Emerging issues

Australia's population is projected to increase from 19 million in 2000 to 21 million in 2011 and 25 million in 2050—a rate of increase of about 1% per year.[1] Added to this increase in resident population is the estimated visitor population forecast to grow from five million international tourists in 2000 to 32 million by 2050—an annual average rate of growth of 10% (currently 7%) (Tourism Forecasting Council 2000). As the population of Australia grows and total resources, used increases, greater stress will be placed on the environment. Environmental pressures will be greater still if per capita consumption levels are sustained or increase, as is evident across a range of key indicators (see the Executive Summary).

In this section we examine several of the emerging issues where human settlement intersects with environment.

Future scale and shape of human settlement

Towards megalopolis

Australian cities are likely to continue to house eight out of every ten residents. Sustained growth of the mega-metropolitan regions will continue to be an important issue within Australia's human settlements, especially those in the south-eastern corridor. It is expected that the big metropolitan regions will continue to expand, and will continue to attract investment and jobs associated with the new economy. In this scenario, Sydney's dominance as Australia's international gateway will also continue as it becomes involved in further global city functions. Other large cities, including Adelaide and Hobart, will continue to face disadvantage unless adequate productive investment and industry can be attracted to these regions. While there are some success stories in these places (i.e. call centres and the 'back office' functions of financial institutions), much more will be required. Any planning must account for the disparities that have emerged, looking at areas of high growth as well as areas of disadvantage.

The urbanisation of coastal environments

The increased urbanisation of the coastal strips—especially those on the eastern seaboard—is also set to continue. This growth is likely to be constrained to areas of high amenity and will be associated with further 'sun-belt' migration from the 'colder' southern states to coastal regions in northern New South Wales and south-eastern Queensland. This growth will raise a number of issues such as the impact of development on the surrounding natural environment and the impact of the changing population profile on the local economy. This may be especially important in some cases, such as localities in south-eastern Queensland that have been identified as welfare or retirement migration regions.

Differential patterns of growth and decline in inland urban areas

In inland Australia there is a wide diversity of performance, which is to be expected. But what is perhaps surprising—but nonetheless encouraging—is the considerable degree of opportunity for growth that exists in a number of inland towns, especially in New South Wales, Victoria and Queensland. Key factors enabling growth have been the ability for towns to tie into emerging economic markets and develop particular niche market opportunities; for example, Shepparton for food processing. A number of remote towns have also shown remarkable growth, again based on niche market opportunities such as mining and ecotourism. The ability of other inland towns to have similar growth will depend on their capacity to attract investment and jobs in key emerging industries.

The role of space-transforming technologies

Three space-transforming technologies provide opportunities for enhancing the benefits while minimising several of the negatives associated with contemporary settlements systems.

Firstly, linking capital cities with provincial centres via high-speed rail links (see photograph on page 138) effectively transforms the latter into the equivalent of inner and

1. The population projections are drawn from ABS (1998a) and do not incorporate immigration scenarios which could be triggered by extreme political, economic or environmental events in the Asia–Pacific region.

High-speed rail could transform provincial cities into middle-ring suburbs of mega-metro regions.

Source: Alstom Australia.

middle ring suburbs of the former (Newton et al. 1997). Upgrading the existing rail links to 160 km/h services between Melbourne and the provincial cities of Ballarat, Bendigo and Geelong would convert them to the equivalent of outer-suburban commuting zones. The proposed high-speed rail link from Perth south to Mandurah would create a new linear city connecting 10 new transit nodes (Bolt 2000). The benefits are likely to be numerous. It concentrates future development into corridors which have demonstrated environmental benefits (energy, greenhouse) over the alternative which is sprawl; provides a much needed boost to the economies of 'provincial' centres as they become more closely integrated into the economic engines of the capital cities; and it extends metropolitan housing and labour markets, increasing access to jobs and services.

Remote Internet and mobile communications redefine time and space relationships.

Source: CSIRO.

Secondly, as Australia's Internet economy matures, residential areas are likely to be redefined as locales which combine the more traditional roles of reproduction and consumption with production (as a result of the growth in home-based work)—a more sustainable landscape of self-contained 'villages'. The dominant impact is likely to remain focused on urban areas; although the opportunity for remote access to personal computers and personal digital assistants anywhere, anytime is now with us (see photograph on page 138).

Thirdly, the emergence of green high-rise buildings (see photograph right) deliver significant environmental benefits over conventional development, through the closed loop treatment and reuse of wastewater; new facades that better control energy, ventilation and noise transmission; greater energy and greenhouse effectiveness (Newton et al. 2000); and increasing flexibility in design to accommodate multiple uses (residential, retail, office, recreation).

Green high-rise buildings redefine space, density and environment relationships.

Source: Grollo Eureka project.

Change in urban activities, transport and land use

Employment patterns are changing in our urban centres. More people are employed in service industries, working hours are no longer restricted from nine to five, and there are many multi-worker households. Households are engaging in more out-of-home activities. These trends lead to increases in travel plus increasing time pressures and complexity in travel patterns, making public transport use less attractive.

The population is ageing and average household size is falling. However, the anticipated greater call on public transport by an ageing population may not occur as the elderly are making a greater proportion of trips by car and maintaining their licences to drive. Indeed, social and recreational trips by retirees may increase car travel. Smaller households may result in more household vehicles, in total, as options for sharing are limited, and daily activity schedules more complex.

At the same time, freight vehicle trips are increasing. Reasons range from transport of construction materials for growing cities, to changes in logistics practice with 'just-in-time' delivery requiring extra trips for more frequent dispatch of smaller loads. Travel and traffic demand management measures to limit the impacts of growing road traffic on the built and natural environments, for example for greenhouse gas amelioration, will need to be tailored to these new circumstances.

E-business and e-transport

The impact of the communications revolution on transport is expected to be increasingly important. Intelligent transport systems and vehicles will have implications for traffic flow, demand management, safety and road pricing. Electronic toll collection is already in place as are freight tracking systems and traveller information systems. Tourists can hire smart vehicles with electronic guidance systems to steer them to their destinations.

E-business has some potential to limit the need for travel by increasing tele-working or replacing meetings with electronic conferences and replacing personal shopping with tele-orders. There will be a substitution of electronic documents and signatures for hard copy, or more efficient goods delivery, including domestic shopping. However e-business is equally likely to generate new goods and services movements, dispatch over greater distances due to sourcing of goods from further afield, and even extra business travel by people visiting new clients and suppliers.

Increased noise resulting from changes in urban activity

Extra noise is generated by extra people and by changes in work and leisure. Areas of cities previously well protected from noise pollution are being increasing affected. For example, the construction of a new runway at Sydney airport, necessitated by increased demand for air travel, has led to previously quiet suburbs experiencing aircraft noise. There is likely to be increased road traffic because of extra passenger, freight and delivery vehicle trips in all cities.

Moreover, environmental noise is extending over longer periods. Daytime traffic noise was once estimated over a 12-hour period, but now the 'day' extends for 18 hours or more. This is in part a result of the growth in industry and commerce but also a result of significant changes in work practices. Increasingly workers are involved in service industries and working longer hours; and the costs of plant and equipment plus deadlines mean that construction and other previously daytime activities continue into the night. Retail outlets, cafes and restaurants are adjusting to a workforce working all hours in the 24-hour city. While inner city residents may be more affected, these changes extend to the outskirts of cities where suburban residents may be disturbed at 3 am by garbage collection or large freight rigs heading into the city.

Fragile foundations: Australia's ageing infrastructure

High-speed rail, broadband networks and high-rise building will be significant new infrastructures in 21st century Australian settlement. Australia's economic performance and quality of life is, however, heavily dependent upon the standard of urban infrastructure laid down in the 19th and 20th centuries. The Langmore Report (Langmore 1988) was among the first of many to draw attention to the decline in public sector expenditure (capital and operating) on infrastructure. Over the past 40 years, national spending on public sector infrastructure generally has declined from 8% of gross domestic product to 2% , which is insufficient to keep pace with demand and obsolescence. This represents a problem for a country which has among the highest ratios of infrastructure to population in the world. The Institution of Engineers Australia recently warned that the corporatisation of the government departments and utilities that provide the services has put greater emphasis on the return on capital, often to the detriment of maintenance (IEAust 2000). Government trading enterprises are under pressure to maximise returns to government coffers, often by reduced spending. The Institution's report on infrastructure rated the nation's roads, bridges, railways, and water and sewerage networks as relatively poor. The best rating, was a C for national roads, which varied in quality from good to poor with selective investment in projects like the Pacific Highway. Suburban roads had excessive traffic and congestion, and rural roads rated a D. Worse still was the condition of the railways; the Melbourne to Sydney to Brisbane corridor rated an F minus, and the Institution warned that Australia cannot benefit from rail's potential without a substantial upgrading of intercapital services. Ageing sewer pipes were considered a major problem; many are 50 to 100 years old, and sewage treatment and disposal systems are often below community expectations. Sydney Water Corporation's oldest sewer pipes are more than a century old and lie below 19th century residential areas. The Corporation is responsible for 20 191 km of water pipes and 21 961 km of sewer pipes servicing four million people in Sydney, the Blue Mountains and the Illawarra. Another 150 km of new sewers and 130 km of water mains are added each year.

Sydney Water Corporation's costs for operating, maintaining and replacing water mains has increased from $273.6 million in 1995–96 to $364.6 million in 1998–99, and in 1999–2000, the Corporation spent more than $500 million maintaining and rebuilding the sewer and water system.

The social, economic and environmental implications of inadequate creation and maintenance of urban infrastructure is reflected in interruptions to gas supply (e.g. at the Longford plant) and electricity supply ('brown-outs'), issues of water availability and quality, train derailments, airport delays (especially out of Sydney), and traffic congestion.

Infrastructure impacts and adaptation to climate change

Reports from the Intergovernmental Panel on Climate Change (IPCC 2001) have established that human-induced climate change caused by the enhanced greenhouse effect is already occurring, and that future change is inevitable: 'it is not a question of whether the Earth's climate will change, but rather by how much, how fast and where' (Watson 2000). IPCC climate models project an increase in global mean surface temperature of between 1.6°C and 6°C between 1990 and 2100. These changes in temperature will be accompanied by changes in rainfall patterns, sea level rise and other factors such as snow and ice cover, ocean circulation and monsoons.

A level of uncertainty currently surrounds the possible implications of climate change on Australia's population and settlement, but impacts are likely in the following areas:

Flooding—recent forecasts by CSIRO's Climate Impact Group show that Australia could experience longer dry spells interspersed with heavier rainfall (Dr Peter Whetton, pers. comm., 2000).

The return period of heavy rainfall events may be reduced by a factor of between two and four if atmospheric CO_2 concentrations double. If the once in 400 years flood was to become the once in 100 years flood, simulations of combined potential residential and commercial damage suggest a tenfold increase in associated costs for urban areas in the Hawkesbury–Nepean region of Sydney (Minnery and Smith 1996).

Drought—for many parts of Australia, rainfall and water supply are generally adequate. However, the drier inland areas of Australia are vulnerable to potential water shortages during seasonal minimum and during droughts.

Drought affects human settlements in a number of ways. In regional areas, crop and stock losses result in loss of income for farmers and consequent repercussions for supporting townships and businesses. Environmental damage from drought, such as vegetation loss and soil erosion, threaten the sustainability of agricultural enterprises. In urban areas the impact is on water availability, with consequent restrictions imposed by water authorities.

Any additional water shortages arising from climate change would sharpen competition among various economic, social and environmental uses and hence increase the effective cost of water. Considerable demand arises from urban development and the diversion of large amounts of water for economic purposes such as mining and irrigated agriculture. This competition may be exacerbated by trends toward population growth, higher valuation of natural waters, and possibly shifts to more intensive farming systems. If, on the other hand, there were to be an increase in water availability as a result of climate change, it might well encourage demand for more irrigation, with obvious short-term benefits—although in the longer term this could lead to increased salinisation in semi-arid regions.

In central Australia, low rainfall and high evaporation forces the few towns—such as Alice Springs and Yulara—and other tourist centres, cattle station, and Indigenous and mining settlements to rely on desalinised brackish groundwater. Economic growth and population growth will put added pressure on these supplies, which are recharged in part by occasional heavy rainfall events.

Bushfires—Beer and Williams (1995) suggest an increase in fire danger over much of Australia, largely attributable to a decrease in relative humidity. Loss of life and damage to property due to bushfire is predominantly centred on Australia's urban centres.

Snowfall and winter tourism—increased temperatures will lead to a reduced fraction of precipitation falling as snow, higher snowlines, earlier spring snowmelt and a shorter snow season. An increasing frequency of poor snow seasons due to climate change could be expected to increase competition among Australian ski fields, and those located at lower altitudes may have to close down their operations, with knock-on effects for associated communities (Whetton et al. 1996).

Sea levels and coastal settlement—parts of Australia's coasts and rapidly growing coastal settlements and infrastructure are vulnerable to any increase in coastal flooding and erosion, which may occur from sea level rises in association with other meteorological changes, such as cyclone frequency and intensity and storm surges (McInnes and Hubbert 1996). Climate change and sea level rise are not well represented in current coastal management planning.

Energy

New drivers of energy policy

The energy sector is in a state of rapid change. Powerful forces are at work, and some of them are in conflict, so that the direction of change is unclear.

Technological change is revolutionising the energy sector. The trends of the past 100 years are being challenged by a variety of changes, including:

- Increasing potential for more efficient energy use. Cars that use less than 3 L of fuel per 100 km, compared with the average of 11 L/100 km today, are under development. The best modern refrigerator uses 80% less energy than typical refrigerators of the early 1980s. Buildings that require 80% less energy for heating and cooling are now being built. New office lighting systems that use up to 90% less energy than those of the 1970s are also available. So it is now possible to do much more with much less energy.
- Electricity generation technologies are being transformed. For most of the past century, the trend has been towards ever-larger centralised power stations using coal. Now the trend is towards distributed energy systems—large numbers of smaller power generation plants using a diverse range of energy sources, including natural gas, organic

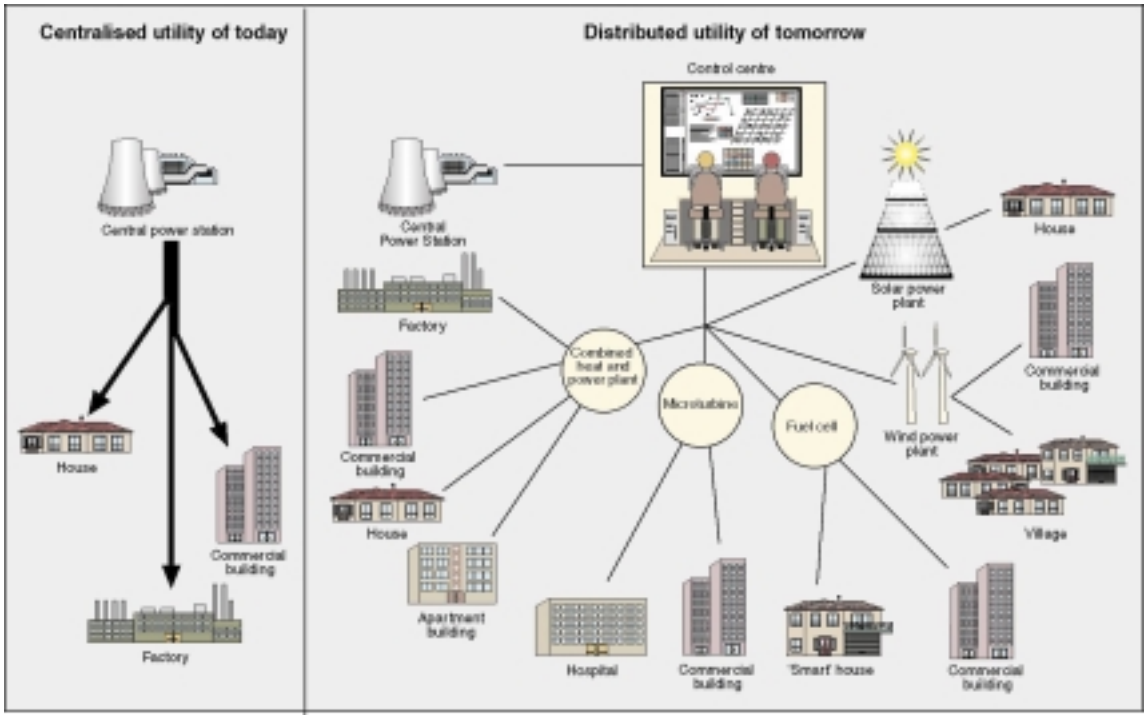

Figure 89: **The shift from centralised to distributed energy systems.**

Source: CSIRO Energy Technology.

wastes and a range of renewable energy sources, including wind, solar radiation, biomass, waves and tides (Figure 89). This is likely to extend over time to include residential suburbs as a new source of energy, via the utilisation of photovoltaic solar energy panels on the roofs and gables of houses and other buildings, and the sale of excess electricity back to the grid (see Bouwmeester and Van Ijken 2000). This is not to say that centralised generation will disappear. On the contrary, it will continue to be a major contributor to an overall integrated power system and may also become the focus of 'industry parks' which can utilise some of the waste heat produced.

The electrical efficiencies of distributed systems, however, are already demonstrated to be up to 70–90% or more when coproduced heat is used. By comparison, coal-based centralised systems with transmission and distribution losses have efficiencies of only about 30%; that is, they use three times more fuel than is theoretically necessary. As a result the greenhouse savings associated with distributed systems are substantial.

New methods of producing transport fuels are now practical and, as oil prices rise, are becoming economically viable. These range from the conversion of fossil fuels such as coal and oil shale into liquid fuels (a process with higher greenhouse impacts than conventional petroleum fuels), to renewable fuels such as alcohol and vegetable oils from biomass. The production of hydrogen from renewable electricity is also foreshadowed.

The production of heat, which provides up to half of the energy requirements of modern societies, is also switching from traditional boilers fired by fossil fuels to cogeneration, small modular heating systems, and renewable energy sources such as solar thermal collectors (e.g. solar water heaters) and biomass conversion. Improving technologies such as catalysts and low-temperature detergents mean that many processes that used to require large amounts of heat now need less or even no heat. Heat recovery technology allows much more efficient use of heat, further reducing the amount needed. Other possibilities include geothermal and nuclear power; Australia is potentially well positioned in both. For geothermal production, Australia has large areas of heat-producing granites, buried at 3–4 km, naturally heated to 300°C. From a nuclear perspective, Australia has approximately one-quarter of the global reserves of uranium ore.

A key social driver is the recognition of the importance of providing high-standard energy services to rural communities, both in Australia and in developing countries. Energy-efficient technologies and small-scale renewable energy systems have an important role to play in satisfying the energy needs of rural communities, especially in developing countries, where the

cost of conventional energy grids is simply unaffordable. The need for affordable energy for low-income households also shapes energy policy. In Australia, this is particularly important for transport, which is a major cost for low-income households.

Political and economic forces are also transforming the energy sector. The 1990s saw the break-up, and in some cases the sale, of publicly owned energy supply utilities and the establishment of a national electricity market. Gas supply is following a similar path. The implications of these changes are far-reaching, and are discussed below. Internationally, oil supply is again becoming an issue. As non-OPEC oil resources are depleted, the potential for disruption of oil supply and increasing costs seems to be increasing. Some experts suggest that world oil production is reaching its geological limits, and that world oil production is likely to peak around 2010 (Konkes 2000). From this point there would be a post-peak decline in availability of around 3% each year. If this is correct, it means the ongoing growth in consumption of oil cannot be maintained, even if the political issues can be managed.

Environmental drivers have always influenced energy use. For example, the shift to coal from wood in Europe in the industrial revolution resulted from massive deforestation. Over the past 15 years, global warming has emerged as a potentially major driver of energy policy. Fossil fuel use is the major contributor to global warming, although land clearing and a range of other activities are also significant. Essentially, humans have burnt so much fossil fuel that the carbon dioxide released has raised the concentration of CO_2 in the atmosphere by 30% over the pre-industrial level, to a point where it is higher than at any time in the past 400 000 years. This CO_2, along with other greenhouse gases, is raising the Earth's temperature as it traps heat that would otherwise escape to space. Unprecedented international negotiations have seen the introduction of the Kyoto Protocol which, if ratified, will require developed countries to reduce their overall greenhouse gas emissions by 5% by the compliance period of 2008–2012. While Australia's target has been set at 108% of its 1990 level of emissions, ongoing energy growth is making it increasingly difficult for Australia to meet its obligations. This puts Australia in a difficult long-term position, as it is expected that much more stringent emission reductions will be required if concentrations of greenhouse gases in the atmosphere are to be limited to levels that do not create dangerous warming effects.

Australia's response to global warming has included an increased emphasis on development of renewable energy and stronger policies on energy efficiency. Reform of the energy sector was originally seen as a greenhouse response strategy, but it has actually increased emissions so far (see below). (Information on Australia's greenhouse response is available at http://www.greenhouse.gov.au) The problem to date seems to be that policies and strategies that promote increased greenhouse gas emissions are outweighing the effects of those intended to reduce emissions. A more integrated approach must be developed over the next few years to resolve this anomalous situation.

One strategy that is likely to become central to our greenhouse response is emissions trading. In broad terms, emitters of greenhouse gases would have to purchase permits for each unit of emissions, while those who reduce emissions or remove carbon from the atmosphere (e.g. through growing trees under certain circumstances) would be able to sell credits. By trading permits and credits, it would be possible for those who can most cheaply reduce emissions or absorb carbon to receive payment from those for whom this was difficult. Overall, economists believe that such a trading scheme would minimise the costs of emission reduction. There are many issues to be resolved, and the Federal Government has announced that it will not introduce a mandatory trading scheme until an international scheme is in place, which is unlikely before 2005.

The implications of emissions trading for fossil fuel suppliers and energy-intensive industries are very significant. While the value of emission permits is not yet known, a wide range of possible prices has been proposed. At the low end, permits may be valued at $10/tonne of CO_2, while prices may exceed $50/tonne according to some authorities. At $10/tonne, the price of coal-fired electricity would increase by around one cent per kilowatt hour—about 10% for households, but up to 30% for energy-intensive industry, which buys energy at much lower prices than small consumers. Petrol prices would increase by around 2.5 cents per litre at this price. A trading scheme would therefore make energy efficiency and renewable energy sources more financially attractive.

Another important driver of developments in the energy sector is the trend towards triple bottom line reporting and management. This approach involves addressing economic, social and environmental performance. When this is done, it is often found that the adoption of

sustainable energy solutions rates highly because it reduces a major environmental impact while often saving on business costs and improving social outcomes.

Restructuring of the energy supply sector

Over the past decade, Australia's electricity and gas sectors have been radically restructured. Traditionally, electricity and gas have been supplied by large publicly owned utilities or, in the case of gas, heavily regulated private or joint public and private organisations. Electricity suppliers were vertically integrated so that one body has been responsible for generating and delivering electricity to consumers. Energy suppliers have had monopolies within their own regions. Restructuring has involved breaking the vertical integration and creating competitive retailing frameworks, so that regional monopolies no longer apply. Power stations or groups of power stations now compete against each other to sell power to retailers. However, transmission and distribution remain as regulated monopolies because, in most cases, it would be wasteful to duplicate their networks. In some states and territories, power stations, networks and retailing franchises have been sold or leased to private businesses.

The restructuring process is only partially complete. While large consumers are now 'contestable'—that is, they can negotiate their own contractual arrangements with energy retailers—domestic and small business customers will only become contestable over the next few years. Also, the East Coast Grid is not fully implemented: four states (Queensland, New South Wales, Victoria and South Australia) and the ACT are now interconnected by transmission lines, while Tasmania may be linked to other states in the coming years.

It is too early to predict the final outcome of this process, but short-term effects have included:

- Lower electricity prices for large consumers, as the participants in the market try to maximise market share, and as increased generation from existing power stations creates a glut on the market. In some states and territories, transition arrangements have meant that households and small business customers have effectively subsidised low prices for large consumers. Prices are now beginning to increase as these transient effects fade.
- Dramatically increased greenhouse gas emissions, estimated at 6 million tonnes per annum above previous expectations of 'business as usual' growth on average over the period 1998–2005 (Allen Consulting and McLennan Magasanik Associates 1999); indeed, the 6 million tonnes is actually estimated to be the impact of restructuring itself. Supporters of the market process argue that over time the market processes will lead to a reduction in emissions. Others are not so confident that a market that does not explicitly place a financial value on the environment will achieve environmentally positive outcomes.
- Efforts to improve energy efficiency and promote renewable energy have faded, as governments cut back programs using the argument that the market would offer them, and new utilities focused on competing for customers using low prices. Recent greenhouse programs by the Commonwealth Government and state organisations such as the Sustainable Energy Development Authority in New South Wales have regained some ground and are building a new momentum.

The focus on low energy prices has obscured the bigger picture. What is important in economic terms is the total cost of energy, which is the outcome of both the cost of each unit of energy and the amount of energy used. Indications are that Australian business has improved energy efficiency more slowly than its international competitors, so the cost reductions have not translated into economic advantage. Instead, Australian business has become more dependent on low energy prices to maintain competitiveness.

The lessons of the early years of energy markets described above are that, if a financial value is not placed on the environment and/or tough regulatory controls are not applied, the market will largely ignore the environment. This is not just Australia's experience. Francois Ailleret, Chairman of the World Energy Council Studies Committee, recently stated: 'clearly market mechanisms and decentralised decision-making have failed to channel investment and technology to develop energy resources in a way that ensures that all energy needs are met and environmental priorities are respected' (Gray 2000).

Schemes such as Green Power tariffs, in which customers voluntarily pay extra for an amount of electricity equivalent to their consumption to be sourced from environmentally sound sources, have met with significant success. By May 2000, more than 70 000 customers

were buying Green Power. Such schemes may be used within the market to differentiate between suppliers, but their impact is likely to be modest. The Commonwealth Government's 2% Renewables Target, a mandatory requirement that electricity suppliers buy extra renewable energy, indicates that the Government is not confident that the market will deliver on renewable energy, and this position is consistent with experience to date.

Introduction of emissions trading or carbon taxes would provide a financial incentive for energy suppliers to integrate renewable energy sources, improve the efficiency of energy supply systems, and to invest in carbon sinks such as forests. However, it may not be in the financial interests of electricity generators to encourage energy efficiency improvements by end users, as they would lose cash flow. The only pressure for energy efficiency improvement would therefore come from the flow-through effects on retail energy prices of the cost of carbon permits. The size of this effect is very uncertain. Experience has shown that key groups who influence energy use, such as building developers or appliance and equipment manufacturers, are not strongly influenced by energy prices, as they are not responsible for ongoing energy bills.

Overall, the impact of energy markets on the environment and on greenhouse gas emissions will be very sensitive to government policies and regulatory frameworks, as well as the timing and form of emissions trading arrangements.

Development of sustainable energy solutions

The vision of a sustainable energy future will be fulfilled by a mix of energy-efficient end-use technologies and sophisticated renewable energy supply systems, combined with restructuring of business activity towards lower environmental impact activities and responsible user behaviour. It will also involve a lengthy transition period from fossil fuels, and from fuels and technologies that have higher environmental impacts. We are beginning to see this transition, with developments such as:

- high-efficiency appliances, equipment and buildings;
- grid-interactive renewable energy systems which draw power from the grid when there is insufficient renewable energy and feed power into the grid when the power generated is greater than the local requirement; and
- integration of renewables with existing conventional energy technologies. For example, Queensland's Stanwell power station will use a solar thermal steam production system to replace some of the coal it now uses.

The amount of energy required for our urban economy depends on the service required, the technology used, and the behaviour of the user. So, instead of assuming that ever-increasing quantities of energy will be needed to achieve economic growth, or accommodate more population, business and households increasingly aim to make energy more productive by doing more with less. For example, businesses and households are becoming more sophisticated in their comparisons of energy options. Instead of just comparing the initial costs of equipment, analysis increasingly includes comparison of savings in future operating costs against higher initial costs of environmentally preferable solutions. At a basic level, many decision makers will now invest in environmentally preferable solutions if the additional cost can be recouped within three or four years. Even this trade-off approach leads to decisions biased against sustainable energy. For example, investing in a solution with a three-year payback effectively requires more than a 30% rate of return each year. This is much higher than the return expected from most other investments. As the perception of risk declines with increasing familiarity, costs decline and performance improves, sustainable energy solutions are gaining increasing market share. Life-cycle environmental analysis techniques are being rapidly developed to underpin environmentally sound decision-making. Energy is incorporated into such analyses, so wider use of such techniques will support greater adoption of sustainable energy solutions. Life-cycle analysis also facilitates consideration of the energy embodied in materials, and the energy used for inputs from a range of activities, such as transport and the manufacture of components.

The economics of these new approaches to delivery of energy services are improving every year, as is their reliability and effectiveness. However, many barriers remain. The emerging competitive energy markets are dominated by traditional energy supply solutions, and more work is required to provide fair access to customers and grids for small independent energy suppliers, and to create incentives for energy companies to promote energy efficiency. Incentives and/or regulations are needed so that designers, manufacturers and builders incorporate energy efficiency into their products. And decision-makers must be provided with

sufficient information to make informed decisions, as well as incentives to consider the long-term consequences of their decisions.

Programs run by agencies such as the New South Wales Sustainable Energy Development Authority, the Sustainable Energy Authority of Victoria, agencies in other states, and the Commonwealth Government's Australian Greenhouse Office and Department of Industry Science and Resources are all contributing to the development of sustainable energy products and services, as well as to the growth of the industry itself. We are also seeing increasing interest at the local government level. More than 85 councils now participate in the Cities for Climate Protection Program, which involves them in the preparation of greenhouse inventories, action plans and targets, as well as the implementation of emission reduction measures.

Water

Water as a limiting factor on future settlement

Opinion is divided on water as a limiting resource factor on the future growth of Australia's population and settlement. Some, such as Withers (1999), argue that water (or the lack of it) is not a barrier to increased population, due to the comparatively high level of renewable water resources in Australia (Walker 2000). Population increase is considered to be more problematic in relation to waste assimilation, environmental systems and greenhouse gas emissions.

The amount of water available per person appears to rank Australia among the most favourable in the world at the national scale; our average annual divertible resource is 7.7 ML per capita (Smith 1998). But Australia does suffer from large temporal and spatial variations in the distribution of rainfall, which is likely to be exacerbated by greenhouse climate change. While there is plenty of water on a gross, time-averaged, national scale, in some catchments water is fully committed. Fundamentally human settlements are not limited by the overall water volume—just the way we use it (Harris 2000).

In the Water and the Australian Economy Study (AATSE and IEAust 1999), the suggestion that water is a prime constraint on Australia's economic growth and population was rejected. The study concluded that there are many ways in which the economy (and population) can grow, despite water resource limitations. The authors felt this could be achieved through maintaining flexibility in water allocation and increases in efficiency of use.

Irrigation within the rural sector is the main consumer of water in Australia; its expansion has been the major factor in the overall growth of water use and the consequent pressures on the resource base and the environment (Crabb 1997). This situation is not expected to change, and the dominant driver of future water demand will continue be the irrigated agriculture sector (AATSE and IEAust 1999). The challenge facing that sector is to ensure that water is used efficiently and allocated to the highest-value uses.

During the 1990s, water use declined absolutely in Sydney and Melbourne and remained static in Hobart and Adelaide (AATSE and IEAust 1999). In comparison, urban water use is still increasing in the Northern Territory, south-eastern Queensland, and the south-west of Western Australia. The latter two regions currently use 38% and 46% of divertible fresh water resources respectively, and are likely to experience pressure for new water resource development (AATSE and IEAust 1999). This pressure for new water resource development may be responded to with traditional approaches such as diverting surface water resources, or with emerging approaches such as stormwater and wastewater reuse and demand management.

Urban salinity

Land and groundwater salinity and rising water tables are not just a rural issue; they also cause problems in many urban areas throughout Australia. More than 80 regional towns and cities as well as suburbs of Sydney have problems related to salinity (AWWA 1999; New South Wales Salinity Summit 2000).

The causes of urban salinity include clearing of native vegetation, roof and paved area runoff draining to the soil profile, disruption of natural drainage line, watering of domestic gardens and public areas, overflows from septic tanks and sullage pits, and water leakage from water supply, sewer and stormwater drainage pipes.

The impacts of urban salinity include the loss of trees, grass and other vegetation; corrosion of gas, water and sewer pipes; damage to roads; and decay of building foundations, local streets and highways (MDBMC 1999). The cost of these impacts to the community is great. For example, the reconstruction of major highways costs up to $1 million per kilometre

(AWWA 1999), while the reconstruction of just one street in a town block costs an estimated $300 000 (Department of Land and Water Conservation 2000).

Pharmaceutical contamination of wastewater

Pharmaceutical substances are used for human and veterinary medicine. Most medical substances are metabolised before being excreted from the body, although, for example, 30–90% of an administrated dose of most antibiotics to human and animals is excreted with the urine as active substances (Halling–Sorensen et al. 1998). Such pharmaceutical substances enter the sewer system and, in most cases, drain to wastewater treatment plants.

Some preliminary research in Britain, Switzerland and Germany found that treatment systems remove as little as 20% and, at best, approximately 95% of the pharmaceutical substances, depending on the substance and the level of treatment (Ternes 1998, Buser et al. 1999, Fisher 2000). These substances (including antibiotics and human hormones such as oestrogen) can reach detectable concentrations in rivers and lakes, and there is growing concern about the occurrence, fate and possible effects of such substances in the environment (Ternes 1998, Buser et al. 1999). Industrial wastewater may also be another source for the contamination of surface water bodies such as rivers and lakes (Ternes 1998).

Past experience with biologically active compounds such as pesticides, antifouling agents and endocrine disrupters has shown that, despite low concentrations, potential effects of biologically active compounds on the environment cannot be discounted (Stuer–Lauridsen et al. 2000). In the case of antibiotics, the selection and dissemination of resistant bacteria in nature should be avoided in order to ensure effective treatment against infectious diseases and maintenance of an ecological balance (Guardabassi et al. 1998). However, there is still not enough information about the behaviour of pharmaceutical substances and their metabolites during wastewater treatment, the contamination of the aquatic environment and the toxicity of such substances (Ternes 1998, Stuer–Lauridsen et al. 2000).

Restructuring of the urban water industry

Since the 1996 State of Environment Report, the urban water industry has undergone considerable change. There has been a shift from development (engineering) to management. This shift in focus has been accompanied by greater involvement of the community, the introduction of pay-for-use price systems, further organisational restructuring and reform (which started in New South Wales and Victoria in the late 1980s), corporatisation of water utilities and, in the case of the Adelaide system, franchising to an international consortium (ASTEC 1995; Crabb 1997; AATSE and IEAust 1999).

Organisational restructuring and reform sought to clarify accountabilities by separating the policy, regulatory and commercial (operator) functions, and providing urban water businesses with clear commercial goals of customer service, environmental compliance and sound business operation free of other conflicting objectives (WSAA 1997). Regulatory roles were transferred to regulatory authorities. According to Smith (1998), the COAG Water Reform Agenda assumed that the public sector model was inefficient and that private sector business practices would lead to better management and financial savings. Referring to both urban and rural reform, Smith (1998) went on to state:

> the hope is that the new institutional arrangements, particularly those linked to tariff changes and other pricing mechanisms, will lead to improvements to all forms of environmental quality. It is recognised, by proponents and critics alike, that attainment of these goals requires strong regulatory bodies.

Again, referring to the water industry as a whole, AATSE and IEAust (1999) considered that the natural resources and environmental aspirations of the COAG Water Reform Agenda are far from being realised.

Settlement scale and economies of scale

In the 1996 SoE Report, the State of the Environment Advisory Council (1996, pp. 3–35) hypothesised that, as settlement size increases, resource use efficiency also increases, due to economies of scale (recycling), higher densities (space), accessibility (transport, energy) etc. The universality of this relationship has been questioned by Yencken and Wilkinson (2000, p.143) who have called for a research focus in this area. A report of CSIRO's Urban Water Program (Speers et al. 2000) assessed how scale effects costs for an urban greywater recovery,

treatment and reuse system. Five scales of greywater recycling systems were analysed, ranging from 12 through to 120 000 household connections, with results suggesting an optimum size falling between 1200 and 12 000 connections. Similar studies are required for electricity generation in the context of photovoltaic systems in residential subdivisions, local stormwater retention and reuse, and local district public transit ('dial-a-bus') systems.

Food

Genetically modified food

Gene technology enables plant breeders to go beyond the capabilities of traditional plant breeding within species, to the introduction of genes from unrelated plants or even from bacteria or animals. Beneficial modifications to food crops are proposed which include increasing yields, improving nutrient values and inducing resistance to insects and plant diseases. In Australia, the only genetically modified (GM) plants grown commercially are insect-resistant (INGARD) cotton (Huppatz and Fitzgerald 2000). Elsewhere, GM soya, corn, canola and potato are grown and others will follow, though their release onto the market may be halting as a result of consumer concern, especially when safety is raised as an issue. The testing of food for safety, where it is not known what the hazard might be, is almost impossible and thus stalemate is the likely outcome. GM food has recently been banned in the UK, predominantly on food safety grounds, presenting the food industry with an insoluble dilemma. The greatest concerns were in fact environmental, which are much easier to address. Australia has a Genetic Manipulation Advisory Committee (GMAC) which advises upon the release of GM organisms, and is establishing an Office of the Gene Technology Regulator (OGTR) which will implement the regulation of industry.

Materials

For Australia, over a century of global wealth based on 'easy oil and metals' is at an end (Konkes 2000). The challenge for Australian mining companies is to continue the search for new reserves, although lack of exploration success is being attributed to three factors: the lack of new-generation exploration and mining technology, the environmental challenges of zero waste and zero emissions in mining by 2020, and uncertainties due to Aboriginal land rights.

Dematerialisation

If materials are seen as a means to an end, with that end being some utility or service, it is possible to envisage a number of possible ways to deliver the service using less net material and energy. Dematerialisation is the reduction or elimination of the material component of services by focusing not on the products but on the utility they deliver. Many examples of dematerialisation exist, such as nappy wash services where the use of the nappy is retained, but its ownership and laundering are not. Efficiency of scale in the production and laundering of the nappies has the potential to reduce material inputs to the system. These, however, have to be traded off against transport energy use to deliver and collect nappies.

One example of dematerialisation at an industrial scale is shared responsibility contracts, which are coming into use in the supply of chemicals to manufacturing industry. The manufacturer contracts the chemical supplier to provide and manage the chemicals required to produce manufactured goods. However, the chemical suppliers are paid, in at least some degree, on a per unit of manufactured output and not per unit of chemical use. This provides the chemical suppliers with an incentive to minimise the chemical inputs required in the manufacturing process. This is the opposite of the dominant existing situation whereby chemical suppliers are rewarded for maximising chemical use in a process through increased sales of the chemical rather than the manufactured product.

The concept of dematerialisation can also be seen in terms of resource efficiency. Weizsaker et al. (1997) argued that it is possible to supply twice the goods and services we currently use with half the resource use, with existing technologies. Others have taken this concept further to suggest a factor 10 (or 90%) reduction in resource use will be required if we are to have a chance of stabilising environmental pressures such as global warming.

Ecodesign and life-cycle analysis responses

The use of most materials is largely set at the design stage of product development and processing. For this reason, it is important to focus on reducing environmental impacts during

the design of new products and processes. This is equally important for something as large as the Sydney Olympic Stadium as it is for a domestic appliance such as a kettle.

The Dishlex dishwasher, made by Email Appliances (formerly by Southcorp Appliances), was redesigned with a focus on materials and water use and overall energy efficiency. Life-cycle analysis was used to determine environmental priorities in the redesign and to evaluate design options against the existing design. The result was a dishwasher that used less materials in its production but, more importantly, used far less material and energy over it useful life because of energy and water savings.

Techniques are being developed that can track the web of energy inputs to products and services, as well as their operational energy use and the energy impacts of their disposal. The full energy implications of our use of products and services can then be evaluated, and optimised to maximise efficiency and minimise environmental costs.

Reducing material impacts through recycling

Much of the policy drive for recycling has been to reduce the volume of waste disposed to landfill, but for many materials such as metals and plastics their disposal in landfill also represents a great loss of resource and embodied energy. The initial production of these materials requires significant energy and resource inputs, and leads to the production of airborne, waterborne and solid wastes. If these 'spent' materials can be collected efficiently and sorted or separated from other materials, they can be recycled with lower environmental impacts than that of the production of new products from virgin material. A recent study commissioned by EcoRecycle Victoria showed that recycling steel, glass and PET (polyethylene terephthalate) containers in Melbourne leads to energy savings of between 70% and 85%, depending on the material (Grant et al. 1999). Recycling aluminium is generally recognised to save up to 95% compared to primary production.

Buy recycled

'Buy recycled' campaigns are used to assist in the development of markets for recycled material. Current programs in Australia are voluntary, while in some other countries mandatory recycled content programs have been initiated. The Buy Recycled Business Alliance is a group of Australian businesses which produce and use recycled products and which promotes the use of recycled products and helps support recycled product producers.

Waste

Beyond recycling—value addition through better reuse and reprocessing technologies

Secondary products manufactured with recycled materials can often be more expensive than products made with virgin materials. This is because of the additional costs associated with collection, transportation and reprocessing. In addition, there is a general perception that some products made with recycled materials are inferior in quality. Value-adding through better reuse and reprocessing is one approach to increasing the use of recycled materials. There are numerous examples of value-added reuse.

Case 1—Value added re-use of demolished concrete. Concrete rubble from demolition has traditionally been crushed for use as a road sub-base. This is a relatively marginal application where the less stringent specification requirements allow the recycled material to compete on an equivalent performance basis against virgin aggregates. Crushed rubble for road base is also nominally cheaper than virgin aggregates for concrete. However, recent research at CSIRO has resulted in the development of premixed concrete containing recycled concrete aggregate (RCA) for non-structural applications. An example of this value-adding innovation is its application in the recent construction of several recreational facilities with premixed concrete containing RCA. The project was conducted in collaboration with the Victorian Government agency EcoRecycle Victoria, the City of Hobsons Bay, Wyndham City Council and The Alex Fraser Group. With the move towards performance-based specifications, it is anticipated that restrictions on RCA content in new concrete will be restrained only to cautionary recommendations for situations where limited technical data exists to support field performance.

Case 2—New value-adding technology for crumb rubber. In Australia, over 16 million waste tyres are generated annually. About 60% go to landfill and 15% are disposed of illegally through dumping (Atech Group 2001). This leads to landfill pressures as well as the risk of

Australia's ecological footprint

The ecological footprint methodology provides a tool for measuring human consumption pressures on the environment. Ecological footprint analysis, as applied by Wackernagel and Rees (1996), accounts for flows of energy and matter to and from a defined economy and converts these into the corresponding area of land required from nature to support the flows. Ecological footprint measurement is able to provide an indication of the sustainability of our consumption levels, by comparing the ecological footprint of a population with the area of land available (Petroeschevsky and Simpson 2000). The current global consumption of natural resources is appropriating an area of land 35% larger than the area of ecologically productive land estimated to be available (Wackernagel et al. 1997).

Ecological footprints can also provide an indication of equity in resource consumption between nations. Wackernagel et al. (1997) calculated that there are 1.7 ha of ecologically productive land per capita available globally—this is called the globally available 'fair share'. The issue of equity between humans and the rest of the biological world is also raised here: the 1.7 ha per capita allows 88% of ecologically productive land for human use and 12% for other uses.

In a comparative study of 52 large nations (80% of the world's population), Wackernagel et al. (1997) found that Australia has an ecological footprint of 8.1 ha per capita. This far exceeds what is available at a global scale; that is, we are consuming more than our global 'fair share'. On the other hand, in Australia there are 9.7 ha per capita of available ecological capacity. This surplus, however, is not available for future increases in Australia's population or to sustain any increase in per capita consumption, as it is being appropriated by other economies as exports.

There have been four major ecological footprint studies undertaken in Australia: Canberra (Close and Foran 1998), south-eastern Queensland, Queensland and Australia (Simpson et al. 1998), and the two most recent studies covering the whole of Australia (Lenzen and Murray 2000, Simpson et al. 2000). The studies take a similar approach to that proposed by Wackernagel and Rees (1996) but with some alterations to account for Australian conditions, so they are not directly comparable with international results. The footprint estimates of these studies range from 4.5 ha per capita for Canberra to one estimate for Australia of 14 ha per capita. Most estimates for Australia are around 4 and 5 ha per capita. In all cases, land for energy and pasture make up the greatest part of the ecological footprint.

Despite the variability in the estimates of ecological footprints in Australia, the results indicate that the average Australian consumes at least more than double their 'fair share' of the world's ecologically productive land. While the total area appropriated by the Australian population is (hypothetically) within Australia's geographical boundaries (i.e. our ecological footprint is less than the nation's available ecologically productive land), our heavy economic dependence on the export of rural goods and increasing land degradation means that the capacity for future population growth and increased consumption is limited.

tyre stockpile fires which emit toxic gases. One of the major obstacles that has prevented effective high volume reuse of scrap rubber is its incompatibility with either rubber or polymer matrices. Therefore, crumb rubber could be used only to produce low-performance products such as impact-absorbing mats or garbage bins. New surface engineering technology developed by CSIRO has significantly changed the outlook for scrap rubber. By increasing the chemical reactivity on the surface of crumb rubber, binding properties are significantly improved. This has resulted in the potential to manufacture high-performance products with up to 60% crumb rubber contained in polymer (e.g. polyolefins, ABS, polyurethane) or rubber matrices for value-added applications in the footwear, automotive and building products industries.

A large range of technologies are available for reprocessing and converting both liquid and solid hazardous wastes (Environment Australia 1997). For domestic wastes, energy recovery is one alternative being considered by various states and territories. In New South Wales, two alternative reprocessing technologies are being implemented to recover energy from organic garden wastes—a bioconversion plant in Port Stephens Council and a gasification facility for Wollongong City Council. The former will also coprocess sewage sludge (Chapman 1999) in addition to garden wastes.

Environmental labelling approach to waste minimisation

Environmental labelling is one approach that may lessen the environmental impact of waste generation and disposal. There are more than 20 countries worldwide with environmental labelling programs. These include the Blue Eco-Angel program in Germany, Green Label in Singapore and EcoLabel in the UK. The German Blue Eco-Angel program provides an

'Eco-Mark' label for over 4000 products and has been running for over 20 years (Blue Eco-Angel 2000).

Environmental labelling may be provided in different ways:

- *government mandated or awarded labels*, such as energy efficiency ratings for appliances;
- *self-declarations* (Type II as per ISO 14021) by manufacturers, for example, recycled materials content in or recyclability of a product; and
- *eco-labels* based on Life Cycle Analysis-type assessments, which provide the consumer with information on the environmental impact due to the manufacture, use and disposal of a particular product in comparison to an equivalent product that performs a similar function.

Since there may be variations in labelling criterion employed in different countries, there have been concerns that environmental labelling can be used as a trade barrier (ASEAN 2000). These barriers may be relevant for international trade or interstate trade. The release of the ISO 14021 standard on environmental labelling is designed to provide generic guidelines on methods to evaluate and verify self-declared environmental claims.

Population health and well-being

As indicators in this report suggest, recent health trends for Australians have been generally positive, although Indigenous communities have largely missed out on the improvements. For Australians in the 21st century, health-related risk factors can be assigned to several major categories (after Guest et al. 1999):

- *non-modifiable*—age, sex, race, family history.
- *modifiable physiological or behavioural*—smoking, diet, alcohol, sedentary lifestyle and their links to cholesterol, high blood pressure, diabetes and obesity.
- *environmental*—air pollution (especially fine particles and tropospheric ozone), electromagnetic radiation from high-voltage powerlines close to housing and workplaces, water quality, new industrial chemicals released to the environment, heavy metals from diverse sources, antibiotic contamination (via urinary excretion) of recycled wastewater, build-up of persistent organic chemicals (PCBs, organochlorides etc.) in the biotic environment, and threats to health as a result of climate change.
- *socio-economic*—the role of social and cultural factors such as family income, levels of education, occupation and working environment, social support networks and residential living conditions. Indicators tabled in this report suggest that Australians living on low incomes in particular are more likely to suffer disabilities and chronic illnesses, or report recent illness. Long-term unemployment would increase the risk of premature death from suicide or mental illness, and lead to greater use of health services (Dixon and Welch 2000).
- *geographic location*—introduces the added dimension of physical access to that of socio-economic access to explain the variability in health outcomes for Australians living in different types of settlements. In this report, on several key dimensions of morbidity and mortality, outcomes were found to deteriorate with increased rurality and remoteness. Developments in telemedicine could make a positive contribution here (see below).

Emergence of new diseases

As the battle to control known diseases continues, other new threats have emerged. Diseases once thought to be retreating have re-emerged. Worse still, new diseases have emerged—many of them unpreventable or untreatable at present. Some have affected international trade and tourism, while others have led to the mass slaughter of poultry and farm animals, as in the case of outbreaks of foot-and-mouth disease in the UK in February 2001. Many have overwhelmed health services and caused significant illness and death (WHO 1999).

Several different factors contribute to the emergence or re-emergence of diseases, including social, economic, political and ecological factors, and the interactions of organisms, hosts and the environment (Longbottom 1997). The changing distribution of populations, the increase in international travel, the development of resistance to antimicrobials, changes in human behaviour and changes in the environment have all contributed to disease emergence.

Australia is not immune to the emergence of new diseases. Recently recognised diseases/organisms in Australia include bat paramyxovirus which causes respiratory disease in humans and horses (Selvey and Sheridan 1994), and a lyssavirus which causes neurological symptoms in humans (Allworth et al. 1996). The first reported outbreak of Japanese encephalitis in Australia occurred in the Torres Strait in 1995, with the first case reported on the Australian mainland in 1998 (AIHW 2000a). There has also been a resurgence of some vaccine-preventable diseases, with widespread outbreaks of measles, pertussis and rubella (Longbottom 1997).

Environmental changes and health

Scientific evidence suggests that the trends in global warming and changing patterns of extreme weather conditions seen in the past few decades may signal unprecedented rapid climate change. Predicted impacts within the next 50 to 100 years include regional decreases in agricultural production, increased prevalence of diseases spread by mosquitoes and other insects, water shortages, and the displacement of tens of millions of people in developing countries through rising sea levels.

Considerable attention has been drawn over the past few years to the possible effects of global warming on human health. This enhanced greenhouse effect, combined with increased ultraviolet radiation as a result of stratospheric ozone depletion, may already be affecting human health in many parts of the world (WHO 1996). Particularly important are the spread of vector-borne diseases and exposure to ultraviolet radiation.

Exposure to ultraviolet radiation

Ozone in the atmosphere absorbs much of the dangerous ultraviolet (UV) radiation before it reaches the ground, but we can still receive enough to cause sunburn and more serious health problems (ARPANSA 1999a). Depletion of the stratospheric ozone layer results in people and the environment being exposed to higher intensities of UV, particularly its more damaging component, UV-B. (See the Atmosphere Theme Report for more details.)

Parts of the body most affected by UV exposure are the skin, eyes and immune system. Exposure to sunlight is known to be associated with various skin cancers, accelerated skin ageing, cataracts and other eye diseases, and possibly has an adverse effect on a person's ability to resist infectious diseases (UNEP 1998, WHO 1998a, ARPANSA 1999b).

Short-term or acute effects of UV exposure include sunburn and photosensitivity. The skin is the principal human barrier to the outside environment, and thus the first line of defence against foreign objects that may threaten health (Longstreth et al. 1998). Long-term or chronic effects of UV exposure include skin dryness, blemishes, ageing, freckles, moles, solar keratosis (pre-cancerous growth of skin cells) and skin cancer, including non-melanocytic skin cancer and melanoma (Longstreth et al. 1998, WHO 1998a, ARPANSA 1999c).

Exposure to UV radiation is also known to impair vision by damaging the cornea, ocular lens and retina (Ewan et al. 1991, ARPANSA 1999c). Effects of UV on the eye include photokeratitis, pterygium, retinal damage such as age-related macular degeneration, cancer of the eye and cataracts.

There is some evidence to suggest that UV exposure of the skin at hazardous levels suppresses some immune response mechanisms in humans.

Vector-borne diseases

Climatic changes are also expected to increase the activity of arboviruses and other viruses by extending the habitats of their mosquito vectors. They may also create a suitable environment for malaria transmission. Globally, a mean temperature increase of 1–2°C would enable mosquitoes to extend their range to new geographical areas, leading to increases in cases of vector-borne diseases, especially in populations living just outside the areas where these diseases currently occur (WHO 1998b). Changes in precipitation and temperature could radically alter the patterns of vector-borne and viral diseases by shifting them to higher latitudes and higher altitudes, thus putting larger populations at risk (McMichael 1991, Patz et al. 1996, WHO 1996).

It is widely recognised that weather is important in the genesis of outbreaks of human arboviral disease in Australia. The main mosquito-borne diseases of concern in Australia are encephalitis (caused by Murray Valley encephalitis and Kunjin viruses), epidemic polyarthritis (caused by Barmah Forest and Ross River viruses), dengue fever and malaria. Heavy rainfall

and flooding may result in outbreaks of Murray Valley encephalitis, while these and other environmental factors such as rising sea levels may lead to greater tidal penetration of coastlines and an increasing incidence of Ross River virus infections (Patz et al. 1996, Mackenzie et al. 1998).

Telehealth

Throughout the world, people living in rural and remote areas struggle to access timely, quality specialised medical care. Residents of these areas often have substandard access to specialised health care, primarily because specialist physicians are more likely to be located in metropolitan areas and large urban centres. Innovations in computing and telecommunications technology, however, have made it possible for many elements of medical practice to be accomplished when the patient and health care provider are geographically separated (Telemedicine Information Exchange 1999).

Telehealth or telemedicine refers to the delivery of health services at a distance through the transfer of information, including audio, video and graphic data, using telecommunications. Telehealth has been developing in Australia since the Flying Doctor Service used pedal radios to communicate with remote settlements from 1928 (http://www.rfds.org.au). More recent years have seen a rapid expansion of telehealth services that provide for considerable reductions in cost for services to remote areas. Current telehealth activities in Australia encompass videoconferencing consultations, counselling and communication, medical image and data transfers, multidisciplinary and specialist support for health workers and clients, education and training, administration activities, access to databases for health workers and consumer information (ANZTC 1999). Because of telemedicine, geographical isolation need no longer be an insurmountable obstacle to the basic needs of timely and quality medical care (Telemedicine Information Exchange 1999).

Improving the quality of indoor environments

Australians will continue to spend over 90% of their time in indoor environments of various kinds. We are thus exposed to pollutants in buildings, outdoors and vehicles. In the past, environmental control has been on the basis of outdoor pollutant concentrations, but it is now realised that exposures in buildings and transit vehicles can be much more significant than outdoors. Risk assessment and control needs to be based on a total exposure assessment, the sum of exposures in all micro-environments that we live in.

To improve the indoor air quality of buildings, the challenges are twofold: to improve the ventilation in buildings and to increase the use of low-emission building products and appliances.

The mechanical ventilation rates of commercial buildings and the air infiltration rates of dwellings have been reduced over the last 15–20 years to conserve energy, but with detrimental effects on indoor air quality when indoor pollutant sources are significant.

The most effective way to control indoor pollutants is to limit their introduction into indoor environments by reducing emissions from source materials. Low-emission products are now manufactured for interior paints, reconstituted wood-based panels and unflued gas heaters, but the methods by which pollutant emissions from these products are assessed and the criteria by which emissions are considered ‘low’ are yet to be standardised and defined. CSIRO research has established preliminary test methods (Brown 1998a, 1999b, 1999c, 2000) that could form the basis of standards, but further research on risk assessment criteria is needed to establish acceptable product emission limits. These limits could then be used in green labelling schemes, an approach now gaining currency in other developed countries.

Indigenous Australia

The impacts of Native Title on settlement patterns

The re-emerging role of Indigenous people in environmental management processes, for the first time since the early colonial contact period, is occurring as a result of the recognition of Native Title Rights. The impact of human settlements and their populations on the natural environment, including river catchments, forests, and coastal areas, as well as on Indigenous sacred sites and heritage places in towns, are all matters related to Native Title Rights. Indigenous groups, through the Native Title process, are negotiating degrees of involvement with all levels of government in environmental decision making. For example, the

Quandamooka Land Council of Moreton Bay negotiated a Memorandum of Agreement with the Redland Shire Council in 1997 which has already resulted in the jointly executed North Stradbroke Island/Minjerribah Planning and Management Study. This study covers a number of towns and coastal resorts in the greater Brisbane metropolitan region. Although the Quandamooka Native Title Claim over this area had not, at the time of writing, been determined by the Federal Court, the cooperative approach to environmental planning and management has been openly embraced by the Shire Council.

The future economies and social environments of Indigenous settlements

In most of the remote discrete Indigenous settlements of Australia, there is a lack of viable industries and enterprises. In the same regions the non-Indigenous economies are often failing, non-existent or inaccessible to Indigenous people. There are a range of mining and cultural tourism projects that are an exception and may represent potential growth areas for future Indigenous employment. However, for the most part there is widespread reliance on welfare support and government-funded programs in lieu of unemployment benefits. Alternative approaches to enhancing Indigenous well-being suggest that the focus should be increasingly on social entrepreneurs building on local capability as compared to a welfare-only approach, and on all relevant government departments taking a coordinated approach to community development.

A general lack of both economic and recreational facilities is parallelled by increasing problems of substance abuse and violence in Indigenous communities. The quality of life of future generations of Indigenous Australians, particularly in remote discrete settlements, represents a critical planning issue in Australia's future.

The ongoing Indigenous health problems

The current inadequacy of housing and settlement infrastructure has been clearly identified as making a significant contribution to the atrocious standards of Indigenous health. Although a number of government capital programs have been implemented in the last decade to address these problems, it will take a much larger and coordinated budget over many decades before Indigenous people can enjoy the same quality of built environment and health in remote and rural settlements as do Australians in metropolitan centres.

Although some minor housing gains were recorded during the inter-census period of 1991–1996, the problems of housing need, such as numbers of people living in improvised dwellings, overcrowding, family stress and homelessness, remain severe (Jones 1999). The Indigenous housing backlog identified by politicians in the early 1970s remains elusively out of reach. Although gains are being made on various fronts, the supply of houses seems to barely match population growth. Not only is funding required in Indigenous communities to offset these shortages, but also training and management systems to ensure adequate care and reasonable life expectancy of the physical infrastructure.

Urban design

The achievement of liveable and sustainable settlements (to the extent that any settlement can ever be fully sustainable) requires more than attention to the specific issues discussed in this chapter. It also requires significant changes to the governance and management of human settlements. Prominent among these changes must be institutional change, change in the structures and approaches of the agencies of government, the private sector and the professions, and change in the way that issues and problems are defined and their solutions are approached.

To illustrate what that might mean in one area of the planning, design and management of human settlements, the concluding section of this chapter explores ways in which urban design might in the future more effectively contribute to liveable and sustainable cities, towns and villages.

Urban Design in Australia, the report of the Prime Minister's Urban Design Task Force (1994), described urban design as being concerned with visual meaning, functional efficiency and broad access to change in cities and towns. 'Good urban design policy and practice', it continued, 'seeks to optimise options that take into account aims of public participation, access, ecological health, social impact, economic growth, technological innovation and meanings of place.' Since 80% of Australians live within 50 km of the coastline—nearly all in urban settlements, and a considerable proportion of the balance live in inland towns—urban

design quality significantly affects most Australians, economically, socially, environmentally and culturally.

What has been achieved through urban design in recent years? It was largely as a reaction to the sterility of some aspects of architectural modernism, especially when applied to the public realm, that a resurgence of interest in urban design took place around the world and in Australia from the 1970s onwards. One significant achievement in the last 25 years has, therefore, been a growth in the awareness of urban design. Today, urban design is a familiar term in academia, in government, amongst consultants and in the community. There is a vast body of international and a growing body of Australian literature on urban design. State and territory governments have taken many urban design initiatives. Municipalities have multifold urban design strategies. Urban designers and urban design consultancies abound, although few have been formally educated in urban design. A further significant achievement has been the movement to protect historic precincts within Australian cities and townships. Many such areas, including city streetscapes such as parts of Collins Street in Melbourne; historic precincts such as Paddington in Sydney; northern Adelaide; and heritage towns such as Fremantle in Western Australia, Beechworth in Victoria and Tilba Tilba in New South Wales, are protected under planning laws and there is now, for the most part, a mature respect for them in the Australian community and treatment of them by government agencies. Table 75 provides an illustration of the extent of local government heritage protection in Victoria and New South Wales. Other material is to be found in the SoE Cultural and Natural Heritage Theme Report. In South Australia, 13 of the 14 regions have been surveyed, and 17 of the 68 councils have local heritage lists and 15 have heritage advisers.

Table 75: Local government and heritage protection in New South Wales and Victoria. [HS Indicator 3.1]

Description	New South Wales (1997)	Victoria (1999)
Number of local councils	177	78
Surveys—comprehensive (completed or under way)	84	42
Surveys—partial	n.d.	24
Protection in planning scheme or local environment plans (LEP)	126	9
Protection—partial	n.d.	67
Councils with heritage officers	40	n.d.
Councils with heritage advisors	102	55
Councils with heritage funds	64	n.d.
Councils with no LEP, advisor, funds or committee (New South Wales)	34	n.d.
Councils with no protection (Victoria)	n.d.	3
Councils with no surveys attempted (Victoria)	n.d.	12

n.d. = no data.

Source: Data from the New South Wales Heritage Office, Sydney; Heritage Council Victoria (1999).

Heritage listings are commonly on property in the most sought-after areas within our cities and towns, with a consequence that pressures for redevelopment remain high and can result in major conflicts between local governments and property developers.

A third important change has been the use of public space. Cafes and delicatessens have spilled out onto the streets in cities and towns across Australia. Public space has become livelier and better used and the quality of streetscape settings has greatly improved. Other achievements have been the improvements in many waterfront environments. Southbank in Melbourne, Circular Quay in Sydney, the Brisbane city waterfront and the Newcastle foreshore redevelopment are good examples. Information on green open space in Australian cities is difficult to access, quantify and compare, with each authority operating their own idiosyncratic classification; most cases relate to zoned land use under planning schemes (e.g. Melbourne, Canberra, Perth) rather than actual land use. Melbourne is distinguished by its many fine public gardens within walking distance of the CBD (see Whitehead 1997), a feature shared with the city of Adelaide and Canberra city, and all products of enlightened planning from an open space perspective. Subsequent generations of planners and developers have deserted the ‘garden city’ concept in favour of privatised open space—the detached house on a ‘quarter-acre’ block of land.

Implications

The practise of new urban design in Australia, with some notable exceptions, is still sadly wanting. In city centres, good strategies are often put in place, such as the strategy for the Southbank area of Melbourne, but then structures that contravene those strategies on many counts are allowed to be built. In the suburbs there seems to be general government indifference to the impact of powerlines and cabling on residential areas, and of inappropriate scale and treatment of suburban shopping centres to the significance of neighbourhood character in inner and middle ring suburbs experiencing redevelopment. Along the coastline there are few coastal towns of any real urban design quality. Of even greater importance is the lack of an integrated vision for urban areas—that is, of a vision that encompasses ecological and equity concerns, effective transport planning, the needs and behavioural preferences of people, the planning of the public realm to maximise public benefits and encourage appropriate commercial, economic and other uses—together with sensitive design skills and approaches. When very creative, aesthetic designs are generated they are rarely integrated with these broader social and environmental concerns.

Of particular concern is the way design for sustainability has been neglected as a key component of successful urban planning and management. Some of the greatest opportunities for interventions to bring about more sustainable settlements are through sustainable design, such as the design of new settlements, infrastructure, buildings and facilities. Important work has been done by the National Centre for Design at the Royal Melbourne Institute of Technology to start to rectify this situation.

One problem is the failure to translate academic research and theory into useful practice. Another is the nature of the operation of the property market and the failure of government to manage and encourage property developers to produce outstanding design, and a corresponding blindness from the development industry to the financial benefits offered by good design. Also an issue is the short-sightedness of politicians in their rush to encourage development of any kind, regardless of its long-term impacts on the city, as is the failure of national governments to take effective leadership roles. Another problem is the absence of strong community organisations focussed on the quality of urban design. And finally, there is the neglect of techniques used in other countries to encourage higher-quality urban design. Each of these problems is briefly explored below.

Although academic urban design research has greatly increased, there is not nearly enough research into the ingredients of successful urban design in Australia. This kind of applied research, together with penetrating theoretical investigation, is of crucial importance. As Stephen Dovers has observed in another context, its absence leads to policy adhocery and amnesia because policies and institutional arrangements are constantly being reinvented (see Yencken and Wilkinson 2000, p.316). We also rely upon the universities to help teach and train policy managers and urban designers to understand the way in which urban design needs to encompass enlightened coordinated approaches to transport, economic, property development, and ecological and social planning, together with research findings on people's concerns and behaviour in public places. Design education for the built environment requires cross-disciplinary teaching, all too infrequently achieved in universities.

Effective public urban design requires an in-depth understanding of the property market and skill in the evaluation of commercial costs and opportunities. There are very few instances where urban areas are under the full control of public authorities. Nearly all major urban design initiatives require the steering and management of private development. There are two possible options for public authorities. One is much more strategic public acquisition of land for development. This is an approach regularly used in Europe. It not only helps to reduce land prices, but also enables public authorities to set higher design and other standards for development. While it is of great importance that governments control the quality and accessibility of public space (roads, pedestrian areas, water edges, open space), land acquisition or assembly by governments does not imply that public authorities have to be the land developers and builders. In many instances, it will be most effective to put the development of acquired land out for tender by private developers. The second option is to develop much higher skills in land and development economics so that public managers are able to debate proposals with developers on equal terms. This is another area of urban design teaching and practice that is greatly neglected in Australian universities.

Good urban design takes time. Nearly all interventions to get work completed to coincide with political or other short-term cycles lead to flawed results. There are many misconceptions

about the real economic benefits of 'cranes in the skies'—the sense that any development, no matter what its impacts, leads to economic vitality. Many developers now understand that design quality has significant long-term benefits, but there are still many who do not. Here the problems are exacerbated by the different motives of short-term developers and long-term owners. The issue of life-cycle analysis in the context of energy costs in building, for example, is explored in an earlier section of this report. The concept of self-containment in urban design is also being explored in several of Australia's cities; for example, the town centres of Canberra, Melbourne's 'urban villages', and Brisbane's new master-planned community at North Lakes.

The commissioning of the Prime Minister's Urban Design Task Force (1994) and the publication of *Urban Design in Australia* in 1994, together with the urban design election platform of the first Howard Government, marked a high point of national interest and leadership in urban design, signifying a bipartisan federal valuation of and approach to urban design. Since that time, the Federal Government has decided to leave issues of urban design to the states and territories. With other national agendas in place, this seems an appropriate moment for the Federal Government to reintroduce a modest national program designed to raise awareness and develop skills across Australia.

A crucial problem for urban design is the absence of strong community groups committed to urban design. In the UK, the Civic Trust plays a key national role in arguing and negotiating for higher-quality urban design. It is supported by many regional and local amenity associations. In Australia, we have powerful non-government organisations, such as the National Trusts and State Conservation Councils, that take an active interest in urban design quality, but there are no comparable bodies concerned, as is the Civic Trust, with wider aspects of urban design. The encouragement of such groups is the key to the future.

In sum, urban design and urban planning and management across the full spectrum of built environment applications should be looked at more rigorously as one of the prime means of dealing with the issues highlighted in this chapter. Good urban design is a form of public wealth creation. Urban design with highly valued aesthetic qualities, good movement and sustainable form goes on creating wealth for centuries.