

BDP ENVIRONMENT DESIGN GUIDE**2006 Australia State of the Environment –
Human Settlements****Professor Peter W Newton****Swinburne University of Technology, Centre for Regional Development and Institute for Social Research****Summary of****Actions Towards Sustainable Outcomes****Environmental Issues/Principal Impacts**

The 2001 State of Environment: Human Settlements Report (Newton 2001) identified levels of per capita consumption across all national headline indicators to be running at unsustainable levels equivalent to three-planet-living.¹ The 2006 Report (Newton, 2006) indicates that rates of consumption have continued to increase.

- Per capita water use at 115 KL/year (2000-1; 3.2% per year increase over 1996/7 level).
- Per capita energy use at 266 GJ/year (2003-4; with a forecast increase of 2.2% per year to 2019)
- Per capita waste generation of approximately 1 tonne/year
- Per capita mobility by car of 8000km/year (and vehicle kilometres travelled are forecast to be one third higher by 2020 in capital cities than in 2002).
- Per capita CO₂ generation of 27.5 tonnes/year
- Floor area of new dwellings has increased at a rate of 2.2% per year over the 10 year period to 2003-4 (where the average was 239 square metres).

In all instances, annual rates of change in per capita consumption are above the rate of Australia's population change (which is 1.2%/year, twice the OECD average) and in combination these twin factors are driving growth in Australia's total consumption.

Cutting EDGe Strategies

There are four key areas where innovation is required to reduce consumption:

- **Planning** – where to encourage new development and redevelopment in order to minimise demand for travel and how to plan in such a way that facilitates a pathway to more sustainable suburbs via a combination of supply side innovations e.g. integrated urban water systems; distributed renewable energy systems, etc that demand integrated strategic development planning.
- **Design** – what to build and how to design in such a way that embraces life-cycle-performance-based innovation (<http://www.auspebbu.org>), including use of an increasing number of eco-efficiency assessment tools capable of interrogating 3D design in real time for feedback to practitioners and clients (Tucker et al, 2005).
- **Technology** – identifying which new technologies from among a spectrum of options provide the greatest opportunity for reducing resource depletion, minimising environmental degradation and enhancing liveability and well-being at lowest life-time cost.
- **Human behaviour** – understanding what motivates the Australian population to adopt a consumption-oriented lifestyle to the extent that is currently exhibited (Hamilton, 2003) and the degree to which a change in behaviour can be orchestrated outside of targeting solely price mechanisms is perhaps the most fundamental and complex challenge. The encouragement is that there has been some progress in areas relating to recycling of domestic waste, with socially responsible investment and with product stewardship for some companies to name but a few – but this is just the tip of the iceberg. Part of the challenge is enlightening consumers about what is possible now with built environment products that have smaller environmental footprints. And that is a task that architects as building design professionals are well positioned for.

Synergies and References

- Related key concepts can be found on the websites of numerous organisations in Australia and internationally: planning (<http://www.planning.org.au>); design (<http://www.construction-innovation.info>; <http://www.raia.com.au>); technology (<http://www.csiro.au>)

¹ Australia's ecological footprint has been calculated at three times that of world average (<http://www.epa.vic.gov.au>). Resources equivalent to three planet earths have been estimated to be required to support its future population at a living and consumption standard equivalent to that of Australia.

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2006 Australia State of the Environment – Human Settlements

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Australia State of the Environment (SoE) 2006 is the third in a series of reports produced by the Department of Environment and Heritage. The report was tabled in Federal parliament by Minister Campbell in December 2006. This Note provides a summary of key points contained in the Human Settlements Report (Newton, 2006) one of eight Theme Commentaries that were commissioned as background to the SoE 2006 main report. All 2006 SoE documents are accessible at <http://www.deh.gov.au/soe>. Related national publications with a focus on sustainability are: Measures of Australia's Progress (2006), Australia's Environment: Issues and Trends (2006) and Triple Bottom Line Reporting in Australia (2003). This summary has been developed to highlight the key issues and challenges identified in the SoE 2006 Human Settlements Report that Australia's building design professionals face in relation to planning, design and managing the nation's built environment. It also identifies some practical strategies to address these issues based on the author's knowledge of the field. This Note should be read in conjunction with its predecessor (Newton, 2003).

1.0 State of the Environment Reporting

SoE reporting is now well established at Federal and State levels in Australia as well as many local governments (see <http://www.deh.gov.au/soe/about.html> for information on SoE reports for different jurisdictions). Most national and state reporting adopts the traditional OECD model of Pressure – State – Response, and a simplification of this is used here: an identification of *key trends and issues* followed by *response*.

2.0 A Model Framework for SoE Reporting

The extended urban metabolism model of human settlements (Figure 1) was again employed as the framework for structuring the 2006 Human Settlements Report. An explanation of the model is found in State of the Environment Advisory Committee (1996) and Report. An explanation of the model is found in State of the Environment Advisory Committee (1996) and

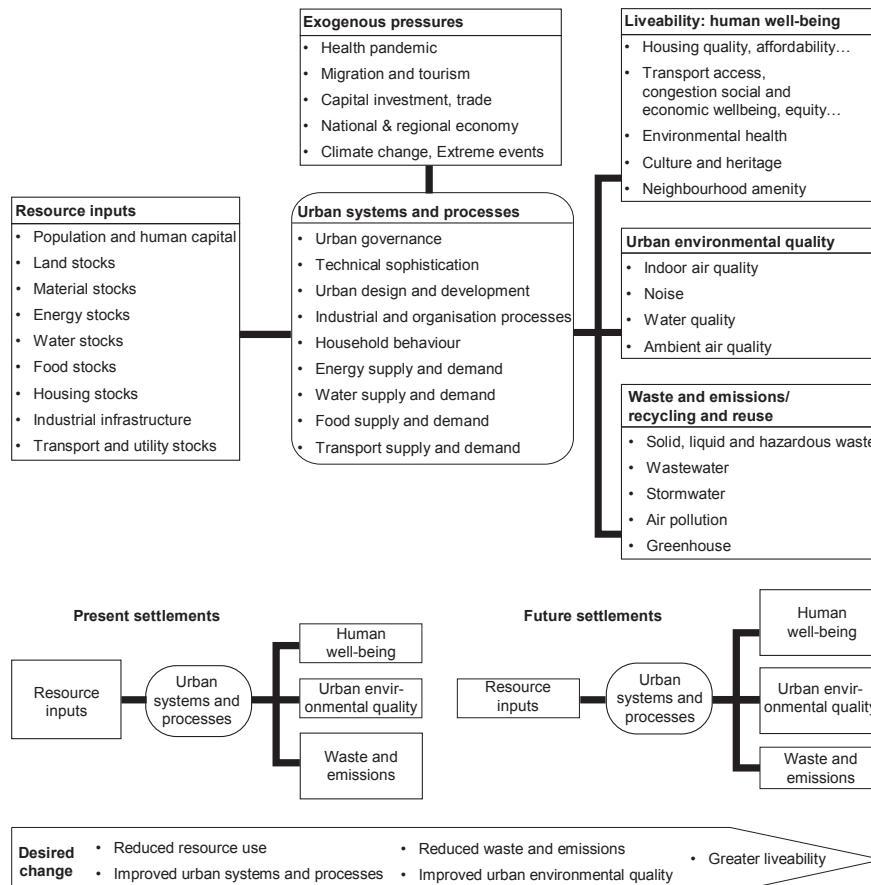


Figure 1. Extended urban metabolism model of human settlements

Source: modified from State of the Environment Advisory Council (1996)

Newton (2003). An additional element of the model has been added to recognise the impact of exogenous pressures on human settlements.

3.0 Exogenous Pressures

3.1 Trends and Issues

Two key exogenous pressures were identified for analysis: climate and population.

3.1.1 Climate

By the end of 2006 there was virtually universal recognition that the earth's temperature was increasing due to an enhanced greenhouse effect related to growth in greenhouse gas (GHG) emissions linked predominantly to a sustained growth in fossil fuels use (see Beaton et al, 2006; Pearman, 2005). For human settlements, the impact of climate change and climate variability warrants a higher level of attention than is currently evident in relation to both adaptation and mitigation. Key human settlement vulnerabilities include:

- Climate variability linked to lower rainfall and more frequent and intense droughts will mean less secure water supplies, accentuate competition between users, threaten allocations for environmental flows, and lower water yields for many catchments linked to urban centres with implications for their future economic viability (e.g. Goulburn). Implications for agriculture (dryland as well as irrigated farmland) and long-term viability of associated service towns are key issues for assessment. The impacts on food prices relative to other areas of household expenditure are also becoming evident. Water quality is also likely to be affected through reduced runoff, increased temperature and higher salinity.
- Increased risk of bushfire to human settlements would also align with the lower rainfall/higher temperature scenario.
- Increased heat island effect in cities (Coutts et al, 2006).
- Urban infrastructure damage could be expected under increased return periods for cyclones and storm surges and episodes of heavy rainfall and flooding in certain regions, accentuated by an absence of planning and design guidelines for jurisdictions historically not associated with such extreme events.
- Sea level rise of the order of 310 + 30mm by 2100 (Church and White, 2006), would significantly impact Australia's coastal settlement directly as beaches erode and shorelines move inland (<http://www.coastalvulnerability.info>; Sharples 2004) as well as via storm surges linked to extreme cyclonic events (see McInnes et al, 2003).
- Climate changes are also expected to enhance the spread of some disease vectors, such as Dengue fever and Ross River virus.

3.1.2 Population

Australia's population continues to grow at twice the rate of the OECD average (1.2%; OECD 2006; ABS, 2005) and is forecast to exceed 30 million by 2051 ... equivalent to adding an extra Sydney, Melbourne and Brisbane over the next 45 years.

Australia intentionally imports half of its annual population growth via its Federal permanent migration program as well as its short term business and student migration programs. Furthermore, international tourism injects an additional 131 million visitor days each year, equating to 364,000 permanent residents. In all instances, the incoming populations favour the capital cities by a ratio of at least two to one (Newton, 2006).

The 2001 Australia SoE Report (Newton et al, 2001; <http://www.deh.gov.au/soe>) documented what was then considered to be an unsustainable pattern of urban consumption by the nation. The 2006 Report (Newton, 2006) reveals that there has been no subsequent improvement in condition. For all SoE headline indicators, performance has, if anything, declined. At present each year the average Australian uses 260 GJ of energy (which releases 27.5 tonnes of GHG to the atmosphere), consumes 115 kL of water, demands more housing space (currently 239 m² for new dwellings), commutes further (8000 km by car) and generates more waste (approximately 1 tonne per person). Total resource flows per person are also of the order of 20 tonnes per year (Lennox and Turner, 2004) exerting significant pressure on transport infrastructures and congestion.

With population increasing and per capita consumption increasing, total consumption confers a double challenge to Australia's sustainable urban development – as our increasing ecological footprint demonstrates (Australia's ecological footprint is of the order of 7.7 ha/person, 3.5 times the global average and increasing; <http://www.epa.vic.gov.au/eco-footprint/default.asp>). Where analyses have been undertaken for particular cities over time – such as Sydney (Lenzen and Lundie, 2002) – size of ecological footprints are increasing faster than the rate of population growth. From a global perspective, the Worldwatch Institute (2006) argues that the world's ecological capacity is simply insufficient to satisfy the consumption ambitions of China, India, Japan, Europe and the United States as well as the aspirations of the rest of the world in a sustainable way.

3.2 Response

The Stern Report (2006) and the Al Gore movie *An Inconvenient Truth* (2006) have been influential in raising awareness about climate change and the urgency of action on GHG reductions by industry, government and community. A change of behaviour in relation to how cities are planned is needed in key areas related to the greening of transport, ensuring mixed use greenfield development as well as higher density development and redevelopment (<http://www.brownfields.com>) in key nodes and corridors as well as more generally across the residential landscape (<http://www.smartgrowth.org>).

The reluctance of the Australian government to price carbon, introduce carbon trading, establish more ambitious targets for renewables and to maintain Australian emissions within the agreed Kyoto limit also makes it difficult for other tiers of government and industry to plan for and invest in future low carbon industries and settlements. It should be remembered that while most countries under Kyoto were required to take emissions below 1990 levels by 2008-12, Australia negotiated an 8 per cent increase. Without that increase, our excess would be far higher. The DEH (2006) report forecasts that by 2020, when the benefits of reduced land-clearing start to fade, Australian emissions will be 17 per cent higher than its Kyoto target.

The projected increase in Australia's population to 26.4 million in 2051 reflects a 'business-as-usual' view of Australia's population future; it occupies a middle ground between environmentally-favoured lower targets and industry-favoured higher targets (Foran and Poldy, 2002; 2003). The most recent summit on Australia's population future (Vizard et al, 2003) captures the mix of drivers for the various scenarios and preferred views of different interest groups. Industry generally argues for higher migrant intake targets from the perspectives of labour supply (current concerns relate to the tightness of labour markets and availability of skilled workers) and the size of the domestic market (consumption). Some commentators see this as a failure by governments to develop policies to encourage higher levels of fertility (that is family policy designed to 'grow our own population') and to address potential skill shortages through enhanced training policies and programmes (Birrell, 2003).

4.0 Settlement Patterns

4.1 Key Trends and Issues

Three key trends were identified regarding Australia's settlement patterns (Newton, 2006):

The Rise and Rise of the Mega-Metro Region. All of Australia's capital cities continue to act as economic engines (75% of national economic activity emanates from metropolitan areas; Allan Consulting, 2002) as well as demographic absorbers. All will experience larger percentage growth than the rest of their states, resulting in further concentration of Australia's population within the capital cities. Sydney and Melbourne will remain the two largest cities, followed by Brisbane, Perth, Adelaide, Canberra, Darwin and Hobart.

The nation's four largest cities are accelerating physical as well as functional transitions to mega-metropolitan region status – as systems of cities. Forecasts suggest the nation's population will increase by 9.5% to 21.5 million in 2011 with the four mega-metro regions of Sydney-Hunter-Illawarra, Port Phillip, South East Queensland and the Perth Corridor accommodating 80 per cent of the growth (Newton, 2006). The high level challenges here relate to strategic planning for smart growth and redevelopment that have clear sustainability targets.

The Booming Beach and the Bleeding Bush. In 2004, 41% of Australia's population lived in coastal municipalities – and they remain a magnet for growth.

At a continental scale, the continuing urbanisation of Australia's coastal regions and the decline of small towns and communities in dryland farming as well as more remote regions is well documented (Salt, 2004) linked predominantly to structural economic and lifestyle factors that are unlikely to be reversed. Between 1996 and 2004 rates of population growth in coastal areas within capital cities were more than twice that of coastal non-metro (Beaton, 2006). The key challenge for coastal Australia is to avoid catastrophic environmental damage equivalent to the ravages of salinity which followed an earlier economic and settlement transition linked to clearing of native vegetation for dry land farming and irrigation agriculture.

Re-Urbanisation Continues Downtown in the Big Cities but Suburbanisation Dominates. The re-urbanisation of the inner suburbs in Australia's largest cities has intensified over the past decade as a result of growth in the supply of and demand for high rise apartments and town houses and an increase in in-fill development (35% of new dwelling stock in Melbourne is infill; Birrell et al, 2005). Although inner cities continue to gain population, the flow of people to the suburbs continues to dominate – a process of centralisation with decentralisation (Newton, 1995; 2006). Residential densities are highest in the inner suburbs but are increasing across middle suburbia assisted by urban consolidation policies of state governments and the resultant process of housing infill. By international comparison, however, Australian cities remain low density. Maximising the benefits while minimising the negative aspects of higher density development remains a key challenge for the planning and design professions, the development industry and government (Speare and White, 1990).

4.2 Response

A key element in the strategic plans of the major capital cities is related to addressing the pressures associated with current and forecast growth. Key initiatives in addition to the Metro Strategies in each State are activities of the Development Assessment Forum (<http://www.daf.gov.au/index.aspx>) and the Planning Officials Group in relation to systems for more efficient (time to assess) and effective (sophistication of performance/sustainability assessments) urban development. The three internet portals (*Your Home*, *Your Building* and *Your Development*) initiated by the Department of Environment and Heritage represent significant new knowledge bases for planning and designing more sustainable built environments.

5.0 Energy

5.1 Key Trends and Issues

Energy use is a major economic and environmental issue for Australia. Economic to the extent that GDP growth is almost a perfect correlate of energy use (Foran and Poldy, 2002). Environmental as a result of greenhouse gas generation linked to Australia's significant exports of fossil fuels – coal, oil and natural gas – as well

as Australia's continuing reliance on fossil fuels at a domestic level across all sectors of the economy.

Primary energy consumption is forecast to increase by 48% to reach 7544 PJ by 2019, growing at an average rate of 2.2% per year. This is significantly above the expected rate of population increase, driven by continued growth in per capita consumption. A key driver of the outlook is also economic growth. A forecast reduction in energy per GDP reflects expectation of a decline in energy intensity, due to increasing energy efficiencies (Productivity Commission, 2004), new energy technologies (ABARE, 2005), and a shift in the structure of the economy towards less energy intensive sectors.

A projected growth of the order of 6 percent to renewables and natural gas over the next 15 years will be a contributor – albeit small – towards a reduction in GHG emissions. Electricity generation is a leading consumer of energy in Australia, with a continuing high growth in electricity demand reflecting the relatively low cost of electricity. At the same time there is a widening gap between electricity demand and supply (Jones, 2004), driven in part by an absence of carbon pricing/carbon tax signals by government and the brake that this is having on new investment in both renewable and non-renewable energy technologies. There is clear scope for greater energy efficiencies in relation to energy conversion, as well as a transition to a more environmentally sound energy platform for the nation (Productivity Commission, 2005) – given that the current centralised fossil-fuel-based electricity generation industry is also the leading contributor of GHG.

Transport, with over 40% of final energy consumption in Australia emerges as the dominant end use energy consumer – significantly above that in the EU, Japan and United States (all of the order of 25%; Awano 2003). By way of contrast, energy consumption by buildings has been significantly lower in Australia – in part a reflection of lower demands for space heating due to a relatively benign climate. However, increasing demand for air conditioners may alter this.

The greatest energy-related threat to Australia is the fact that the nation is running out of oil and the implications that this will have for urban transport and urban mobility in general. The greatest energy-related threat from Australia is its global contribution to GHG. Transition to a renewables-based solar-hydrogen distributed energy economy represents a long term solution to these twin threats.

5.2 Response

There are a range of future energy options available to Australia (Energy Task Force, 2004). Given its abundant reserves of coal, there is considerable economic and political pressure directed towards development of zero-emission coal fired power stations (Thambimutu, 2006). Utilisation of natural gas in electricity generation while not zero-emitting, confers significant GHG benefits over coal-fired stations. Utilisation of uranium in power generation, while positive from a GHG perspective, continues to raise questions around safety of operation, disposal of spent fuel and nuclear proliferation — as well as sustainability

of reserves. Australia's *Solar Cities* initiative (<http://www.greenhouse.gov.au>) launched in 2005, is designed to demonstrate how solar power, smart metering, energy efficiency and energy pricing can combine to provide a more sustainable energy future for urban Australia. Distributed energy initiatives allow a spectrum of technologies (e.g. reciprocating engines, small gas turbines, fuel cells, PV, wind, solar thermal and waste heat recovery) to be utilised at scales ranging from individual building to neighbourhood, suburb and city to deliver further energy efficiencies (<http://www.deforum.org>). A hydrogen economy lies still further in the future (Horizon 3), but it will usher in an energy secure future for both stationary and mobile consumers of energy as well as one that is zero GHG gas emitting.

In the context of energy and housing, the performance range for energy used in heating and cooling Australian housing is very wide as the current (interim) AccuRate starbands for 0.5 and 5.0 star-rated dwellings attest (Delsante, 2006): Townsville: 466 – 215 MJ/m²; Brisbane: 280 – 71; Western Sydney: 574 – 116; Melbourne: 662 – 140; Canberra: 1068 – 252.

Furthermore, a recent report on an international comparison of building energy performance standards indicated that "... the proposed [Australian] 5-star standard is 1.8 – 2.5 stars below comparable average international levels of performance" (Horne et al, 2005). Scope for improving the energy performance of the housing shell for both existing and new houses in Australia is large. The principles for designing more energy-efficient housing have been known for decades. They are now combined in an easy-to-use design assessment tool (AccuRate). An absence of more ambitious energy performance goals in the BCA represents a key barrier to more energy efficient housing.

It is likely that at the 5 star level, behavioural changes could easily outweigh further building envelope improvements in terms of energy use (Lenzen et al, 2004 clearly demonstrate the link between household income and energy use). Simulations indicate that small changes in thermostat settings, as but one example of change in behaviour in relation to human comfort, result in large changes in energy use (e.g. a 2.5 star Canberra house can reduce heating energy by 80 MJ/m² via a one degree decrease in thermostat setting).

Also refer to the special issue on energy planning in *Australian Planner* (2006) and the Energy modules in *Your Home, Your Building and Your Development*.

6.0 Urban Water

6.1 Key trends and Issues

Currently, there are three networks that provide water services to urban communities. These are: the drinking (or potable) water supply system the sewerage (or wastewater) system and the drainage and stormwater system. It is a 'linear' urban water system model: distribution of water from central/catchment storage areas to consumers and discharge of stormwater and wastewater (with varying levels of treatment) to receiving waters.

Mains water is almost universally the source of providing water to the capital cities (99%) – less so (86%) for other urban settlements; and the method of supply has been relatively fixed for decades. This is to a large extent due to the capital intensive nature of these systems with long (100+ years) asset life. It is also due to the fact that satisfaction with water quality is relatively high and until recently there has not been a threat to a continued safe yield of water to our urban centres. Historically, environmental impact on receiving water has not rated as highly as a force for re-thinking urban water systems.

In considering the consumption of water by Australian households, it is important to recognise its various uses. The available data at national, state and capital city levels clearly indicate that between one third and perhaps as much as 60% of household water consumption for some urban centres is used outside the house, primarily on gardens (a significant contrast to UK which averages 3%; WSAA, 2003). This represents the area with most significant potential for reduction in use, followed by increased medium density living (Newton, 2006).

In 2001-02 only nine percent of Australia's sewage effluent was being recycled for re-use; more so in rural Australia (Radcliffe, 2003). The level of water recycling and re-use is currently very low across all capital cities – well below the national average except for Adelaide and virtually completely absent from the domestic sector as it would require introduction of an additional 'pipe' into the system. Capture, treatment and use of stormwater – the realisation of "city as catchment" is even less well developed – and without some radical changes towards integrated urban water systems (a Horizon 3 solution) there is the real prospect of major Australian cities running out of water.

6.2 Response

Integrated urban water management has been proposed as a more holistic approach to the way diverted water, wastewater and stormwater can be provided to urban communities. For Australia's largest cities, stormwater and wastewater – mostly disposed to receiving waters – represent a 'resource' to be tapped as they currently generate a volume that is 1.5 times in excess of present levels of water use (Mitchell, 2004). This closed loop approach involves shifting to a more decentralised approach to urban water management as on-site as well as neighbourhood level treatment technologies enable a transition to water-sensitive urban design in greenfield as well as infill sites e.g. Rouse Hill, Epping North, Mawson Lakes, Roachdale (CSIRO, 2006; Coombes et al, 2000; Gold Coast Water, 2003; Gardner and Sharma, 2005; West, 2003).

For potable water use, the type of dwelling occupied is a factor in consumption; e.g. in Sydney, households in detached houses consumed 304 kL/yr on average compared to 211 kL/yr for medium density and 148 kL/yr for high rise, a difference of over 100%; (IPART 2004). This is attributable to outside water use (gardens and pools) and greater stock of water-using appliances in the separate houses – as well as more occupants.

Installation of water-saving fittings can contribute savings in the range of 12% (houses) to 25% (flats) of total consumption (e.g. flush toilets 21 kL/yr less; Troy et al, 2005; shower roses 14.5 kL/yr less; Plant, 2006).

Water use, while relatively uniform in terms of per capita in-house consumption (Loh and Coghlan, 2003), varies significantly according to population characteristics and attitudes: e.g. water use is higher in single person households and in households with higher incomes (40%; IPART, 2004) – although there is sensitivity to pricing. Overall one third of households in the Sydney survey believed they could easily reduce their water consumption (IPART, 2004). Web-based tools can also assist here (<http://www.education.melbournewater.com.au>). In the long term, the greatest savings in potable water use will occur via substitution (i.e. use of recycled waste water and stormwater) as a result of the introduction of integrated urban water systems and water sensitive urban design.

7.0 Transport, Mobility and Urban Air Quality

7.1 Key trends and Issues

Levels of personal mobility continue to grow in urban Australia and are being driven primarily via growth in car use (rates of growth in vehicle kilometres travelled or VKT are higher than population growth rates).

The negative environmental, human health and economic impacts of Australia's car dependent transport system are reflected in energy use and GHG emissions, urban air pollution and traffic congestion respectively. Transport contributes approximately 15% of Australia's total GHG emissions (ABS, 2003) as a result of its fossil fuel use which has increased by more than one quarter in the decade 1991-2001 – due primarily to demands of road transport.

Projections of car traffic for Australia's capital cities to 2020 suggests volumes one third higher than that in 2002 – and 40% higher when growth in light commercial vehicle traffic is included (one quarter higher for non-metro Australia). When these projections on traffic volumes are linked to data on current road capacity, BTRE (2000) forecasts of congestion and associated costs to the national economy if nothing is done could amount to about \$30 billion per year by 2015.

Urban air quality in Australia's cities continues to improve with the exception of ozone (photochemical smog) and fine particle pollution (Beer et al, 2006).

7.2 Response

A study undertaken by Newton (1997; 2000) for AATSE (1997) indicated that compact cities represent the most fuel efficient of all urban forms, with over 40% less transport fuel consumption than a dispersed form. The urban consolidation policies now operating in Australia's capital cities are encouraging less sprawl and more compact styles of development (but are the subject of debate in respect of the perceived benefits

in areas other than resource consumption – namely neighbourhood character and amenity). However, as indicated in Section 4, low density suburbanisation dominated by single family detached housing remains the dominant form of urban development in Australia. Between 1996 and 2001 levels of population density have increased in all capital cities, but most noticeably in the larger cities and predominantly in the inner city municipalities (e.g. City of Melbourne, City of Sydney) where high rise development dominates (Newton, 2006). A transition to higher levels of residential density within cities is seen as a means of achieving a number of key environmental objectives (Newton, 2006). Higher densities of urban development are associated with:

- reductions in per capita demand for land
- reductions in rate of loss of biodiversity as a result of lower rates of conversion of green space to residential use
- reductions in levels of operating energy in housing; also significant reductions in life cycle energy use and greenhouse gas emissions
- reduction in water consumption due to less outdoor water use (e.g. gardens, swimming pools)
- reduction in volume of building materials consumed (medium density housing has approximately two thirds the material intensity of detached single family housing)
- reduction in solid/municipal waste generation
- improved human health linked to less car use and greater pedestrian activity
- less energy consumed and GHG emitted in travel

Also refer to the special issue on transport planning in *Australian Planner* (2006).

8.0 Waste Management and Minimisation

8.1 Key trends and Issues

The volume of solid waste disposed to landfill across Australia remains high at around one tonne per person per year (ABS, 2003). Although there have been significant reductions in waste disposed in NSW, Queensland, SA and ACT between 1996-7 and 2002-3, Victoria and WA have experienced increases (Newton, 2006). Across the three main categories of solid wastes disposed to landfill, municipal waste tends to be highest (40%), followed by commercial and industrial waste (37%). There are also a range of hazardous wastes disposed across Australia. Of particular concern is the extent to which hazardous household wastes are currently disposed of in combination with municipal garbage (Newton, 2006). The transformational challenge in this area of urban performance involves seeing waste streams as potential resource streams that are capable of minimising the draw-down on natural resources as feedstock for manufacturing. In this respect Australia lags international best practice for all waste streams for which data are readily available.

In the absence of an increase in recycling and re-use at household as well as industry level via product stewardship programs, Australian cities will continue to display the heavy metabolic flows characteristic of Southeast Queensland: 20 – 25 t/person/yr (Lennox and Turner, 2004).

8.2 Response

In spite of developments in waste recovery in a small number of streams (Nolan – ITU, 2002), millions of tonnes of materials continue to be disposed to landfill accounting for the majority of waste generated in Australia. This linear pattern of ‘resource’ flows, based on single use and then disposal (akin to water use in Australia) is also unsustainable in the long term.

There are a range of important responses that are beginning to occur: product stewardship; green procurement (<http://www.epa.gov/cpg> and <http://www.geca.org.au>) landfill pricing; eco-efficient design (Tucker et al, 2005) and cradle-to-cradle manufacture (McDonough and Braungart, 2002).

Eco-industrial development represents a larger scale and a more systemic response to utilisation of multiple waste streams than those listed above that are typically limited to an individual company or product line (Sterr and Ott, 2004). Eco-industrial complexes however, are not self-organising – as is possible between one or two firms. They require intentional planning and investment by government and industry, possibly in PPP: in mapping waste streams – both liquid and solid; characterising waste streams; encouraging new technology development for recovery, treatment, and new material development; incubating new industries in public-private partnerships and undertaking the necessary spatial planning of eco-industrial parks as engines of a new green economy in mega-metropolitan regions. Mega-metro regions such as Melbourne would appear to have the key start-up ingredients: a growing agricultural economy; significant solid and liquid waste streams; energy – and a requirement for new sustainable industries and employment in outer metro and peri-urban areas. VicUrban’s Dandenong Logis project – a proposed 154 hectare eco-industrial development is indicative of what needs to be achieved more broadly across our major urban regions (<http://www.vicurban.com>).

9.0 Conclusion: Transitioning to Sustainable Urban Systems

The infrastructures upon which Australia’s settlements have developed are unlikely to sustain future urban populations and economies beyond the next generation at current quality of life levels. The transitions envisaged are from linear, centralised systems that are wasteful of water, energy and material resources to closed-loop, distributed systems that attempt to maximise collection, recovery, reuse and recycling of each resource. Specifically, the required transitions are towards:

- integrated urban water systems based on utilisation of stormwater and wastewater

- green energy systems based on distributed renewable energy and a hydrogen economy
- zero waste economies based around eco-industrial development (utilising solid and liquid waste streams as resources) and cradle-to-cradle manufacturing
- sustainable subdivisions, integrating housing and neighbourhood innovation across multiple key liveability and sustainability dimensions
- reducing car-based travel by adopting smart growth planning principles as well as reducing traffic congestion by utilising intelligent transport systems, road pricing, spreading peak travel and broadband communications to substitute telecommunication for travel.

The ultimate transition is that involving human behaviour – linked to lifestyles that are more sustainable from the perspective of individual and household consumption.

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