond (quality of public space, land-use, etc.)
Not considered	Cost internalisation	Review of transport costs and benefits also across policy sectors

Source: <www.mobilityplans.eu> (rev Sept 2012).

car'[3] may already have passed—meaning that the belief in the personal freedom provided by the automobile has finally been defeated—not by fuel costs or traffic congestion, but by the difficulty of finding city parking.

Public transport, powered largely by electricity, in conjunction with cycling and walking will be key components of future urban mobility. Habits, convenience, perceptions of safety and a lack of alternatives all continue to create demand for motorised 'self-directed vehicles'. The local provision of appropriate transport infrastructure and flexibility for travellers using inter-modal transport is essential in encouraging changes in behaviour.

4.6 Key findings

- **The cost of urban congestion will increase four-fold in two decades**
  Without investment in additional capacity or demand management innovations for current infrastructure, the economic extent of congestion costs in Australian capital cities is forecast to grow from $13.7 billion in 2011 to around $53.3 billion in 2031 (*State of Australian Cities* 2014–15).
- **The majority of Australian children are no longer actively mobile as commuters**
  More than 60% of children in Australia are now driven to and from school; this constitutes as much as 17% of peak traffic. Chauffeuring of children, during the week and over weekends, contributes significantly to traffic congestion. It also counters the benefits of active modes of transport (walking, cycling, skateboarding, etc.), which increase physical activity and help to prevent obesity.
- **Planning for the origin-destination distance is key to sustainability**
  A transition to more localised patterns of living will help to reduce or avoid the need for travel. Planning for sustainable urban mobility, including shortening the distance between origins and destinations, contributes to this goal.
- **Access to multi-modal transport choices promotes sustainability**
  The availability and frequency of multi-modal transport choices is key to improving accessibility and the ability to benefit from opportunities. Access to opportunities such as education, employment and health care promotes social equity and contributes to economic growth.

3. For a discussion of 'peak car' in relation to wealth creation, see Kenworthy, J 2013, 'Decoupling Urban Car Use and Metropolitan GDP Growth in World Transport', *Policy & Practice*, vol. 19.4, October.

Without investment in additional capacity or demand management innovations for current infrastructure, the economic extent of congestion costs in Australian capital cities is forecast to grow four-fold in two decades.

5 Economic perspectives

5.1 Introduction

Sustainability in the transport sector is as much an economic imperative as an environmental and social goal. Improved productivity is dependent on increased accessibility for all residents. Addressing the relationship between transport and productivity will also deliver substantial co-benefits (including congestion mitigation, cleaner air, healthier population).

The chapter considers the cost of addressing the Australian infrastructure deficit that has built up over the last forty years. It concludes that this may exceed $350 billion by 2025, but is forecast to lead to a continuing annual economic benefit of $75 billion. In contrast, the economic cost of inaction is higher. Traffic congestion, GHG emissions and air pollution cost Australia billions of dollars annually. Carefully targeted planning and infrastructure project selection, emphasising the development of high technology industry nodes in middle-city sub regions, will improve local and national productivity and contribute to

sustainable urban mobility. The chapter concludes that road pricing reforms; a regulatory regime in respect of GHG emissions; and a planning philosophy that promotes social inclusion are necessary micro-economic reforms.

5.2 Sustainable development

The urban transport sector is economically sustainable when resources are efficiently used and distributed to maximise the benefits and minimise the external costs of mobility (UN-Habitat).

ACOLA commissioned an economics study (Stanley & Brain 2014) in support of this report. The study begins with the Brundtland conception of sustainable development[1],which may be summarised as: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

1. Introduced on page 15 of this report.

This definition has been widely adopted by UN, the Organization for Economic Cooperation and Development (OECD) and the World Bank. The ACOLA study then adds some absolute end-state targets likely to be indicative of a long-term sustainable urban mobility/transport outcome. The conception of a sustainable city is one of constrained maximisation: maximising economic values/opportunities that are affected by urban mobility, subject to meeting social and environmental constraints.

A city that will be improving its sustainability is likely to demonstrate the following outcomes in its transport and land use systems:

- Increasing economic productivity
  - Improving sustainability will increase Gross Domestic Product (GDP) per capita, an imperfect indicator of human needs but one that is nonetheless widely used. Urban productivity can be improved through enhanced accessibility, supporting the economic leg of a triple bottom line approach to sustainability.
- Reducing ecological footprint
  - In terms of the concept of passing on a stock of natural assets that will assist future generations to meet their own needs, however conceived at the time, there are strong arguments for taking a hard line when it comes to urban transport greenhouse gas emissions, with a target set for end-state transport GHG emissions for 2050.
- Increasing social inclusion and reducing inequality
  - Social inclusion and reducing inequality are about ensuring that all residents have the opportunity to benefit from living in urban areas. A trip or activity rate target can provide a feasible threshold indicator, as might a minimum transport service level that supports trip making and inclusion. Recent OECD research is showing that economic productivity is assisted by more equal income distributions.
- Improving health and safety outcomes.
- Promoting intergenerational equity.
- Community engagement.
- Engaging communities widely in development and delivery of land use/transport plans and policies is an essential ingredient in social sustainability and a matter of rights.
- Integrated land use.

Pursuing integrated land use/transport plans/policies in the widest sense (e.g. across sectors, levels of government, modes, etc.) is included as a sustainability dimension in its own right simply because it is so fundamental to achievement.

5.3 Macro-economic perspective

Increasingly, the test of cost-effective transport infrastructure is whether the project is 'bankable', that is, capable of attracting loans and private investors. Urban transport infrastructure is expensive. Crafting reliable and equitable funding programmes for transport infrastructure that reward efficient and sustainable behaviour remains a formidable challenge (UN-Habitat).

In the developed world, two of the more important transport budget issues are providing the necessary public subsidies for public transport systems and paying for ongoing road maintenance and expansion. Specific macro-economic challenges in Australia also involve considering how urban mobility and accessibility can address declining rates of urban productivity growth overall, as well as the differential productivity performance between different parts of Australian cities.

5.3.1 Productivity growth

Sluggish productivity growth is a major concern for many developed countries. As Table 5.1 shows, average annual growth in multi-factor productivity in Australia has fallen from 1.7% to 0.03% over the period 1995–2012.

Table 5.1: Average annual growth in multi-factor productivity, 1995–2012 (% p.a.)

Period	Australia	Canada	UK	US
1995 to 2000	1.70	1.13	1.63	1.22
2001 to 2006	0.77	0.62	1.48	1.47
2007 to 2012	0.03	–0.52	–0.5*	0.83

Note: UK data for this period is for 2007 to 2011.

The deteriorating condition of infrastructure is often seen as a contributing factor in sluggish productivity growth, linked to lower infrastructure spending as a proportion of GDP. Although Australian transport infrastructure spending has increased in relative terms in recent years, it shows a substantial decline in relative terms over the past forty years. This is a time period reflective of the asset life of many transport assets built up over this period.

The links between infrastructure investment and economic output are now well established. Daley (Daley 2012) has estimated that a 10% increase in Australia's stock of infrastructure increases GDP by 1%.

Widening disparities in income levels within some countries are at the heart of increasing economic inequality. Reducing inequality tends to produce improved outcomes across a range of indicators, such as levels of trust, life expectancy, obesity, maths and literacy scores and homicide rates.

5.3.2 Lifting urban infrastructure spending

The World Economic Forum has ranked the quality of Australia's infrastructure 20th out of 144 countries. Some of the poorest scores were for the quality of Australia's roads and ports. These patterns emphasise the fact that improving Australia's international competitiveness requires ongoing attention (*Australian Infrastructure Audit* 2015).

In 2014 it was estimated by the then Secretary of the Department of Prime Minister and Cabinet that Australia's current infrastructure shortfall amounted to $100 billion[2]. Further analysis for the ACOLA report suggests that in urban areas, Melbourne and Sydney alone showed a shortfall of more than $50 billion each. By this approach, the national shortfall was estimated at $145 billion. Factoring in further increases in shortfall during the period in which the gap might be addressed and the cost of preventing the development of a further backlog to 2025, a total amount of $364 billion in infrastructure spend to 2025 would be required. This spending, though, is calculated to lead to a continuing annual gain of $75 billion, in non-mining, non-community services gross product (NMNCGP) at factor cost.

Viewed on a regional (i.e. city) basis and assuming that tax revenue generated from state or local government expenditures is returned to the spending authority, the requisite financing would be self-funding. Given the historically low interest rates on ten-year government bonds, this is a good time to be investing in well-chosen infrastructure initiatives.

5.3.3 Using transport investment to support productive trends

The analysis cited above suggests that tackling Australia's infrastructure backlog has the potential to deliver significant productivity benefits. It also shows that the revenue gains from selectively targeted infrastructure stimuli are capable of funding the infrastructure expansion. The key to such an approach will be project selection.

2. There are various estimates of Australia's infrastructure deficit. In 2013 PricewaterhouseCoopers cited a figure of $700 billion calculated by Infrastructure Partnerships Australia and Citibank (PwC 2013). In the same year, Infrastructure Australia reported an estimate of $300 billion (DIRD 2013, *National Infrastructure Plan*).

Box 5.1: Urban renewal and revitalisation

Papers published by the Brookings Institution point to urban revitalisation strategies for neighbourhoods and entire cities. In *From Despair To Hope: Two HUD Secretaries On Urban Revitalization And Opportunity* (2009) the transformation of parts of cities as diverse as Atlanta, Baltimore, Boston, Denver, Louisville, Pittsburgh and Seattle, with Federal government support, is described. Public housing projects, which had fallen into disrepair and in some cases come under the control of criminals, became targets for investment through the HOPE VI program. *Turning Around Downtown: Twelve Steps to Revitalization* (2005) by Christopher Leinberger describes the fundamentals of a turnaround plan and the private-public partnership required to succeed. *Transformative Investments: Remaking American Cities for a New Century* by Katz and Wagner (2008) details the effects of an urban practice that embraces the remaking of downtowns as living, mixed-use communities; the creation of neighbourhoods of choice that are attractive to households with a range of incomes; the conversion of transportation corridors into destinations in their own right; the reclaiming of parks and green spaces as valued places; and the revitalisation of waterfronts as regional destinations, new residential quarters and recreational hubs. *The Rise of Innovation Districts: A New Geography of Innovation in America* by Katz and Wagner (2014) discusses the geographic clustering of leading-edge anchor institutions and companies in combination with start-ups, business incubators and accelerators. It cities in North America and Europe, underutilised areas (particularly older industrial areas) are being repurposed. Such clustering can offer opportunities for denser residential and employment patterns, reducing the distances between journey origins and destinations.

In Australia, the U*rban Renewal Guidebook 2014* published by Clayton Utz and KPMG reports on the success of projects such as the Sydney Exhibition & Convention Centre and the Darling Harbour precinct in enhancing tourism revenue; the strategy of bringing city workers closer to employment areas characterised in the Bowden development in Adelaide and the Kuripla Riverfront development in Brisbane. Housing for low-income earners has been included in Melbourne's Docklands and the Eveleigh Rail Corridor re-development in Sydney. The report details the on-going 25-year project in Toronto, covering a development area of 800 hectares, requiring an investment of approximately A$35.5 billion of private and public funding to complete.

5.3.4 NIEIR analysis data: 'rules' of regional economic development

Recent work at the National Institute of Economic and Industry Research (NIEIR) is showing how understanding the way structural economic changes are affecting urban development patterns can be used to inform project selection. The NIEIR work has particularly concentrated on land use transport policy and planning implications of growth in the knowledge or high-tech economy. These findings, in respect of Melbourne and Sydney, have been summarised for this report.

The NIEIR research points to the fact that by both boosting productivity growth and enabling the sharing of that benefit more broadly amongst urban residents, two of the triple bottom line goals can be served.

The following 'rules' of regional (i.e. urban) economic development can be derived:

- There is increasing inequity in regional economic performance, with fringe areas at an increasing disadvantage. That is, without strong policy intervention increasing inequality is expected, with the general rule being the greater the distance a sub-region is from the central LGA (of the City of Melbourne or Sydney), the greater the increase in inequality. [Appendix Figures 2.2 (a) and (b)].[3]
- The greater the level of economic activity located within a region's catchment, the greater the economic benefit to residents within the catchment. That is, the level of income received by a region's households from work is determined by the level of economic activity generated in the region's catchment, as determined by acceptable travel times. [Appendix Figures 2.3 (a) and (b)].

3. A more comprehensive statement of the impact of transport options on regional inequity might include distance, commuting time and cost.

- Cumulative regional investment, that is, the capital stock per capita installed in a region, is a core fundamental factor that determines the level of economic activity. [Appendix Figures 2.4 (a) and (b)].
- Increased scale of the Metropolitan Area will increase the opportunities to increase overall productivity. [Appendix Figures 2.5 (a) and (b); Figures 2.6 and 2.7]
- If the Metropolitan area of a major city is to maximise the increase in its productivity, the scale of the central region will have to increase, at the very least proportionally to the overall increase in Metropolitan scale. [Appendix Figures 2.8 (a) and (b)].
- The capacity to export out of a region is the core proximate driver of economic activity. [Appendix Figures 2.9 (a) and (b); Figures 2.10 (a) and (b)].
- The skills of households within each region's catchment is a core driver of the region's economic performance. [Appendix Figures 2.10 (a) and (b); Figures 2.11 (a) and (b); Figures 2.12 (a) and (b)].
- Different industry types have different multipliers (or flow-on impacts) for expansion. Here the rule is, high-technology industries have the largest multipliers and therefore the greater the concentration of high-technology industry in a region the better the relative economic performance. [Appendix Figures 2.13 (a) and (b)].
- High-technology industries4 require the concentration of high-skilled households within their labour market catchments. [Appendix Figures 2.14 (a) and (b)].
- The main reason why high-technology industries have high multipliers is the importance of scale and scope to productivity in these industries and hence profitability and the capacity to expand. Therefore, the rule is the greater the scale of high technology industries the greater will be the productivity. [Appendix Figures 2.15 (a) and (b)].
- High-technology industries need to cluster in and between regions. Hence, the rule is that the share of high-technology industry in a region's economic activity diminishes with distance from the central activity areas of Australia's major metropolitan areas. [Appendix Figures 2.16 (a) and (b)].
- High technology industries require sustained innovation to be competitive. High-technology industries will prefer to locate where there is strong knowledge-creation infrastructure within a region's catchment. [Appendix Figures 2.16 (a) and (b)].
- Skilled households locate in regions where strong cultural and community infrastructure is available within the region's catchment. The thesis is that high-technology industry has to locate within the catchment where high-skilled households want to reside. [Appendix Figures 2.17 (a) and (b)].

Each of the 'rules' above is presented with empirical tests, notes on context and supporting data in the form of maps or graphs. Since the advantages of urban planning around high technology industry nodes and other innovation districts will become one of the principal findings of this report, the NIEIR analysis is presented in its entirety at the end of this report as Appendix 1. It is calculated that the total impact of Sydney's high technology industry growth between 1992 and 2012 would account for nearly 70% of the Sydney metropolitan area's total growth. The figure for Melbourne is similar, where the contribution of high technology industry employment growth amounts to over 60% of the total.

5.3.5 Application to high technology industry nodes

Since the 1990s, broad technological change and the rise of digital technologies in particular have changed the rules of success in planning for regional growth. Allocation of outer-fringe land and investment in transport infrastructure (almost exclusively roads) to connect new industrial precincts to the existing transport network is no longer an appropriate strategy.

4. The potential impact of innovation districts generally as attractors is noted in Box 5.1 above.

Today's local economies are defined by their capacity to generate globally and regionally competitive goods and services and to attract highly skilled workers capable of creating and generating high value outputs.

Planning can play a role in stimulating high-technology industry expansion, through measures such as the location of education, health, research and training infrastructure and the regional allocation of transport and community infrastructure.

Transport infrastructure can play a direct role in increasing the value of the high technology industry multiplier, both by underpinning exports and by increasing labour and service market catchment size, which for high technology enterprises will directly increase economies of scale and scope.

The NIEIR analysis makes clear the economic importance of the inner-city region. Reducing travel time to the CBD from outer areas will have the effect of reducing the inequality of opportunity for employment opportunities for outer suburb resident, relative to residents who live closer to the inner city. However, the impact on productivity for those industries operating in the more remote LGAs will be relatively low.

The central area is very important for a productive city and its growth should be supported, but the inner city does not account for most jobs. Equally important as improving access to the inner city for all is the development of a network of clusters of high technology industries or innovation districts in the middle sub-regions, designed to act as conduits to connect and strengthen industry connectivity across the entire metropolitan area. The number of strong strategic nodes a metropolitan area should include for sustainable development is approximately one per one million people. This would mean one such node in Adelaide for example and four each in Melbourne and Sydney.

5.4 Micro-economic perspective

Markets are usually an efficient way of allocating resources. Yet there are a number of well-known situations in which free markets fail. Stopher and Stanley (Stopher & Stanley 2014) identified a range of such issues that can be associated with transport:

- public goods (e.g. law and order, such as road rules)
- quasi-public goods (merit issues, e.g. social safety net minimum service standards on public transport; local roads)
- externalities (e.g. agglomeration economies; congestion; air pollution)
- natural monopoly (e.g. rail)
- limited extent of markets (e.g. the individual 'cost' of social exclusion)
- lack of information (for making informed choices)
- distributional considerations.

The major negative external impacts of motorised urban transport include congestion, greenhouse gas emissions and air pollution. These are discussed in more detail below.

5.4.1 Micro-economic reforms

> "Cities should strive towards full cost pricing for cars. Cars do not pay prices that match the full value of the economic and social costs that they impose in the pursuit of access. Revenues collected via congestion pricing and licensing fees should reflect the costs that private car use imposes on urban life. However, it is both short sighted and ineffective to attempt to sustain public transport systems via monies raised by car-based charges. These monies alone will almost never be sufficient to allow for the creation and financial sustainability of high-quality urban public transport."
>
> UN-Habitat

There are three micro-economic areas in which policy reforms, regulations and planning can make a difference:

- improving the way road use is priced
- implementing a regulatory regime that will accelerate the reduction of GHG emissions
- planning that reduces the risks of social exclusion.

In 2014, the Productivity Commission reported that government revenue streams associated with road use (particularly fuel excise and vehicle registration) totalling $20 billion per annum are barely meeting direct government expenditure on road construction and maintenance. When externalities such as the cost of congestion, GHG emissions and air pollution and accidents costs not met by road users—an additional $35 billion—the Productivity Commission suggested that road users pay governments considerably less than half the social costs of $55 billion annually attributable to their road use (Productivity Commission 2014).

> "Providing more transparent links between user charges and expenditure on transport planning, investment and maintenance could provide governments with greater means of implementing a more effective road and transport-user charging model than currently exists."
>
> *Australian Infrastructure Audit*

This report recommends a user pays approach, including all road users not just heavy vehicle operators and combining fuel taxation with a distance-based charge that varies by location and vehicle mass. This makes it possible to allocate charges in a way more directly related to the impact on road infrastructure and to separate urban and rural road use. A large-scale community conversation should be an integral part of road pricing reform as also a willingness to provide assistance for those who might be adversely affected. The London approach of improving bus services in areas where risks of adverse impacts are high has much to commend it.

> "The travel needs of many city centre workers can only be met by mass public transport. As Australia's urban economies have transitioned and more jobs are located in city centres, patronage on public transport has grown significantly. In the past decade, the rate of average annual growth of public transport patronage (2.4 per cent) surpassed the rate of population growth in capital cities (1.8 per cent). Additionally, the presence of public transport infrastructure attracts higher-density development, with corridors of higher density housing and commercial premises locating along transit routes. This is an increasingly common urban form change in Australian cities."
>
> *State of Australian Cities* 2015

Minimum public transport service levels are a way of introducing support for sustainable incomes. Half hourly services for at least 18 hours a day, within 400 metres of dwellings within 5 years, will be a minimum that will demonstrate the economic value of inclusion.

Legislative and regulatory approaches are already in place towards managing air pollution and noise. These can be refined to include variable registration charges as a function of a vehicle's emission-control technology. Voluntary industry-based approaches have not achieved the rate of sustained reductions in emissions intensity that would be required to meet targets of 80% or thereabouts. It seems then that mandatory standards—already the norm in Europe and the United States—will be needed in Australia. Transport will need to be a priority sector in mitigation efforts, because of its absolute emissions scale, the likely scale of overall emissions reductions Australia will need to pursue in coming decades and the fact that emissions from the sector are still growing, at a time when the global and national focus is on emissions reduction.

Road transport will need to be close to GHG emissions-free by 2050 if the necessary target of an 80% transport emissions cut (on 2000 levels) is to be approached. Europe, the UK and the USA all have reduction targets of at least 80% by 2050.

5.5 The cost of inaction

In 2007, BITRE estimated that the cost of congestion alone to Australia in 2005 was almost $9.5 billion nationally (BITRE 2007). BITRE projected that this cost would double by 2020. A 2014 DIRD report cites a current congestion cost to the economy of $15 billion per year (Australian Government 2014).

The annual cost of greenhouse gas emissions produced by urban road transport is estimated at close to $5 billion annually (Stanley & Brain). Air pollution damage associated with transport has been calculated at 2.6c/km travelled averaged across all transport modes (Stanley, Hensher *et al*. 2011). Health costs were detailed in section 3.2 above.

It seems there is no data tracking the value of Australia's land transport systems in reducing disadvantage and the risk of social exclusion. However, (allowing for the danger of the case being overstated), research undertaken for the Australian Bus Industry Confederation has shown the significance of a reasonable level of public transport in reducing the risks of urban social exclusion. Research commissioned by Bus Association Victoria suggests that the largest single benefit from urban route bus services in Melbourne is their social inclusion value, which has been assessed at almost $800 million annually, or 60% higher than the cost of providing the service for this benefit alone.

Against this background, it seems reasonable to conclude that while the many interrelated steps that will be required to address the issue of sustainability in urban mobility in Australia will carry significant costs, there will also be much wider socio-economic benefits.

Unsustainable transport systems are associated with reduced urban and rural access, worse road safety, greater air pollution, greater transport congestion, greater greenhouse gas emissions and social exclusion.

5.6 Key findings

- **Economic progress is not evenly distributed**
  Within and between cities, economic progress has not been evenly distributed against a number of economic indicators. Infrastructure plays a key role in improving the productivity of Australia's cities (*State of Australian Cities* 2014–15)
- **Australian cities have a significant infrastructure deficit**
  The available international comparisons suggest that, despite recent increases in government spending and increased private participation, the overall quality of our infrastructure lags behind comparable nations.
- **Infrastructure requires a spend of $364 billion over ten years**
  An Australian infrastructure deficit has built up over the last forty years, estimated in 2014 by the Department of Prime Minister and Cabinet to amount to $100 billion. Further analysis for this report suggests that the national shortfall by 2025 (and the cost of preventing the development of further backlog to that point) requires an infrastructure spend of $364 billion over the next ten years.
- **Integrated planning is essential**
  Reforms will be essential to integrate land-use planning and the implementation of sustainable urban mobility principles. Engagement with industry including the design, construction and transport sectors, is necessary.
- **Policy reforms and regulation have a role to play**
  Among the ways in which policy reforms and regulations can make a difference are three micro-economic examples: improving the way road use is priced; implementing a regulatory regime that will accelerate the reduction of GHG emissions; and planning that reduces the risks of social exclusion.
- **Polycentric cities bring people closer to opportunities**
  Planning for the development of polycentric cities will help to reduce transport poverty and improve the quality of life for Australians on a more equitable basis. High technology industry nodes and urban renewal projects are examples of polycentricism and take advantage of the employment growth opportunities that middle suburbs and innovation clusters provide.

6 Towards sustainable urban mobility

6.1 Introduction

The fundamental goal of sustainable urban mobility planning is to maximise the economic, environmental and social benefit-cost ratio for citizens and businesses. There is broad agreement amongst urban planners in Australia, Europe and the United States regarding the principles of sustainable city planning. The Australian urban environment however is not directly comparable with either Europe or the United States. The cycle of planning activities shown in Figure 6.1 is a process of research and analysis; strategising and consultation; elaboration; and implementation applicable to a wide range of local conditions.

The European experience has demonstrated the value of a national planning framework. All Australian cities (of 100,000 people or more) should play an active role in developing their own sustainable urban mobility plans, with national support. A far-sighted, transparent planning process that entails extensive consultation builds individual and community trust. Planning governance in Australia

requires deep reforms and in many cases responsibility should be vested at the metropolitan level. Both incremental and transformative changes are called for. Section 6.7 draws substantially upon the work that John Stanley has done with others in recent years. It proposes four main policy directions and a series of action areas, leading to six priority strategies proposed for consideration.

6.2 The value of urban mobility

The value of urban transport is directly related to its quality as an integrated system, distinct from a collection of independent modal options and specific routes. The more options that urban residents have to access work, education, shopping, social connections, etc., the more value-added the city creates (UN-Habitat).

The fundamental aim of any sustainable approach to urban planning is balancing social equity, environmental and economic development (the 'triple bottom line'). Failure to effectively address major contemporary issues such as urban mobility is not only short sighted; it also carries a series of significant economic costs.

The growing Australian infrastructure deficit; decreasing urban productivity; GHG emissions; traffic congestion; social exclusion (as affected by housing affordability, transport and urban form); and chronic disease associated with sedentary behaviour, all have an economic price.

Too often, urban mobility is approached as a 'road problem'—a single issue viewed in isolation. As soon as we ask the question 'what sort of city do we want?' our perspective changes, emphasising access over mobility. This visionary approach is what characterises planning approaches to sustainability, leading to the identification of policy measures suited to the delivery of the intended land use outcome. Economic approaches to the same goal of sustainability focus on identifying the marginal damage costs (and benefits) of different arrangements and using pricing mechanisms to correct for these market failures. Both approaches are important.

> "When they work properly, cities generate and distribute wealth and opportunity: a rising tide that lifts all boats. But they are increasingly divided…"
>
> *City Limits*, Kelly & Donegan 2015

6.3 The role of planning

Translating visions and plans for sustainable urban mobility depends on the presence of supportive and nurturing governance, as well as sound institutional and regulatory structures. Institutional fragmentation undermines the ability to coordinate urban transportation services. A farsighted, transparent planning process is required, one that provides the certainty essential to build confidence and attract investors. Another institutional void is the minimal involvement of citizens and broad-based community interests in the planning and design of urban transport facilities and services. Decision-making needs to be more inclusive, transparent and democratic (UN-Habitat).

There is broad agreement amongst urban planners regarding the principles of sustainable city planning, in order to meet the triple bottom line goals (Australian Davos Connection 2010):

- large cities should have a networked polycentric shape rather than a single CBD
- planning should be for 'whole communities', providing for access to jobs, schools, shops and services, recreational facilities, open space, and for access to other people
- this planning should involve the relevant communities in the planning processes and encompass both 'top down' and 'bottom up' perspectives outward growth of cities should be constrained
- 'green' areas should be retained within and around cities
- 'close to market' agricultural and horticultural land should be retained as far as possible
- higher density and mixed-use development should be encouraged at public transport stops, particularly rail stops but also along major public transport routes (e.g. tram lines and key trunk bus routes)
- all neighbourhoods should have access to urban villages and be walkable and cyclable
- use of public transport, walking and cycling should be encouraged wherever possible
- use of the car should be discouraged wherever possible
- open space and recreational space should be accessible to every neighbourhood
- public space should be human scale, well designed and encourage concentrated and varied activity
- neighbourhoods should have diverse housing to enable people of a wide range of ages and economic levels to live there
- housing, neighbourhoods and cities should be planned to maximise energy and water efficiency and resilience
- planning for industry and freight should include consideration of neighbourhood amenity as well as economic efficiency

- regional residential and employment land use should be built around public transport
- regional institutions and services should be located in urban areas
- cities should have the capability to respond to disasters and the resilience to respond and rebuild.

The principles set out above were agreed at the ADC Forum (formerly the 'Australian Davos Connection') Cities Summit in 2010. ADC planning principles parallel those of the *Action Plan on Urban Mobility*, adopted by European transport ministers in Luxembourg on 24 June 2010. In Europe, the EU has accelerated the take-up of sustainable urban mobility planning through a three-year project (2010 to 2013) (Rupprecht Consult 2012), providing guidance material, promoting best practice exchange, identifying benchmarks, and supporting educational activities for urban mobility professionals (Rupprecht Consult 2011).

In Australia, the Department of Infrastructure and Transport published *Our Cities, Our Future: A National Urban Policy* in 2011 (Australian Government 2011). The planning principles embodied in that policy closely paralleled those expressed by the ADC and the EU. The Australian Government document also looked closely at productivity in Australian cities and the impact that urban planning can have on boosting productivity. For the first time at a federal level, it sought to establish national goals for Australian cities, recognising the roles of States, Territories and local governments, as well as the private sector and individuals in planning, managing and investing in cities.

Today the States and Territories still have their own urban planning laws and procedures. There is no single urban plan planning system for Australia. Instead there are a number of planning systems that operate largely independently of each other, along state based lines.

6.4 The planning deficit

Tensions have existed between urban planners and residents doubtless since the Romans first raised a neighbourhood to accommodate a famously straight roadway. In modern liberal democracies, a measure of consultation is demanded by citizens. In the worst cases, this amounts in practice to little more than "an informal phase in which early agreements are reached in closed negotiations between municipal planners and private developers" (Falleth *et al*. 2010).

In Australia, as elsewhere, cities are now the powerhouses of innovation and growth. The major Australian cities compete successfully to attract international businesses and investors. Cities such as Brisbane, Melbourne, Perth and Sydney face strong challenges from other city-states that have better organised themselves to meet the economic, social and environmental challenges of the 21st-century. The distinctive characteristics of these cities are: a strong planning ethos to ensure that they develop the human and material infrastructure to support growth; strong leadership; an appropriate fiscal and governmental base. The challenge for Australia is to develop the forms of planning to meet these challenges, without compromising a tradition of participative democracy.

In the post-war years in Australia, concerns arose regarding the negative aspects of urban growth that resulted from a long period of economic prosperity. Several capital cities began developing metropolitan-wide spatial plans in an effort to guide further development over periods of 20 years or more. The conceptualisation of cities as a series of concentric rings built around the original colonial settlements and extending out towards the rural-urban fringe dates from this era, as does the preference for building motorcar-based infrastructure. Early examples were the Sydney *County of Cumberland Plan* of 1948, followed by the *Sydney Region Outline Plan* of 1968.

Contemporary approaches contrast with the lengthy and considered discussion presented in earlier Australian schemes, such as the 1971 planning policies document prepared by the erstwhile Melbourne Metropolitan Board of Works (MMBW), or the National Capital Development Commission's measured articulation of *Tomorrow's Canberra* in 1970. A comprehensive corridor plan for metropolitan Perth was produced in 1970 by the Metropolitan Regional Planning Authority, a rare and arguably effective example of dedicated metropolitan governance in the Australian planning experience (Gleeson, Dodson & Spiller 2010).

In 1973, the Whitlam government established for the first time a Department of Urban and Regional Development (National Archives of Australia), attending to sewage servicing backlogs in major metropolitan centres, the establishment of growth centres and new towns to foster de-centralisation, funding infrastructure and public housing. None of these ventures were long lasting and today a planning deficit arises "from the lack of sustained and accountable metropolitan governance frameworks which have responsibility for creating and implementing workable strategies for urban development" (Gleeson, Dodson & Spiller 2010).

The effects of this deficit in Australian cities have fed perceptions of an 'infrastructure crisis', to which politicians have sought to respond. 'Big-ticket' projects (or packages of projects) have come to symbolise the government's 'planning' efforts. This has meant a shift away from metropolitan planning as a more subtle strategy.

Australia would benefit from a strong and consistent pipeline of well-planned infrastructure projects. This would provide greater certainty for infrastructure constructors and investors, and provide the basis for a well-resourced environment for project procurement and informed decision-making (*Australian Infrastructure Audit* 2015).

6.5 Cities planning for themselves

> "The vast majority of economic activity takes place in Australia's large cities. And within these cities, economic activity is heavily concentrated.
>
> Australia's cities are the backbone of our economy, with CBDs and inner city areas critically important to the nation's prosperity. Their predominance reflects the economy's evolution from one based on primary industry, then manufacturing, then increasingly knowledge-intensive services."
>
> Kelly & Donegan 2014

Gleeson *et al*. identified an "immediate need to improve structural planning in Australia's metropolitan regions and to urgently give meaningful effect to the goal of decentralised concentration". Side by side sits the need to "vastly improve the planning and functioning of our long neglected public transport systems to ensure realisation of the mutually reinforcing goals of urban accessibility and equity". The goal is to create more economically efficient cities and provide a boost to regional productivity.

Particularly since the failure to reach agreement on how to effectively address climate change at Copenhagen in 2009, many cities have begun to act without waiting for countries to agree on national targets. This seems to foreshadow a sense that future sustainability planning might have to take place at a new tier of government.

A city is about buildings, open spaces, products, services, information, transport, energy, food, waste and water, all the things we need to flourish as people. To be sustainable it is not only these resources we need to consider, but also how we source these; the way in which we construct infrastructure, what we do with it, the ways in which we behave and how we govern ourselves (after Ryan C, Victorian Eco-Innovation Lab, University of Melbourne, *City Systems are Socio-cultural-physical-technical: you can't deal with one without the other*, an address to the Cities in Future Earth Conference, Canberra, 8 December 2014).

Box 6.1: Streets for people

> "Cities should be built around the concept of 'streets', which can serve as the focus for building liveable communities."
>
> UN-Habitat 2013

'Traffic calming' is the translation of the German word '*verkehrsberuhigung*'. The modern traffic calming movement began in Holland in the early 1970's. But the idea has been around since the ancient Romans used stepping-stones to slow chariots at pedestrian crossings. Traffic calming street designs abounded in pre-war US cities, including NYC, before newer, auto-centric cities became common. Traffic calming holds that streets are valuable public space and should be shared equally by all users. It is a set of street designs and traffic rules that slow and reduce traffic while encouraging walkers and cyclists to share the street. Traffic calming methods include: speed humps, raised crosswalks and raised intersections; extended and widened sidewalks; mini-roundabouts; widened medians; bicycle lanes and rumble strips. Traffic calming measures like speed humps are easily modified to accommodate emergency vehicles, garbage trucks and buses (Transportation Alternatives, New York City).

Through the SA Active Living Coalition, the City of Adelaide is committed to its own 'Streets for People' program, which treats streets as being "increasingly important as public spaces for social and commercial interaction and for building health and wellbeing" (Healthy by Design SA 2012).

In a planning regime where as much as 30% of the land area of a city is currently dedicated to the motorcar and discourages active modes of transport, let alone other forms of social engagement, this approach may yet have far reaching influence.

Examples of social innovation, often at the neighbourhood level, emerge to "satisfy human needs which are unmet by the state or markets; to provide access rights which enhance human capabilities and are empowering to people and social processes; and to change social relations and power structures that lead to more inclusive governance" (Moulaert, F, Swyngedouw, E, Martinelli, F, Gonzalez, S (eds) 2012, *Can Neighbourhoods Save the City?*, Community Development and Social Innovation (Regions and Cities).

Australian examples of socially innovative neighbourhood projects include the 'walking school bus', city farms and community gardening projects, baby-sitting co-ops and car-pool systems. An example from India that has grown to the point of attracting international attention as an informal response to complex business logistics is *dabbawalas* of the Mumbai Tiffin Box Suppliers Association.

Some buildings, precincts and cities are already exploring removing themselves from the main distribution grids, recycling their own water and waste and generating their own energy.

> "Engaging communities throughout the decision-making process is a key element of sound infrastructure planning. An ongoing commitment to analysing and addressing community needs and expectations can improve the economic and social outcomes of projects."
>
> *Australian Infrastructure Audit*

Cities have to face the reality of climate change in a number of ways. Firstly the construction of cities has contributed to climate change, by reducing forestation and wetlands. Secondly, cities now serve as amplifiers of climate change through the phenomena of urban heat islands and carbon emissions, which on a large enough scale have the capacity to influence the weather above and near cities. Finally, of course, cities are being impacted by climate change: by drought, bush fires and floods linked to extreme weather events. The size, the function and the built forms of our cities are all factors in this.

It is particularly important therefore, that as cities become wealthier, that they provide attractive high-density living opportunities to ensure that those with the financial capacity to make location and lifestyle choices, have the opportunity to live in attractive compact urban environments. If the only attractive residential opportunities for those with higher incomes are sprawling, low-density communities, particularly distant gated

communities or 'golf course estates', then this will work against sustainable transport. It will also tend to deteriorate urban transport options for those on lower incomes through increasing traffic and congestion and a lower quality public realm (Kenworthy).

A 'Sustainable Urban Mobility Plan' is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. The idea of 'Sustainable Urban Mobility Plans' has gained considerable momentum in recent years. Encouraged by the European Commission, many cities across Europe are working to integrate this concept in their daily transport planning practices.

Sustainable Urban Mobility Plans (Rupprecht Consult 2012) involve a different approach to planning from the more traditional. Above all, the aim is planning for people and the guiding purpose is to help achieve a better quality of life. In some European countries, it is the largest cities that are responsible for rising to the challenge, even though there may exist no national guidance.

Outside Europe, there are cities engaged in planning of their own within a sustainability framework. These include small, medium and larger cities and examples are Barcelona, Bogota, Dublin, Durban, Portland, Singapore, Sydney and Tel Aviv. (See for example National Academy of Sciences 2014, *Pathways to Urban Sustainability: Perspective from Portland and the Pacific Northwest: Summary of a Workshop*.)

Pascal Perez of Wollongong University has developed what he calls the *Factor 8 Conundrum* (Perez 2014). What happens, he asks, if we have to accommodate double the number of people in our cities, with half the resources and the aim of providing twice the liveability? It turns out that this is achievable, at least in theory. But it won't be so, or won't be sustainable, without major behavioural change.

6.6 The democratic deficit

Cities and metropolitan areas, all around the world, experience considerable institutional, regulatory and governance problems when trying to address urban mobility challenges. In many cases national, regional and local institutions may be missing or their responsibilities may be overlapping, and even in conflict with each other. To address such concerns, it is essential that all stakeholders in urban transport—including all levels of government, transport providers and operators, the private sector, and civil society (including transport users)—are engaged in the governance and development of urban mobility systems.

It is generally recognised that State Ministers for Planning should not be involved in the everyday development assessment or decision-making processes that guide infrastructure development and the delivery of urban services. This detachment is necessary to avoid conflict of roles and to safeguard against more egregious governance failures, including corruption, nepotism and ad-hoc, reactive decision making that compromises policy objectives. Arguably, the unhealthy melding of urban development ambition with state political intent has brought planning into conflict and disrepute on a number of occasions (Gleeson *et al*. 2010).

This democratic deficit is revealed, firstly, through compromised decision-making processes, often involving ministerial intervention in what are routine, development control decisions (such as approval of permits for controversial buildings). This increases the politicisation of planning at the state level, and in turn makes local councils and communities more defensive of their local 'turf'.

Local councils can rapidly marshal local resistance should aspects of a metropolitan strategy run counter to local property interests or self-appointed environmental priorities. Local governments have tended to become a very conservative force, frustrating moves for urban consolidation and more sustainable transit-oriented development.

Box 6.2: Developing a vision

Developing a vision of a sustainable city is often the first essential step in planning pathways for transition. Many cities have already introduced such visions[1]. The points below might be generic issues to consider in the case of Australian cities.

- Australia's largest cities will nearly double by 2050. For example, about 7 million people will live in both Sydney and Melbourne.
- Transport oriented development will be a key feature of urban planning, which will be based on nationally agreed principles.
- The future development of the city will be polycentric, spreading the employment opportunities and reducing the pressure on transport networks connecting the city to the CBD.
- There will be greater provision for safe cycling and walking and greater utilisation, in part because of the greater recognition of the health benefits.
- A higher proportion of public will use public transport because of ease of use and affordable cost. Public transport will adopt new technology which provides opportunities to improve efficiency and reduce pressures on the environment, especially greenhouse gas emissions.
- Improved urban design and technology developments will redress the rapid increase in the use of commercial vehicles in Australian urban areas.
- There will be relatively less reliance on self-directed motor vehicles, assisted by more home based work and transport oriented urban development.
- Adoption of new technologies will make self-directed motor vehicles less reliant on carbon-based fuels.
- In particular, there will be a high proportion of electric cars (PEVs) in the urban areas and the infrastructure to support them will be available.
- Information with supporting Information and Communications Technologies (ICT) infrastructure will play a significant role in improving the efficiency of mobility.

1. Examples can be found at <www.un.org/esa/dsd/susdevtopics/sdt_pdfs/shanghaimanual/Chapter%201%20-%20Towards%20a%20harmonious%20city.pdf>, which includes sustainability plan goals for Portland, Oregon, and case studies including *Sustainable Sydney 2030* and *Nairobi Metro 2030*. The important body of work developed by Rupprecht Consult in Europe and recently consolidated at <eltis.org> is summarised in its characteristics at Table 4.1 and as a process at Figure 6.1.

The result can be that the interests of citizens and the wider city are 'lost' between state government politics and policy (say, attempting to implement compact city policies against local wishes) and reactive local governments (say, opposing any development). In response, Gleeson and others argue for a form of cooperative, local representative control over citywide decision-making, described as metropolitan governance.

States and territories do not raise sufficient tax to fund their service provision responsibilities, across health, education and policing, public transport and other essential service domains, and are hence reliant on Commonwealth grants for around half of their income. This makes reliance on state and territory government funding a tenuous basis on which to conduct long-range planning, including for needed major infrastructure works. Further, the Commonwealth's role in specifically financing urban services, including public transport, has varied over time, depending on the policies of the government of the day (Gleeson *et al.*).

Clarity is required as to who will take responsibility for what. Cities can work together to great effect in response to the challenges of urbanisation and climate change. But the scale of change required is such that they will need the support of national governments to be able to

achieve the sort of transformative change that is called for. Government at all tiers will also need to involve the corporate sector. Australia will need to confront the democratic deficit, ensuring that politicians and others who are compromised are not involved in planning decisions.

Informed participation is essential, in a process that provides choices or options for stakeholders to consider during the development phase. The people who will be directly affected by urban planning need a significant chance to reflect on choices, and the inevitable trade-offs that will follow from those choices.

The tension between the planning and participative democracy has been referred to above. Some international examples of bold (and even ultimately successful) urban planning can be found in cities that are notably non-democratic, at least by liberal Western standards. Cities that are now most admired by planners and environmentalists originally evolved under benevolent autocrats. It was Louis-Napoléon Bonaparte, the first President of the French Second Republic (later Emperor Napoléon III) who commissioned Baron Haussmann's renovation of Paris in the mid-nineteenth century, transforming the city from 'an immense workshop of putrefaction' into 'la Ville Lumière' (the City of Light). Vienna's famous 'Ringstrasse' design was implemented in the time of the Austro-Hungarian Empire created by Emperor Franz Joseph I.

In twenty-first century Australia, our property-owning democracy is inherently difficult to plan for. Planners eager for comprehensive urban consolidation express annoyance when local communities resist them, sometimes insisting that the people exercising their democratic rights are misguided. Planning ministers from both political parties regularly override local democracy in the interests of what they see as the larger good. What is called for is the creation of a new planning consensus, such as might be represented by a national framework for urban planning.

> "Design a good street and you design a good city."
>
> Professor Rob Adams
> Director of City Design
> City of Melbourne

6.7 Conclusion

> "Good public transport requires a capable public sector. The debate about the relative efficiency of public and private agents in the production of public transport has been an irrelevant distraction. Regardless of organizational form, the key to success in creating effective urban mobility systems is always a capable public governing authority operating in a transparent manner."
>
> UN-Habitat

Australian cities face immense challenges in meeting the demands placed upon them by rapid population growth in the context of global economic ruptures and environmental stress. Australia's urban managers will need to act decisively to relieve the pressures and resolve the paradoxes that will flow from these forces. There are manifold technical solutions available to support the reshaping and restructuring of our cities. These tools and strategies will not, however, produce solutions to urban problems in the absence of sound and decisive governance arrangements. Good governance must guide and enact the planning of safe urban trajectories. Our present urban governance mechanisms are deeply compromised and under resourced and therefore cannot play this role. Cities are a lynchpin of the emerging national reform agenda. This program must include reconsideration of city governance (Gleeson *et al*.).

Aromar Revi (Revi 2014) speaks of the tensions between national, regional and local governments as one of the global dichotomies that require resolution. It's a train of thought that might lead us to ask: where does the power reside now and into the future to bring about transformative change? If international agreements are impossible and national policies fail us, can we devolve the power, so as to respond to climate change and develop sustainable plans at a more local level instead?

The evidence suggests promoting (particularly high-tech) agglomeration economies or innovation districts with appropriate public transport capacity; supporting precinct scale urban renewal, with good radial and

circumferential accessibility; improving access for outer urban residents to areas of employment concentration; supporting freight and logistics movements through key trunk demand corridors and major freight hubs; supporting strong and sustainable neighbourhood communities; and providing informed choices for people to consider during the planning process.

The approaches that follow are closely based on the work of John Stanley and Peter Brain (Stanley & Brain 2014).

From an economic viewpoint, improving the sustainability of our urban transport/mobility systems is essentially about pursuing four main policy directions:

1. **Supporting the clustering of economic activities** in a select number of inner and middle urban high tech nodes or innovation clusters, to promote productivity growth and a wider sharing of the benefits of this productivity growth. It has been shown that an accelerated infrastructure investment program can lift the rate of productivity growth and, if well targeted, can be self-funding in terms of government revenue gains. The idea of clustering also extends to how we plan neighbourhoods, where clustering is likely to support some local job growth.
2. **Changing the modal balance for transport of people and goods** away from such a high dependence on motor vehicles and more towards methods of transport with less adverse impact on the triple bottom line. This will reduce a number of external costs of urban travel.
3. **Improving the environmental performance of all transport modes** but particularly of cars and trucks, because of their dominant roles. In this domain, Stanley and Brain have suggested a need for new cars, in particular, to be essentially GHG emission-free by about 2035, with trucks well down the same path by that time. An end-state goal related to absolute transport GHG emissions at 2050 has been suggested, based on cuts of about 80 per cent on 2000 levels by 2050.
4. **Ensuring that travel opportunities (and, by implication, the associated activities they support) are available to all, irrespective of personal circumstances**. This will help to better meet human needs for all urban dwellers. The implementation of minimum public transport service levels as an effective way to meet this goal area, supported by improving walking and cycling opportunities across each city. Improving access from outer urban areas to clusters of high tech employment in inner and middle suburbs is also an important way of enhancing social inclusion.

The four urban transport policy objectives can be translated into **five major action areas**, with indicative actions of the type shown below:

1. Support development of compact, mixed-use polycentric cities (reducing the requirement to travel to accomplish any given range of activities and promoting productivity growth)
    i. Land use planning for more compact cities, focusing on building strong CBDs and a small number of high-end knowledge-based hubs; increased density across the whole city; more mixed-use planning; better jobs/housing balance; development of '20 minute neighbourhoods' from which people can undertake most of the activities needed for a good life within 20 minutes by foot, bicycle or public transport. Melbourne's new long term land use plan, Plan Melbourne, has promoted this model; planning for 'last-mile' freight access).
    ii. Transport planning to promote clustering and the strengthening of neighbourhoods, in support of the 20 minute city, with protection from heavy vehicle intrusion.
2. Promote a mode shift to low carbon transport modes
    i. From cars to public transport, walking and cycling (e.g., road pricing; PT service improvements; comprehensively designing active transport opportunities into cities, at regional and local levels).

ii. From trucks to rail for freight (e.g. road pricing, development of inland freight hubs).

3. Improve vehicle utilisation
   i. Higher car occupancy rates (e.g. priority to, and policing of, high occupancy lanes on freeways and major arterials).
   ii. More efficient freight movements (e.g., freight-only roads; accelerated vehicle performance-based standards innovation for productivity).
4. Reduce vehicle emissions intensity (esp. with respect to GHG emissions and air toxics)
   i. More efficient vehicles (mandatory GHG, air and noise emission standards).
   ii. Smaller passenger vehicles (e.g. pricing reforms).
   iii. Alternative fuels.
   iv. Intelligent transport systems.
   v. Better driving practices.
5. Increase mobility opportunities, especially for people at risk of transport-related social exclusion
   i. Provision of reasonable base public transport service levels.
   ii. Urban design to increase opportunities for active travel.

The broad policy directions outlined above are relevant to all Australian large cities. In terms of application, it is possible to highlight **five issues** that seem likely to be important for successful development and implementation through integrated land use transport strategies:

1. The central area is very important for a productive city and its growth should be supported. However, the CBD does not account for most jobs or residences in any capital city. Its needs should not dominate those of the rest of the city.
2. Structural economic changes are increasing the importance of the central city but also of parts of the 'forgotten middle suburbs', as places for future employment growth, population growth and urban renewal. Accessibility improvement is critical in enabling these middle suburban areas to play a greater role. This improvement is mainly about systemic and programmatic changes in arterial roads and bus services, particularly for movement around the city (not just radially), and for walking and cycling to support more compact urban form. Improving access from outer urban areas to the job-rich middle suburbs is also important.
3. A strategic approach to land use transport integration should look both regionally and locally, at the way a neighbourhood functions. It is unusual to see both done in strategic land use/transport studies (which tend to be top down) but very important in terms of citizens' wellbeing. Future land use transport planning should devote more attention to the local level.
4. Long term integrated land use transport strategies should be intimately linked to (integrated with) short to medium term (5-10 year) implementation plans, that specify the particular project initiatives intended to be to be undertaken, financing/funding plans and governance arrangements for delivery.
5. In preparing both long term and short to medium term strategies/plans/actions, community engagement should be seen as both a right of communities and a practical way of improving content and prospects for implementation.

Applying the policy directions and action areas outlined above to land use development in Australian capital cities, and taking account of the preceding five points, suggests that priority should be accorded to:

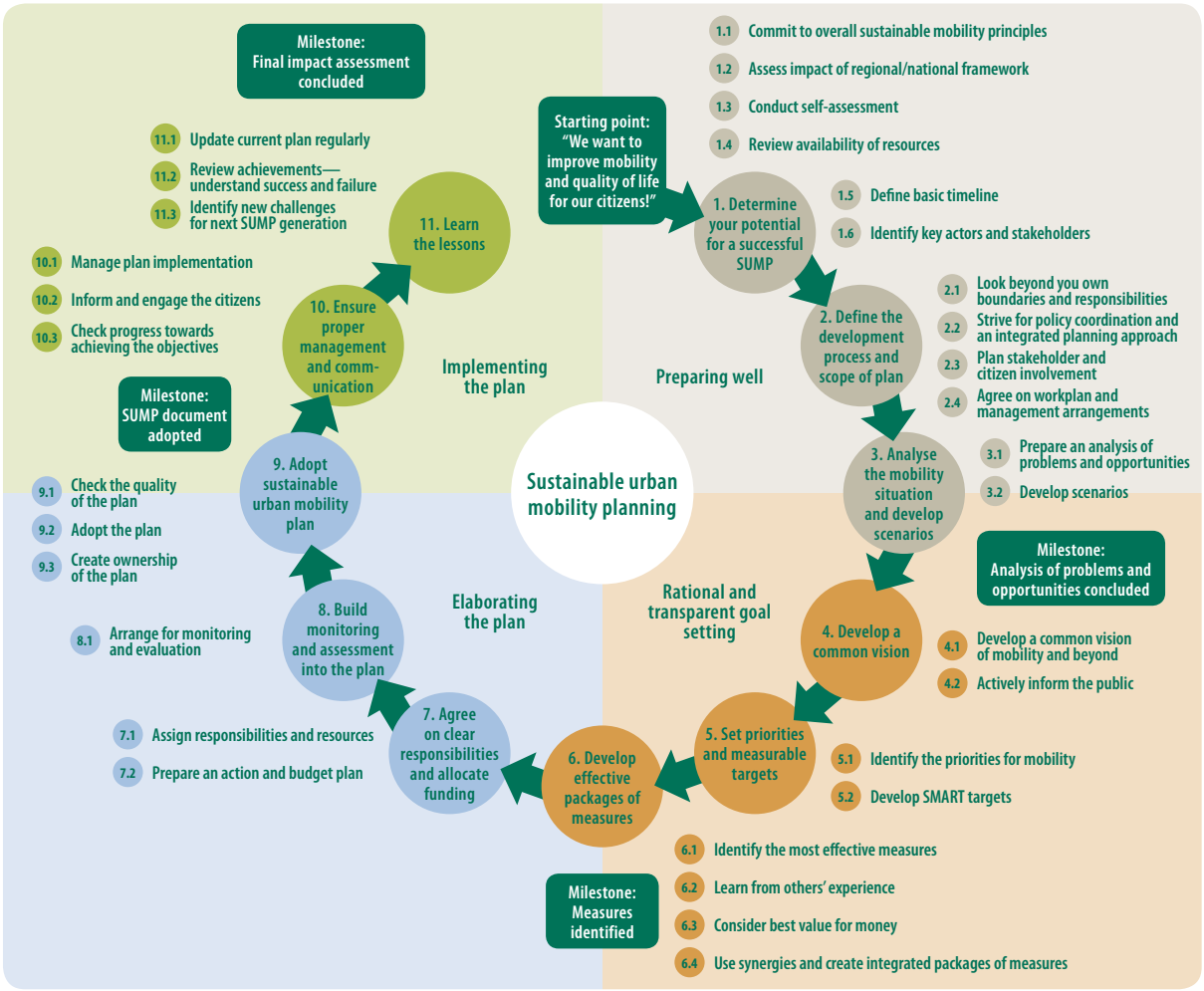
1. Promoting agglomeration economies in the CBD/inner city and in a small number of selected mixed-use, knowledge-based suburban hubs, due to the productivity benefits associated therewith (e.g., Parramatta in Sydney and the Monash precinct in Melbourne). There is a case for about one high tech node per million people living in

a city (this needs further research). Radial road capacity can never hope to adequately serve more than a minor part travel demands to high density nodes efficiently and effectively, particularly for CBDs. In transport terms, then, a strong CBD and surrounds is primarily about ensuring that adequate trunk public transport capacity is available to facilitate growth. Public transport (PT) is crucial to strong suburban knowledge-hubs. With CBDs and key suburban knowledge hubs accounting for a significant portion of national GDP, all governments have a strong interest in supporting transport initiatives that facilitate further development in such precincts, including public transport

2. Supporting precinct scale urban renewal more broadly, including unlocking capacity in the most accessible parts of the middle suburbs (e.g., transit-oriented development), especially where these areas are relatively job-rich. This implies a need for good radial and circumferential accessibility, including by public transport. The latter, in turn, requires high quality road capacity to support circumferential movement of cars, road-based public transport, with on-road PT priority where possible, and freight movement, in and through middle suburban areas (crossing and supporting trunk radial rail lines and linking activity centres). High frequency trunk PT services should be provided along these circumferential corridors and good quality opportunities for walking/cycling should be provided within and to/from activity centres

3. Improving accessibility for outer urban residents, particularly those living in growth corridors to areas of employment concentration. For person movement, this means providing adequate arterial road

Figure 6.1: The sustainable urban mobility planning cycle



Source: RupprechtConsult.

capacity and high quality trunk PT services between outer suburbs and the most proximate employment hubs in the local vicinity and middle suburbs, where jobs are more readily available

4. Supporting freight and logistics movements, tourism and other trade-exposed businesses, through a focus on key trunk demand corridors and major freight hubs (e.g., ports, airports, manufacturing/logistics hubs)
5. Supporting strong and sustainable neighbourhoods/communities, which requires an emphasis on providing local PT services, walking and cycling, connecting with trunk services, at a frequency that will help to facilitate social inclusion. The NIEIR analysis also identified the important role of social/cultural and community infrastructure in attracting talent, underlining the importance of taking a broad approach to integrated policy and planning for outcome achievement (at both regional and local levels)
6. Ensuring that the land use transport plan development process provides choices or options for people to consider during the plan development process. When availability of funding is scarce, it is important that people have the opportunity to reflect on choices, and the associated trade-offs that will follow from those choices, when they consider their preferences for overall strategies/plans or elements.

6.8 Key findings

- **Community consultation and active local involvement is essential**
  Engaging communities widely in development and delivery of land use/transport plans and policies is an essential ingredient in social sustainability. In modern liberal democracies a measure of consultation is regarded as a right. A far-sighted, transparent planning process that entails extensive consultation builds individual and community trust.
- **Successful sustainable urban planning often includes action at the metropolitan level**
  Cities that are successfully confronting sustainability challenges often demonstrate a form of cooperative, local representative control over citywide or regional decision-making, described as 'metropolitan governance'. The Port Authority of New York and New Jersey; the Brisbane metropolitan area; the metropolitan region of Nice; the Tennessee Valley Authority and the Greater Toronto Area are diverse examples.
- **A national framework for urban planning ensures that infrastructure investments are maximised**
  There is a growing consensus that broad-scale, multimodal, high-level planning systems are needed (*State of Australian Cities* 2014–15). Integrated planning outcomes will recognise that different parts of the city have different transport tasks and different infrastructure needs. A national approach to planning and managing cities will provide a framework within which cities, regions, metropolitan areas and local governments can develop responses to sustainable mobility challenges in forms appropriate to particular local communities.

The fundamental goal of sustainable urban mobility planning is to maximise the economic, environmental and social benefit-cost ratio for citizens and businesses.

Appendix 1
The 'rules of economic development' in Melbourne and Sydney

1

Macro rule

There is increasing inequity in regional economic performance, with fringe areas at an increasing disadvantage. That is, without strong policy intervention increasing inequality is expected, with the general rule being the greater the distance a sub-region is from the central LGA (of the City of Melbourne or Sydney), the greater the increase in inequality.

Empirical tests

Assessment of the changes in resident gross regional product per capita and access to hours of employment and productivity in terms of $/hour of gross product. Figures 2.2(a)(b) show that the greater the distance from the central LGA the less the growth in per capita household real incomes and, therefore, declining access to high productivity employment and, in some cases, declining access to hours of work. Figs 2.3(a)(b) show that the productivity gap has been widening between inner and outer areas over the last 20 years.

Context

The empirical validity of this rule is essential to justify the regional development policies. If this rule was not empirically valid, overall planning outcomes would be independent of where resources were distributed across the regions. For example, this would be the case if residents of all regions could reach all others within a reasonable travel time budget.

Figure 2.2(a): Sydney: Local GRP (residents) at factor cost per working age population, deviation in per cent of mean from 1992 to 2012

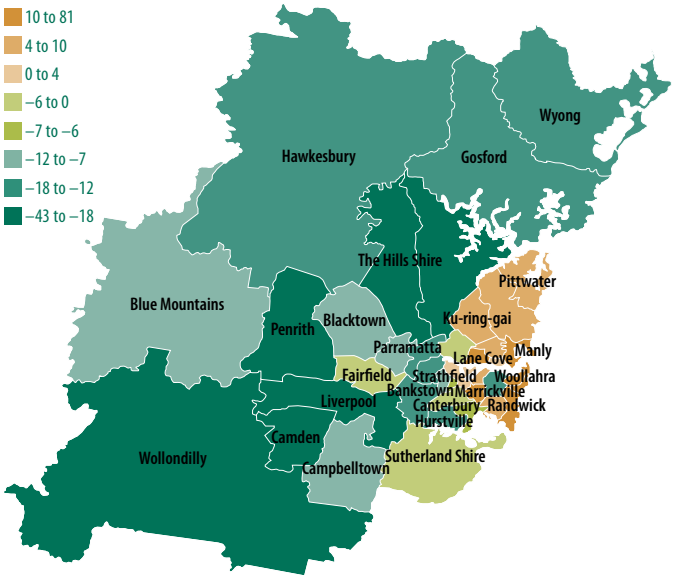


Figure 2.2(b): Melbourne: Local GRP (residents) at factor cost per working age population, deviation in per cent of mean from 1992 to 2012

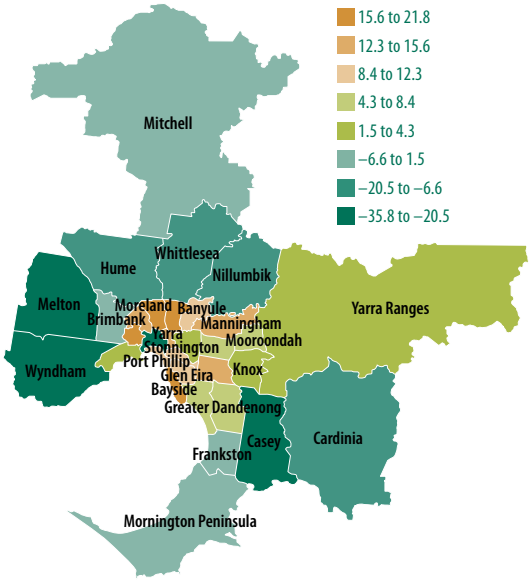


Figure 2.3(a): Sydney: Change in deviation about the mean 1992 to 2012 for headline GRP per hour worked

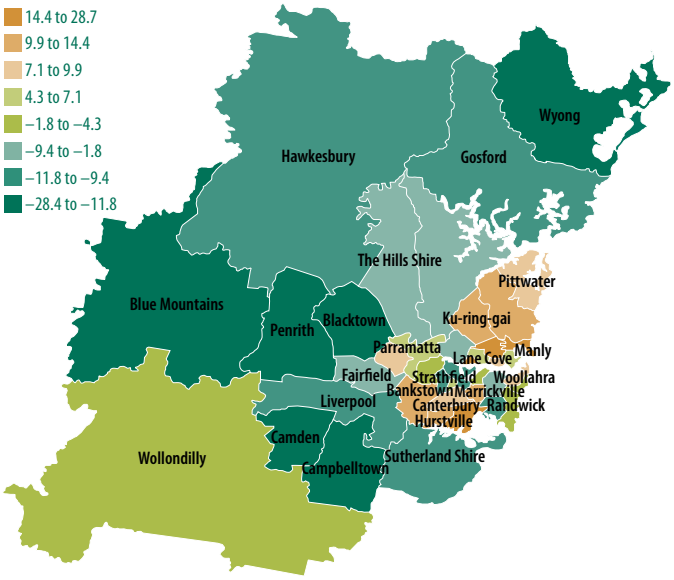
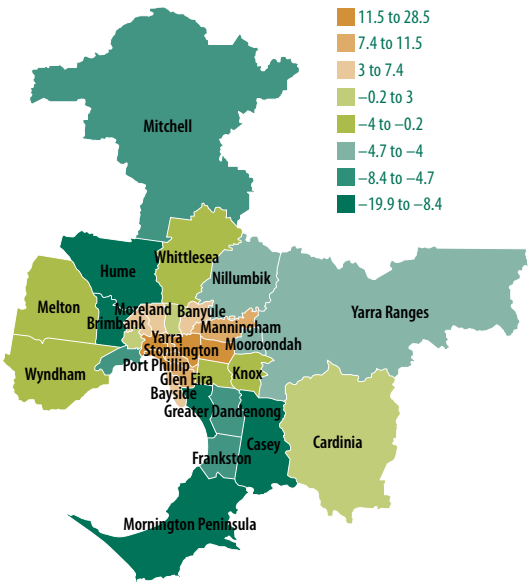


Figure 2.3(b): Melbourne: Change in deviation about the mean 1992 to 2012 for headline GRP per hour worked



2

Macro rule

The greater the level of economic activity located within a region's catchment, the greater the economic benefit to residents within the catchment. That is, the level of income received by a region's households from work is determined by the level of economic activity generated in the region's catchment, as determined by acceptable travel times.

Empirical tests

The relationship between industry economic activity and resident economic activity. If the two are highly correlated the rule is validated.

Figure sets 2.4 show the correlation holds.

Context

If this rule is not empirically valid, there would be no point in attempting to allocate investment to specific regions since this would be ineffective in stimulating economic activity in the targeted regions. That is, there should be a strong policy focus on equalising employment opportunities and access to quality employment opportunities across labour market catchments of a metropolitan area.

If resident employment is deficient in a given sub-region, then the solution is to either increase employment opportunities within the catchment of the LGA or alternatively widen the catchment size by reducing travel time.

Figure 2.4(a): Sydney: Headline GRP versus resident GRP—Catchment analysis

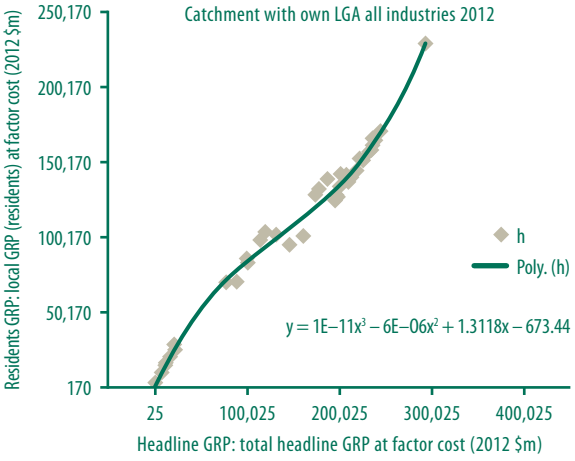
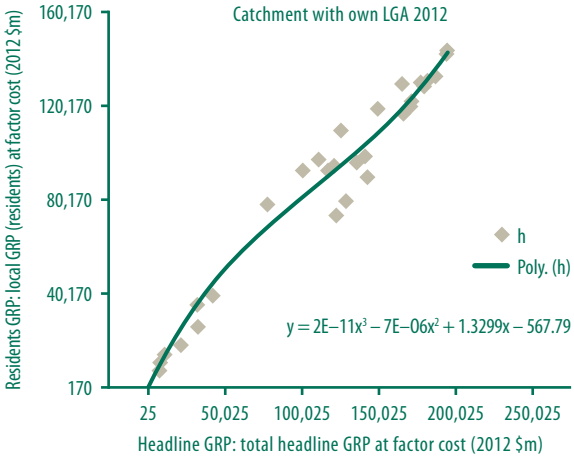


Figure 2.4(b): Melbourne: Headline GRP versus resident GRP—Catchment analysis



3

Macro rule

Cumulative regional investment, that is, the capital stock per capita installed in a region, is a core fundamental factor that that determines the level of economic activity.

Empirical tests

Calculate the correlation between regional capital stock installed and regional economic activity.

Figure 2.5 clearly shows the strong relationship between construction capital stock installed in a catchment and catchment level of economic activity. The relationship approach is a one-to-one relationship. That is, a dollar increase in capital stock generates a similar annual increase in economic activity. The incremental output-capital ratio would fall to between 0.6 and 0.8 if equipment capital stock is allowed for.

Context

The empirical validity of this rule indicates the high effectiveness of planning instruments and, therefore, planning. An important planning instrument is to allocate public sector capital directly to regions, using this to influence private sector investment decisions.

Figure 2.5(a): Sydney: Capital stock versus economic activity, 2012—Catchment outcomes on both axes

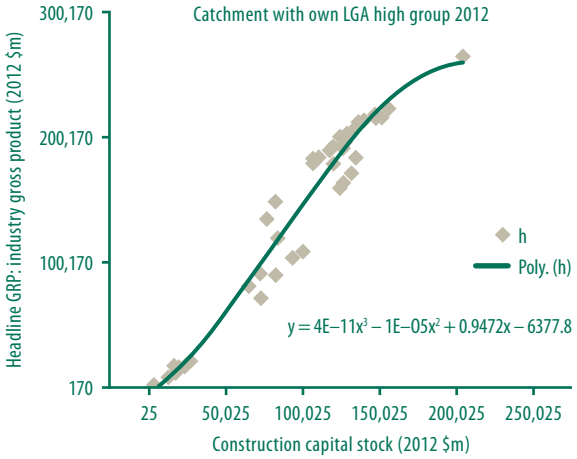
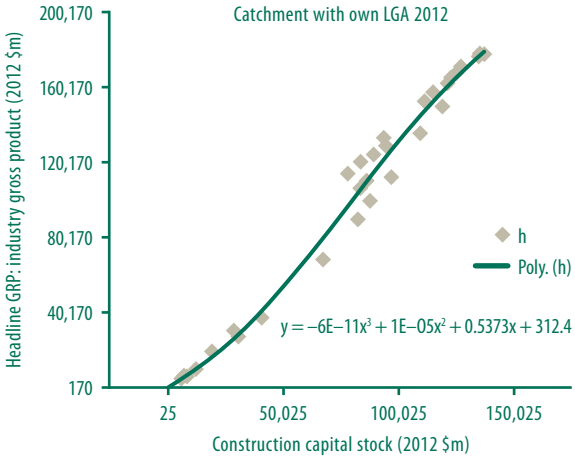


Figure 2.5(b): Melbourne: Headline GRP versus resident GRP—Catchment analysis



4

Macro rule

Increased scale of the Metropolitan Area will increase the opportunities to increase overall productivity.

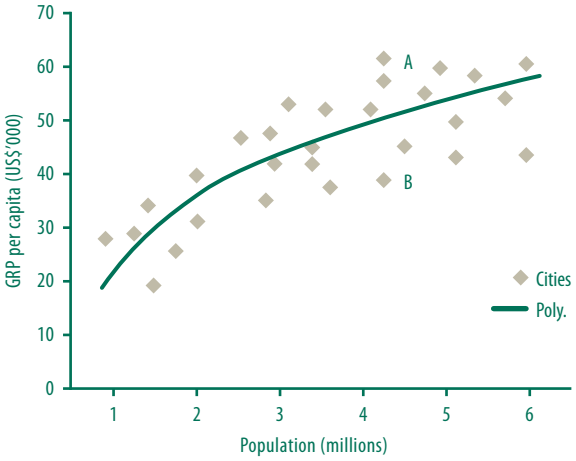
Empirical tests

The empirical relationship between metropolitan-wide productivity and scale compared to other cities, shown in Figure 2.6 for international cities and Figure 2.7 for Australian cities, indicates a strong relationship. That is, economies of scale and scope are strong as city size increases.

Context

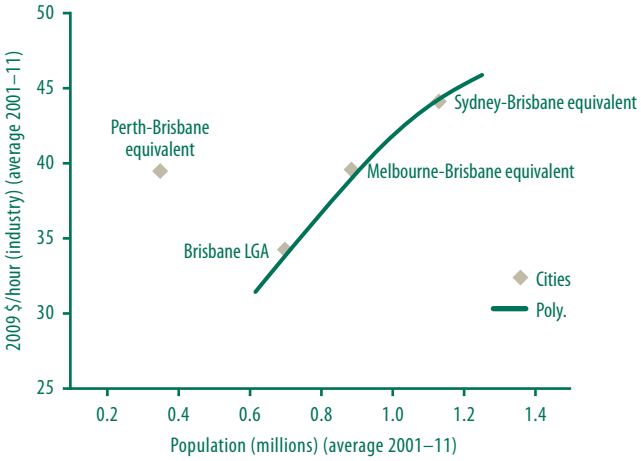
This rule is for reference as a reminder that, once economic activity is established, it will only be sustained if the competitiveness of the region, compared to the rest of the world, is sustained.

Figure 2.6: The relationship between city scale and productivity



Source: Adopted from Figure A.3.1 in OECD "*Competitive in the Global Economy*", 2007, p. 277 using the cluster of the Developed Country Cities.

Figure 2.7: The relationship between region size and productivity is as relevant for Australia as it is for the world for non-resource based cities



5

Macro rule

If the metropolitan area of a major city is to maximise the increase in its productivity, the scale of the central region will have to increase, at the very least proportionally to the overall increase in Metropolitan scale.

Empirical tests

From Figure sets 2.8 and 2.9 the Central City LGAs have the highest productivity, as generally do the LGAs closer to the Central City LGA. Also, the Central City region in both cities is by far the most important in generating export activity, the core proximate driver of growth.

Context

The importance of this rule is for plan design. If the rule is valid, mechanisms in the plan design to allocate economic activity closer to the fringe regions must not undermine the growth in the central region. This is necessary if the metropolitan area as a whole is to maximise its economic performance. The impact of this on plan design would be via the establishment of a minimum threshold level of central region contribution to metropolitan activity. Above this threshold level any further increases in the central region's share may well be at the cost of metropolis-wide economic performance.

Figure 2.8(a): Sydney: Productivity versus travel time to Central Sydney in minutes—Individual LGA—2012

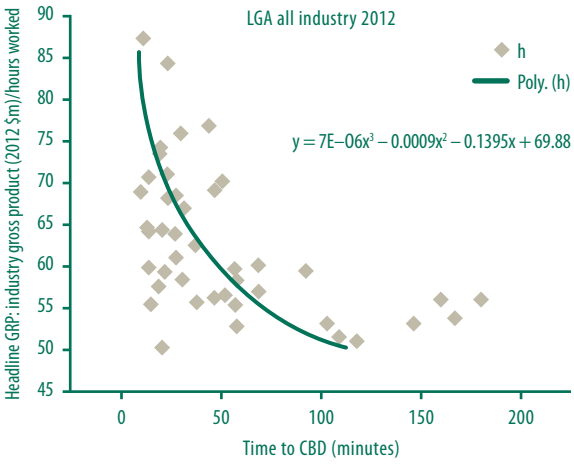


Figure 2.8(b): Melbourne: Productivity versus travel time to Central Melbourne in minutes—Individual LGA

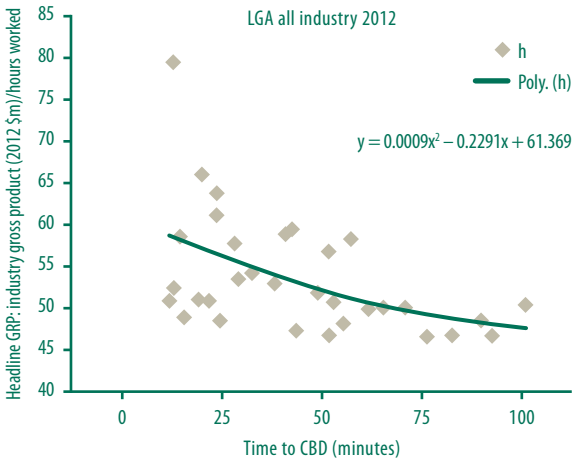


Figure 2.9(a): Sydney: High technology productivity versus travel time to Central Sydney in minutes—Individual LGA—2012

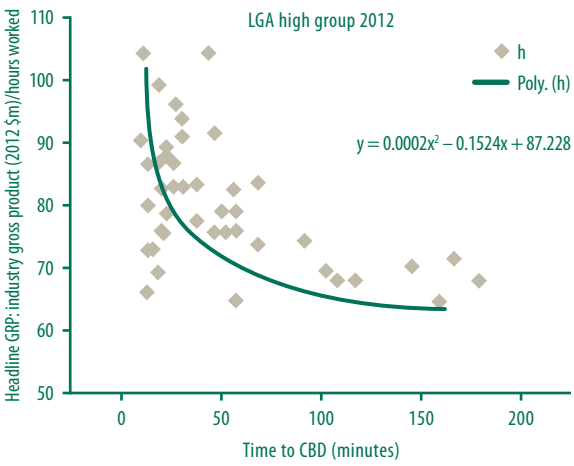
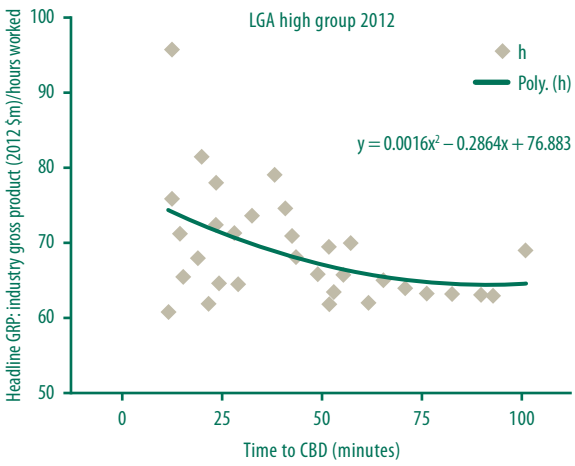


Figure 2.9(b): Melbourne: High technology productivity versus travel time to Central Melbourne in minutes — Individual LGA—2012



6

Macro rule

The capacity to export out of a region is the core proximate driver of economic activity.

Empirical tests

The correlation between exports and economic activity.

This is clearly demonstrated by Figure sets 2.10. The strong relationship also holds even when the Central City regions are excluded (chart not included).

Context

The validity of this rule is important to the legitimacy of the planning philosophy. If it was not valid, then local demand formation, not planning strategies, would be the main mechanism of determining regional development.

Figure 2.10(a): Sydney: Region's export share versus gross product share (per cent)—2012

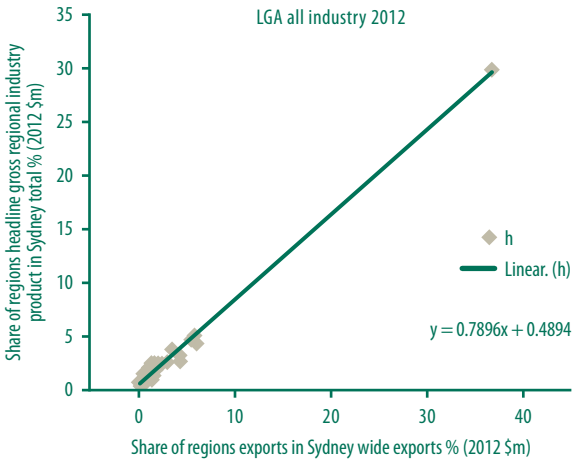
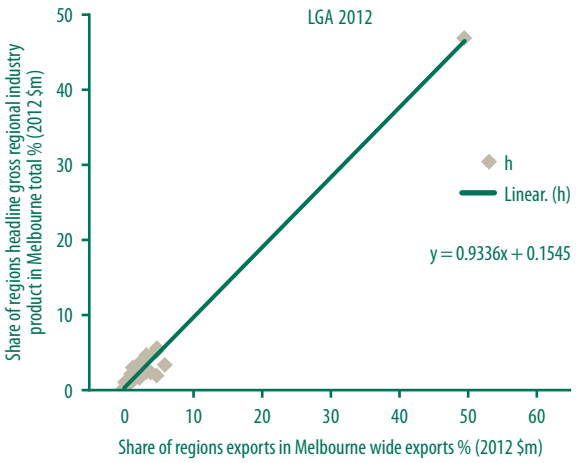


Figure 2.10(b): Melbourne: Region's export share versus gross product share (per cent)—2012



7

Macro rule

The skills of households within each region's catchment is a core driver of the region's economic performance.

Empirical tests

The relationship between the regional concentration of high skilled households and economic performance.

As Figures 2.11 demonstrate, compared to Figures 2.12, the relationship is particularly strong for high technology industry activity.

Context

Improving economic outcomes for residents in part requires increasing the skilled household share. If this rule was not valid, then, like Rule 1, the strategy could be relatively ineffective in channelling enhanced economic activity in each region into resident benefits. More importantly, if skilled residents are not willing to move into the labour market catchments of developing high technology clusters it will be difficult to exploit economies of scale and scope to improve living standards.

Figure 2.11(a): Sydney: Regional resident economic performance and skills within catchment

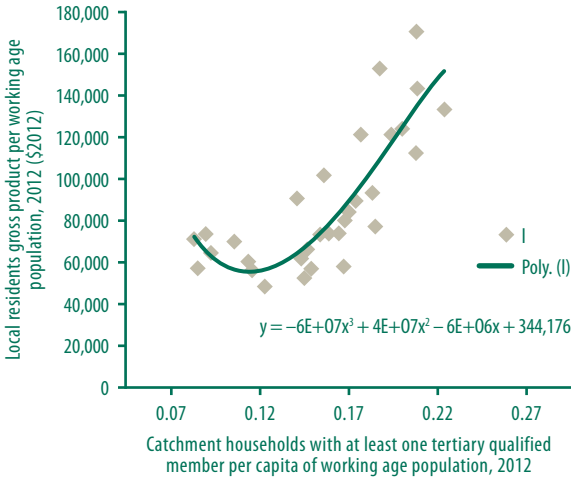


Figure 2.11(b): Melbourne: Regional resident economic performance and skills within catchment

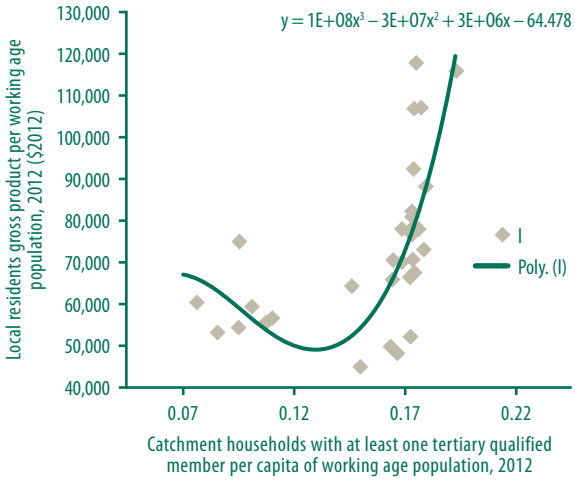


Figure 2.12(a): Sydney: Catchment skilled household availability versus high technology industry activity

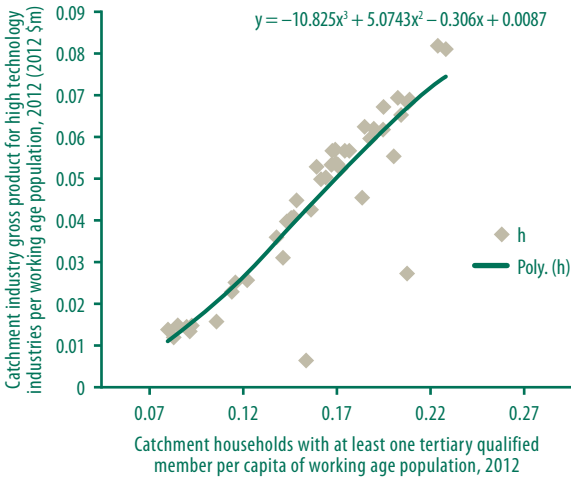
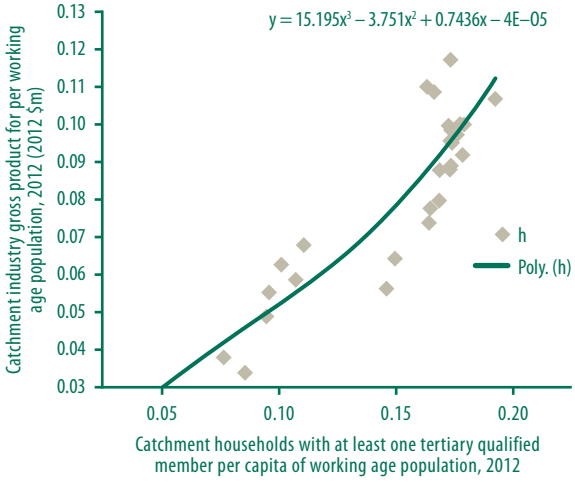


Figure 2.12(b): Melbourne: Catchment skilled household availability versus high technology industry activity



8

Macro rule

Different industry types have different multipliers (or flow-on impacts) for expansion. Here the rule is, high-technology industries have the largest multipliers and therefore the greater the concentration of high-technology industry in a region the better the relative economic performance.

Empirical tests

The relationship between the economic performance of a region and high-technology industry concentration.

Figures 2.13 show that if high income employment is to be accessed the residents must have strong access to high technology industry employment. Over the 1992 to 2012 period, there is a reasonably strong relationship between the high technology industry employment share in the change in hours of work (chart not shown).

Context

If high-technology industry concentration was not associated with superior regional economic performance there would be no point in targeting high-technology industry to improve economic performance.

Figure 2.13(a): Sydney: Local gross resident product versus high technology employment share—2012

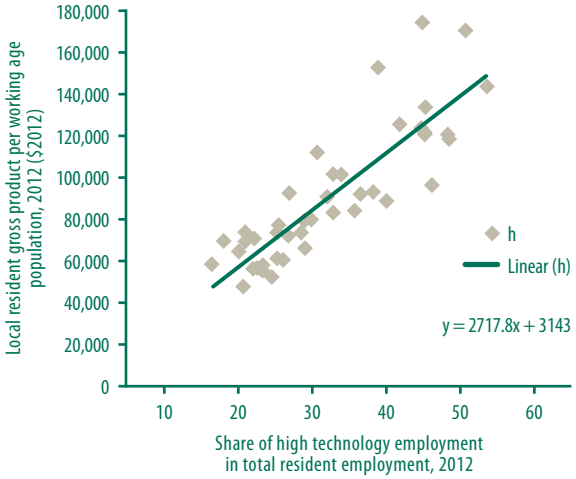
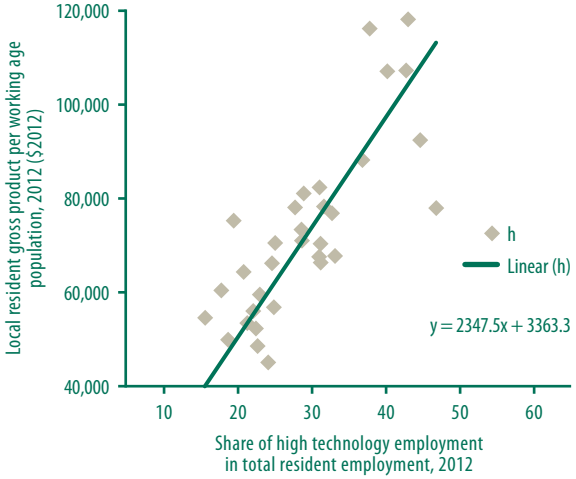


Figure 2.13(b): Melbourne: Local gross resident product versus high technology employment share—2012



9

Macro rule

High-technology industries require the concentration of high-skilled households within their labour market catchments.

Empirical tests

The relationship between household skills available within a labour market catchment of a region and the concentration of high technology industry.

This is indicated by the strong empirical relationship as shown in Figures 2.14.

Context

This rule is complementary to Rule 7. If Rule 7 is valid, then the validity of Rule 9 would indicate that the mechanism to improve the concentration of skilled households in a region is to encourage high-technology industry activity within the labour market catchment.

Figure 2.14(a): Sydney: Catchment skilled household availability versus high technology industry activity

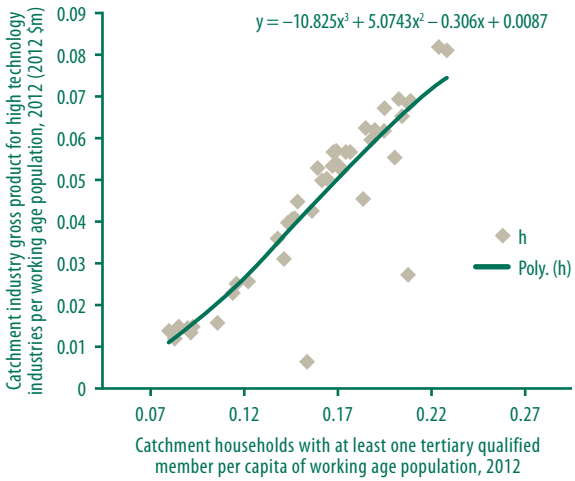
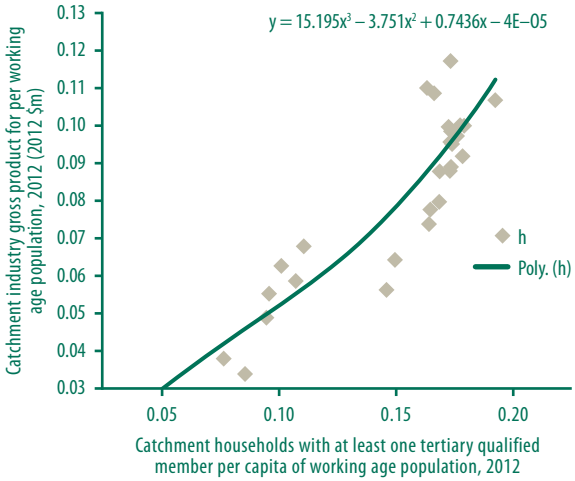


Figure 2.14(b): Melbourne: Catchment skilled household availability versus high technology industry activity



10

Macro rule

The main reason why high-technology industries have high multipliers is the importance of scale and scope to productivity in these industries and hence profitability and the capacity to expand. Therefore, the rule is the greater the scale of high technology industries the greater will be the productivity.

Empirical tests

The relationship between high-technology scale in a region and its productivity.

The positive relationship between productivity in scale is particularly strong for high technology industries as Figures 2.15 indicate. It is also strong for all industries (chart not shown).

Context

Rule 10 complements Rule 8. The validity of Rule 8 would help to establish that high technology industries have relatively high multipliers. The validity of Rule 10 would reinforce evidence that this is the case by establishing a link between the expansion of high-technology industry and increases in the productivity and profitability of other, and in particular high technology, enterprises within the region and surrounding regions.

Figure 2.15(a): Sydney: Productivity versus scale, 2012, high technology industries—Catchment on both axes

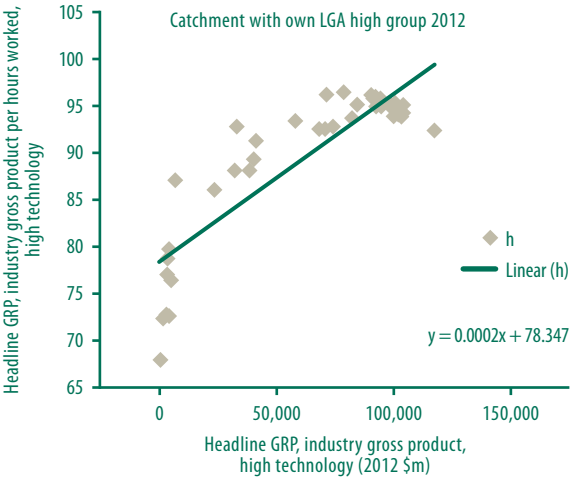
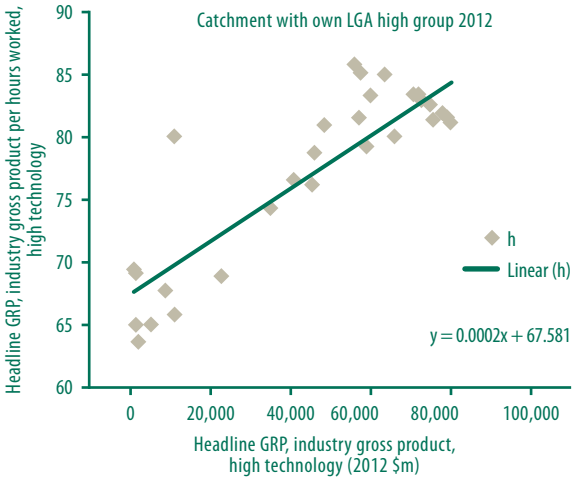


Figure 2.15(b): Melbourne: Productivity versus scale, 2012, high technology industries—Catchment on both axes



11

Macro rule

High-technology industries need to cluster in and between regions. Hence, the rule is that the share of high-technology industry in a region's economic activity diminishes with distance from the central activity areas of Australia's major metropolitan areas.

Empirical tests

The relationship between the distance of a region from the central activity area of major metropolitan regions such as Sydney and Melbourne and industry productivity.

Figures 2.8 and 2.9 above showed that this is strong for both all industries and high technology industries. The closer to the central region the higher the productivity.

Context

The comments to Rule 10 apply. If economies of scale and scope were not important in high-technology production the multiplier associated with these industries would be similar to low and medium technology industry clusters and there would be no argument against forcing high-technology industries to be distributed fairly equally across the metropolis.

The empirical validity of the rule is also important in justifying a central premise of the Discussion Paper that an important, and perhaps difficult, task of developing the Plan is to ensure that decentralising high-technology industry further from central regions should be encouraged and resourced in a way that does not undermine the benefits from the continued development of existing high-technology industry clusters.

12

Macro rule

High technology industries require sustained innovation to be competitive. High-technology industries will prefer to locate where there is strong knowledge-creation infrastructure within a region's catchment.

Empirical tests

The correlation between high-technology industry concentration and the availability of tertiary education, advanced health and advanced business services. This strong correlation is evidenced by Figure set 2.16.

Context

Rule 12 is important for the application of policy instruments. The location of supporting knowledge creation infrastructure involves resource allocation decisions which are under the direct control of the public sector.

Given the validity of Rule 12, resource allocation decisions for knowledge-creation infrastructure (e.g., where universities, hospitals, research institutions are placed and their rate of expansion) can help facilitate the concentration of high technology industry activity within a region and therefore determine which regions will have superior economic performance outcomes.

Figure 2.16(a): Sydney: High technology industry activity versus knowledge creation industry capacity, 2012

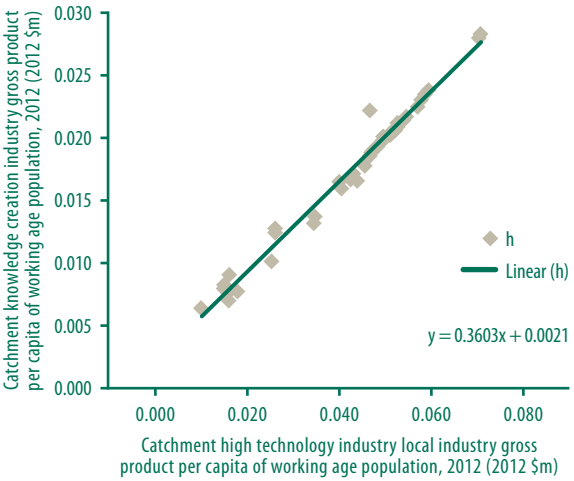
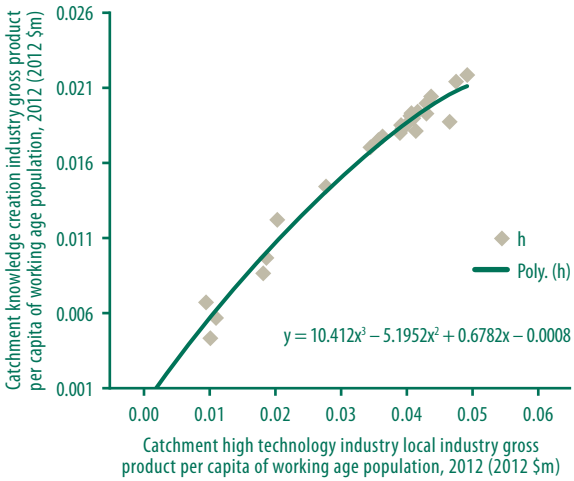


Figure 2.16(b): Melbourne: High technology industry activity versus knowledge creation industry capacity, 2012



13

Macro rule

Skilled households locate in regions where strong cultural and community infrastructure is available within the region's catchment. The thesis is that high-technology industry has to locate within the catchment of where high-skilled households want to reside.

Empirical tests

The correlation between community and cultural infrastructure services and the regional concentration of skilled households. This strong correlation is evidenced by Figure set 2.17.

Context

If Rule 13 is valid, it indicates that the instruments of Plan implementation, to the extent that they influence the distribution of community (health, education) and cultural (entertainment, recreation) infrastructure services, can also influence the location and scale of high-technology industries. The rule relates to the effectiveness of the Plan and the ability of Plan implementation to impact on a Planning Area's economic performance.

Figure 2.17(a): Sydney: Skilled household availability versus community and cultural service availability

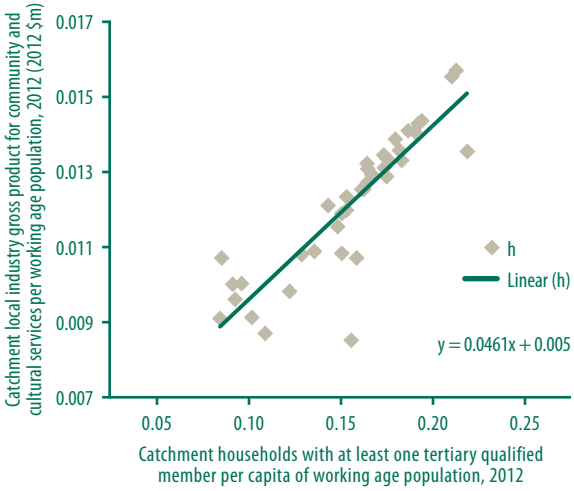
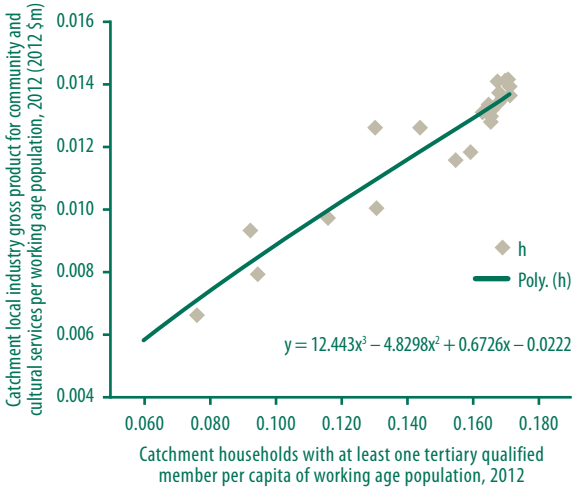


Figure 2.17(b): Melbourne: Skilled household availability versus community and cultural service availability



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Evidence gathering

The project began with a rigorous scoping process, chaired by Professor Peter McPhee, which identified the principal research questions. An Expert Working Group was established under the chairmanship of Dr Bruce Godfrey. The EWG commissioned three initial consultant reports, in the fields of technology, social studies and public health and safety. These reports were written by David Singleton and Brendan Pender (technology); John Stone and Elizabeth Taylor, supported by Andrew Cole and Yvonne Kirk (social studies); and Billie Giles-Corti and Serryn Eagleson (public health and safety). The EWG then commissioned John Stanley and Peter Brain to produce an economic perspectives report and finally asked David Singleton to expand the initial technology report to include aviation and road freight.

A synthesis of the four consultant reports was produced by the Secretariat and made available to invitees at a sector workshop held at Deakin University, Melbourne. The principal consultants presented their views on the various paths to sustainable urban mobility. The consultants' findings were debated by 38 participants from local, State and Federal government, universities, Learned Academies and the planning sector. The workshop deliberations were meticulously captured by Cathy Alexander. The results of the workshop were discussed by the EWG, with a view to beginning to develop a synthesis of findings. The Secretariat then produced a first draft project report, for further discussion within the EWG. The first draft report was also significantly informed by the 2013 UN-Habitat global report; the regular publications of the European Platform on Sustainable Urban Mobility Plans; and other international sources.

The first final draft project report was tabled for discussion by the Program Steering Committee, chaired by Professor Michael Barber. After further refinement, the project report was submitted for peer review.

Expert Working Group

Dr Bruce Godfrey FTSE (Chair)

Dr Bruce Godfrey has built his career in business, innovation investment, government and technology development fields. His current role is as CEO of Australian Scientific Instruments Pty Ltd, an Australian National University-owned instruments manufacturing company. He has focused on the advancement and commercialisation of technologies (particularly new energy technologies); investment readiness of products and companies; and innovation policy and programs. He has served on a number of AusIndustry and other government agency innovation funding and advisory committees, including as Chair of ARENA's Advisory Panel until mid 2014. He is Chair of ATSE's Energy Forum.

Professor Bruce Armstrong AM

FAA FRACP FAFPHM

Professor Bruce Armstrong is an Emeritus Professor in the University of Sydney and a senior adviser at the Sax Institute, Sydney. He has held senior positions in State and Commonwealth Governments, including Commissioner of Health in the Health Department of Western Australia and Director of the Australian Institute of Health and Welfare; and in the Australian tertiary education sector, including Head of the University of Sydney's School of Public Health. For a period he was Deputy Director of the World Health Organization's International Agency for Research on Cancer in Lyon, France. Professor Armstrong was made a Member of the Order of Australia in 1998 for his services to medicine through research in cancer epidemiology.

Professor Graeme Davison AO

FAHA FASSA

Professor Graeme Davison is Emeritus Sir John Monash Distinguished Professor of History at Monash University. He was educated at the University of Melbourne and Oxford University where he was a Victorian Rhodes Scholar. He has held academic appointments at the University of Melbourne and Monash University, and visiting appointments at Edinburgh, Harvard, ANU, Tübingen and King's College London. He has written widely on the history of Australia, especially on Australian cities, where his books include *The Rise and Fall of Marvellous Melbourne* (1978 and 2004), *The Unforgiving Minute* (1994), *The Use and Abuse of Australian History* (2000), *Car Wars: How the Car Won Our Hearts and Changed Our Cities* (2004) and *Trendyville: The Battle for Australia's Inner Cities* (2015). He has advised or served on the boards of several public bodies, including the Heritage Council of Victoria, the National Museum of Australia, the National Archives of Australia and the State Library of Victoria. His next book, *The City Dreamers: The Urban Imagination in Australia*, will appear in 2016.

Professor Brendan Gleeson FASSA

Professor Brendan Gleeson is the Director of the Melbourne Sustainable Society Institute, at the University of Melbourne. He joined Melbourne University in January 2012 as Professor of Urban Policy Studies and then took on the directorship of the Melbourne Sustainable Society Institute in early 2013. Professor Gleeson came from the position of Deputy Director of the National University of Ireland's National Institute for Regional and Spatial Analysis. Prior to that he set up the Urban Research Program at Griffith University and was its inaugural Director. Professor Gleeson has made significant scholarly contributions in urban and social policy, environmental theory and policy and is a regular commentator in newspapers, television and radio. He has qualifications in geography and urban planning, including a masters degree from the University of Southern California and a PhD from the University of Melbourne. He is the author or editor of thirteen books, three of which have won national and international prizes, as well as numerous journal articles. His research interests include urban planning and governance, urban social policy, disability studies, and environmental theory and policy. His recent work has focused on socio-spatial analysis of suburbs, their vulnerability to oil shocks and the need for better public transport options. Professor Gleeson was the inaugural recipient of the John Iremonger Award for Writing on Public Issues (Allen & Unwin Publishers) leading to the publication of his seminal book *Australian Heartlands: Making Space for Hope in the Suburbs*. His latest book is *The Urban Condition* (Routledge 2014).

All EWG members have declared any relevant interests.

Consultants

Dr Peter Brain

Andrew Cole

Dr Serryn Eagleson

Professor Billie Giles-Corti

Yvonne Kirk

Melanie Lowe

Dr Brendan Pender

David Singleton

Professor John Stanley

Dr John Stone

Dr Elizabeth Taylor

For ACOLA Secretariat

Dr Jacques de Vos Malan

Ms Navi Randhawa

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The Expert Working Group records its gratitude to the principal consultants, experts and research assistants who contributed to this report through the evidence gathering process detailed above. We offer our thanks to Dr Will Howard of the Office of the Chief Scientist for his advice and feedback throughout the project. We are grateful to Professor Michael Barber, Professor Ruth Fincher, Professor Peter McPhee, Dr Susan Pond and Dennis Trewin of ACOLA, who took a particular interest in the project, on behalf of the Program Steering Committee.

Review Panel

This report has been reviewed by an independent panel of experts. Members of this Review Panel were not asked to endorse the Report's conclusions and findings. The Review Panel members acted in a personal, not organisational, capacity and were asked to declare any conflicts of interest. ACOLA gratefully acknowledges their contribution.

Professor Robert Clark AO FAA FRSN

Professor Robert Clark was appointed Chief Scientist in Residence within the Faculty of Art and Design at the University of New South Wales in 2014. He was formerly Professor and Chair of Energy Strategy and Policy at the University of New South Wales from 2012. Prior to this role he was the Chief Defence Scientist (CDS) of Australia and Chief Executive Officer of the Defence Science and Technology Organisation from 2008–11. As CDS he was a member of Australia's Defence Committee, served as the Australian Principal of the 5-nation Defence Technical Cooperation Program (US, UK, Australia, NZ, Canada) and was a member of the Prime Minister's Science, Engineering and Innovation Council. In 2000 he established the Australian Research Council Special Research Centre for Quantum Computer Technology (ARC Centre of Excellence from 2003) and served as its Director until he was appointed CDS. His early career involved 10 years of service in the Royal Australian Navy as a Seaman Officer and Ships Diving Officer, and a Faculty appointment at the University of Oxford and Fellow and Praelector (Member of Governing Body) of The Queen's College, Oxford. Most recently he was a co-author of a report to government on a study of shale gas in Australia and co-author and editor of the book *Transport Fuels from Australia's Gas Resources: Advancing the nation's energy security*.

Associate Professor Scott McQuire FAHA

Scott McQuire is Associate Professor and Reader in the School of Culture and Communication at the University of Melbourne where he undertakes interdisciplinary research into the interplay between digital media and urban space. He has held eight ARC grants and is the author and co-editor of seven books and over 100 scholarly essays. Scott is a founding member of the Research Unit for Public Cultures at the University of Melbourne, sits on the Executive Committee of the Melbourne Networked Society Institute, and a member of the advisory board of the Microsoft Centre for Social NUI.

Professor Peter Newman

Peter Newman is the Professor of Sustainability at Curtin University. He has written 17 books and over 300 papers. In 2014 he was awarded an Order of Australia for his contributions to urban design and sustainable transport. Peter has worked in local government as an elected councillor, in state government as an advisor to three Premiers, in the Australian Government on the Board of Infrastructure Australia and in the UN on the IPCC as a Lead Author for Transport. His new book is *The End of Automobile Dependence: How Cities are Moving Beyond Car Based Planning*.

About Securing Australia's Future

In June 2012 the Australian Government announced *Securing Australia's Future*, a $10 million investment funded by the Australian Research Council in a series of strategic research projects. Projects are delivered to the Commonwealth Science Council by the Australian Council of Learned Academies (ACOLA) via the Office of the Chief Scientist and the Australian Chief Scientist.

Securing Australia's Future is a response to global and national changes and the opportunities and challenges of an economy in transition. Productivity and economic growth will result from: an increased understanding in how to best stimulate and support creativity, innovation and adaptability; an education system that values the pursuit of knowledge across all domains, including science, technology, engineering and mathematics; and an increased willingness to support change through effective risk management.

Six initial research topics were identified:

i. Australia's comparative advantage
ii. STEM: Country comparisons
iii. Smart engagement with Asia: leveraging language, research and culture
iv. The role of science, research and technology in lifting Australian productivity
v. New technologies and their role in our security, cultural, democratic, social and economic systems
vi. Engineering energy: unconventional gas production

Five further research topics have been identified:

vii. Australia's agricultural future
viii. Delivering sustainable urban mobility
ix. Translating research for economic and social benefit—country comparisons
x. Capabilities for Australian enterprise innovation
xi. Business diasporas in Australia: maximising people to people relationships with Asia

The Program Steering Committee responsible for the overall quality of the program, including selection of the Expert Working Groups and the peer review process, is comprised of three Fellows from each of the four Learned Academies:

Professor Michael Barber FAA FTSE (Chair)

Mr Dennis Trewin AO FASSA (Deputy Chair—Research)

Professor James Angus AO FAA

Dr John Burgess FTSE

Professor Bruce Chapman AO FASSA

Professor Ruth Fincher FASSA

Professor Paul Greenfield AO FTSE

Professor Lesley Head FAHA

Professor Peter McPhee AM FAHA FASSA

Professor Stephen Powles FAA FTSE

Dr Susan Pond AM FTSE

Professor Graeme Turner FAHA

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