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Renewable Energy Policy and Practice in Western Australia

Chacko Thomas[a] and David Harries[b]

[a]*Energy Studies, Murdoch University, western Australia*
[b]*Research Institute for Sustainable Emergy (RISE). Murdoch University, Western Australia*

ABSTRACT. Renewable energy is commonly seen as an essential strategy for sustainability. Many governments, however, have sustainable energy or sustainability strategies that place little emphasis on renewable energy. One reason is that despite acceptance of the concept of sustainable development as a concept, the reality is that economic growth remains the dominant policy objective of most governments and sustainability and sustainable development are such ill-defined concepts that lack of precise definition often confuses the debate. Climate change, however, is one issue for which the meaning over what is sustainable and what is unstainable has become clearer and the need to balance economic growth with reductions in greenhouse gas emissions has become urgent. The question of by when, by what means, by how much and by whom GHG emissions need to be reduced are now the critical questions. The question of the extent to which renewable energy is essential to the goal of reducing emissions therefore has become more pressing. Some governments continue to see renewable energy as an expensive and unnecessary option and that other, lower cost options for reducing greenhouse gas emissions from the energy sector exist. Western Australia makes an interesting case study as the State is experiencing rapid economic growth supported by rapidly increasing energy use and greenhouse gas emissions. Policies to date have focused on the fact that the state relies heavily on natural gas rather than coal and encourages the efficient use of energy. Western Australia's energy situation and greenhouse gas emissions strategies are reviewed in order to assess the extent to which this greenhouse gas reduction policy that has to date placed a relatively low emphasis on renewable energy is likely to be successful.

INTRODUCTION

Market-based economies the world over have resulted in the development of a socio-economic system that can produce, distribute and consume vast amounts of commodities. The strains being placed on the resource base and life support systems of the planet as a result of the productive power of the global market system are increasing. Ironically, the very signs and symbols of material progress are breaking up both the traditional ways of life and resource use of contemporary societies and paradoxically, resulting in increasing strains on the social, economic and environmental fabric of our environment.

Development is normally defined in economic terms, with economic growth at the heart of the concept. Growth signifies an increase in size, number, value or strength. Given this definition, growth cannot be sustained indefinitely on a finite planet. At the macro level (GNP), measures of economic well-being are quantified mainly in terms of growth. The extent to which economic growth represents an adequate measure of development is increasingly been questioned and the limitations of GNP as a measure of growth of a society or nation are well known. Neo-classical economics, however,

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does not acknowledge that resources bear a relationship to each other in the natural environment, as part of environmental systems and fails to recognise that depletion of environmental resources in the pursuit of economic growth is akin to living off capital rather than income. The concept of sustainable development was developed to address the failure of economic development to account for the ecological and social factors.

The concept of sustainable development is not without problems. Conservatively over 60 definitions of sustainable development exist today, with the definition contained in the Brundtland Report being the most commonly sighted. The different definitions do not exist in a socio economic or ethical vacuum; whilst the economistic definitions attempt to extend the neo-classical economic perspective to embrace sustainable development, the ecocentric definitions search for a new paradigm of sustainable development. At present neither of these two competing views is able to capture the complexity underlying the concept of sustainable development.

Many governments nonetheless have incorporated the concept of sustainability into policy making and policies. In terms of renewable energy, this raises the question of an increased reliance on renewable energy is a necessary component of any sustainability strategy.

The difficulty in attempting to answer this question is that it requires weaving a course through a fog of vague terms and definitions, the immediate one being the lack of precision over meaning of the term "sustainable development". The common definition of "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" [1] is too high a level definition to be of practical use. A more practical interpretation of sustainable development is that decisions that affect future generations need to address social, economic and environmental issues, without trading one off against the others. To provide greater rigour to the assessment of the impacts of an activity, economic, social and environmental indicators are used to assess the impacts of an activity. Trade-offs between the social, environmental and economic impacts, however, are always being made in development decisions, with what constitutes "an acceptable" trade-off being a political decision. The political reality, furthermore, is that economic growth is the primary political imperative of government as it is seen as the principle means of generating employment and improving living standards. In their pursuit of this economic growth, governments are therefore under pressure to trade-off environmental and social objectives in order to increase the economic outcomes. This is politically possible as what these trade-offs mean in terms of reduced sustainability is unclear as sustainability is ill-defined.

One relatively unquestioned indicator of sustainability, however, is the impact that an economic activity or development will have on climate change. Although consensus over the degree to which climate change is occurring or represents a threat is not total, there is very broad and growing acceptance that the current level of global greenhouse gas emissions is unsustainable. A "business as usual" (BAU) projection of greenhouse gas emissions based on projected population growth, economic activity and energy use, is for greenhouse gas emissions to more than double pre-industrial concentrations before the end of this century [2].

Continued economic growth will require significant increases in energy use as the supply of reliable and competitively priced energy is a prerequisite for maintaining a

productive economy. World energy demand is projected to increase by 53% between 2003 and 2030 without additional policies to constrain growth in demand, indicating the need for strong policy action to move the world onto a more sustainable energy path [3]. This increase in energy use will not be sustainable unless the increase in greenhouse gas emissions resulting with this energy use is constrained by relying on low or zero emission energy sources, or is offset in some way.

There are two diametrically opposed perspectives on the question of how necessary it will be to rely on renewable energy resources to meet this increase in energy demand. One assumes that sustainable economic growth will necessarily require the portion of total energy use that is supplied from renewable energy to be increased significantly. In those cases where economic growth and energy demand are increasing most rapidly, the increase in renewable energy use would therefore also have to be the most rapid as it would be insufficient for the rate of increase in renewable energy to be exceeded by the rate of growth of total energy use. The policies of many environmental groups and renewable energy proponents are aligned with this view.

The diametrically opposed view to the above is that it will not be necessary to rely to any real extent on increased reliance on renewable energy to meet this increase in energy demand as other energy technologies are (will become) available to reduce greenhouse gas emissions and reliance on those other technologies will enable greenhouse gas emissions to be reduced or constrained at a lower cost. The policy positions of governments that have sustainability strategies or policies, but which do not rely on increased use of renewable energy to any significant degree, are aligned with this second view.

Western Australia is a case in which the government position to date has been aligned with the latter view and represents an appropriate case study for asking whether it will be necessary to increase reliance on renewable energy in order to achieve sustainable economic growth. It makes a useful case study because economic growth in the State is very strong, contributing to growth in the State's already very high per capita greenhouse gas emissions, and yet policy support for renewable energy remains relatively low.

ENERGY CONSUMPTION – THE AUSTRALIAN CONTEXT

A prevalent theme in celebrating the centenary of the federation in Australia is how the environment has shaped the people and the people have shaped the environment. National policies have an important bearing on state policies and hence in order to understand WA's sustainability, greenhouse and energy policies it is therefore imperative to first look at the national energy situation and policy context. Idiosyncratic responses by the Australian state to policy challenges have been fundamentally shaped by Australia's geography, climate and resources exploitation.

The primary energy sources used in Australia are fossil fuels - coal, oil and natural gas (Figure 1). Approximately 41% of primary energy production is sourced from coal, 35% from crude oil and 19% from natural gas. Australia is the largest exporter of coal, with three times as much black coal being exported as is used in Australia. It also

exports large amounts of natural gas and is also a major producer of uranium, all of which is exported as Australia does not have a nuclear power industry.

Renewable energy sources account for only 4.7 per cent of primary energy production, with hydro-electricity being the predominant renewable energy resource.

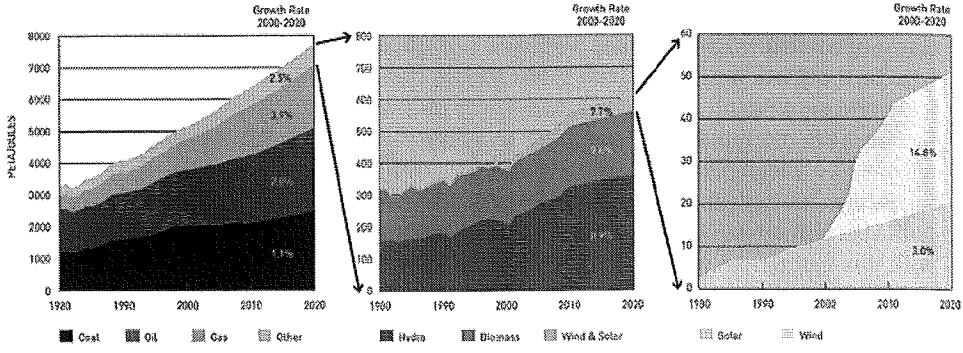


FIGURE 1. Past and projected energy use in Australia [4].

Energy consumption in Australia has more than doubled over the past 30 years from around 2,700 petajoules to more than 5,500 petajoules a year. Though, the average annual rate of growth in consumption has fallen from a peak of 5.8 per cent in 1988-89 to 1.9 per cent in 2004-05, large differences occur in the rates of growth in energy consumption among the states and territories.

The increase in energy intensity and energy use was due to increased transport, commercial and residential sector energy intensities and structural changes in the economy towards energy-intensive manufacturing industries. However, both energy intensity (energy consumed per dollar of GDP) and carbon intensity (carbon emitted per dollar of GDP) in Australia have decreased slightly over the past decade [4]. According to the U.S. Energy Information Administration (EIA), Australia ranks ninth among countries of the Organization for Economic Cooperation and Development (OECD) for per capita energy consumption and third among OECD countries for per capita energy-related carbon emissions [5].

Electricity generation today accounts for 44% of Australia's primary energy use, most of which is produced from brown coal (54.8%), black coal (21.9%), natural gas (14.2%, hydro-electricity (6.8%), and petroleum oil (1.3%). Other sources, including other renewable energy sources, represent just 1% of the fuel mix (Figure 2). Electricity use increased by 60% between 1990 and 2005 and is growing at 3.2% per annum, with demand projected to increase by 35% by 2020.

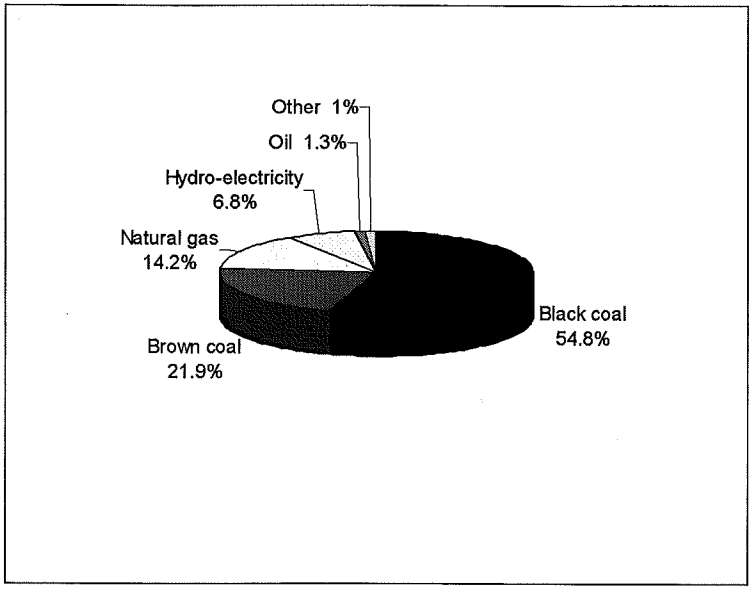


FIGURE 2. Fuels used to generate electricity in Australia, 2004[6].

Approximately half the electricity produced in Australia is consumed in the residential and commercial sectors (Figure 3) and demand in these sectors is increasing at a rapid rate due to both increasing demand from existing residential and commercial customers as well as increasing numbers of customers [7]. Furthermore, Australia's population is projected to grow by approximately 30% by 2020, which may further exacerbate the problems associated with fossil energy production.

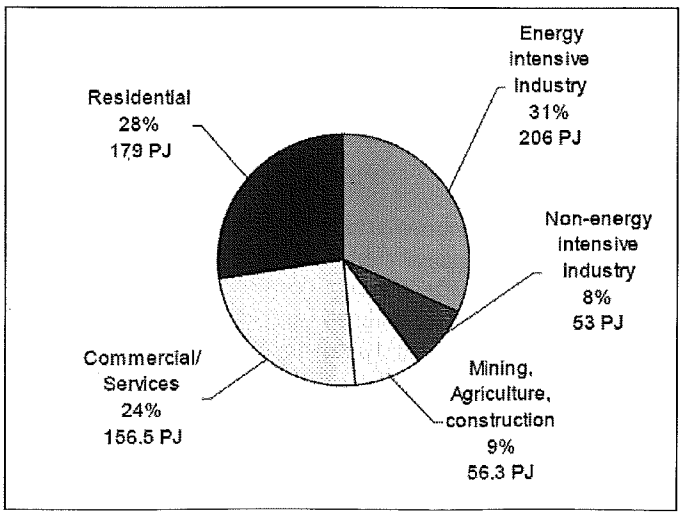


FIGURE 3. Electricity use in Australia by sector, 2001[8].

Although, the Australian government has not ratified the Kyoto Protocol, it has committed to meeting its Kyoto Target of limiting growth in greenhouse gas emissions to 108% of 1990 levels by the first Kyoto commitment period primarily through the use of voluntary measures and changes in land use change and forestry. However, Australia's greenhouse gas emissions are projected to reach 603 Mt CO2-e/year over 2008–12, or 109% of 1990 levels, only 1% above the Kyoto Target.

It is estimated that the measures put in place by Commonwealth, state and local governments will cut annual emissions by 87 Mt CO2-e by 2010 below BAU projected emission levels (i.e. without these measures emissions would have been 125% above 1990 levels by 2010). A substantial portion of the reduction in emissions achieved to date has due to a reduction in forest clearing. Emissions from land use change and forestry in 1990 were estimated to be 129 Mt CO2-e and this is expected to be reduced to 45 Mt CO2-e by 2010 (Figure 4).

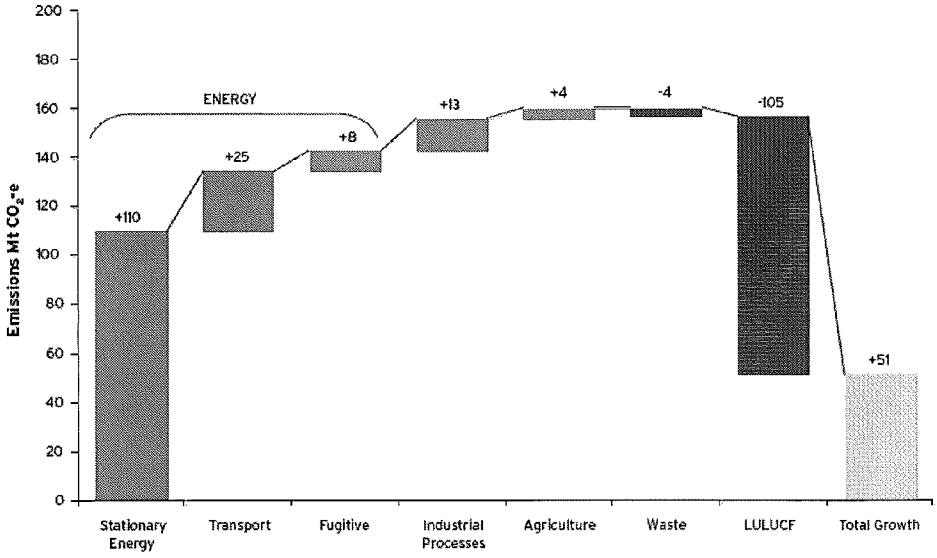


FIGURE 4. Change in emissions by sector: 1990 to 2008-12[9].

Australia's greenhouse gas emissions are projected to reach 127% of the 1990 levels by 2020[8]. Energy emissions are projected to reach 516 Mt CO2-e by 2020, an increase of 80% over 1990 levels. Seventy percent of stationary emissions produced from electricity generation and emissions from stationary sources are projected to increase by 56%, or 110 Mt CO2-e, by 2010, and 84% above 1990 levels to 361 MT CO2-e, by 2020

It is estimated that the combined impact of all of the measures that are being put into place to reduce emissions from the stationary energy sector will reduce emissions by 35 Mt CO_2-e by 2010. Renewable energy measures will make up a portion of these reductions from the stationary energy sector.

The most important renewable energy initiative has been the Australian Government's Mandated Renewable Energy Target (MRET), which was introduced in the negotiations leading up to the Kyoto Agreement in Japan in 1998. The MRET will result in the amount of electricity in Australia that is generated from renewable energy resources being increased by 9,500 GWh by 2010. Electricity retailers and wholesalers meet their requirements by purchasing renewable energy certificates (RECs) from accredited renewable energy generators. The scheme is now fully subscribed and the MRET will not drive any further investment in renewable energy The MRET was initially designed to increase the proportion of electricity in Australia that was generated from renewable energy resources by an additional 2%. Due to more rapid growth in electricity demand than was forecast at the time the MRET was introduced, the MRET will not result in any significant increase in the proportion of electricity that is generated from renewable energy resources. The MRET was reviewed and the review committee recommended that the scheme be extended, a recommendation that was rejected by the Australian government.

Reasons For Limiting Reductions In Greenhouse Gas Emissions and for Low Reliance on Renewable Energy to do So

The Australian government's relatively low reliance on using renewable energy to reduce greenhouse gas emissions can be attributed to its views on the need for reducing greenhouse gas emissions and the options for doing so. These views are summarised below:

1. Climate change is not yet proven to be a real threat

Federal government members have on occasion publicly expressed the view that climate change is not yet proven to be a real phenomenon or a serious threat. The federal Minister for Industry, the Hon. Ian MacFarlane, for example, in late 2006 described Al Gore's popular documentary, An Inconvenient Truth, as "just entertainment" [10].

2. Australia's contribution to global greenhouse gas emissions is very small

One of the primary arguments used at the national level to argue against further reducing greenhouse gas emissions has been that Australia's contribution to global climate change is very small (1.4% of total global greenhouse gas production) and that greenhouse gas reduction measures would therefore risk damaging the nation's economy while contributing very little to the solution globally.

Australia, however, ranks as the 14th largest emitter as a country in the world [11]. While it is therefore true that whatever Australia does to reduce its greenhouse gas emissions will have a relatively small impact in terms of slowing global climate change, the same is true of most other countries. As a relatively wealthy country it will be more difficult for Australia to avoid reducing greenhouse gas emissions using this argument.

Australia's per capita emissions in 1990 were 33 tonnes/capita. This is expected to reduce to 29 tonnes per capita by 2010 and to then increase again to 31 tonnes per capita by 2020 [12], making Australia the largest per capita greenhouse gas emitter in the world and thereby seriously eroding the capacity to argue against the need for Australia to reduce its greenhouse gas emissions.

Nonetheless, some members of the federal government argue that since Australia is responsible for only around 1.4% of the world's GHG emissions, it should not worry too much about reducing them, as it will have minimal effect on global climate change. This 'pragmatic' argument contravenes the principles of both polluter pays and ability to pay, as Australia has very high emissions per capita and is a wealthy nation. If a wealthy nation with high per capita emissions refuses to adopt and pursue emissions reduction targets, it will be impossible to persuade developing countries to adopt targets. More importantly, what message does this send to countries in the Asian sub continent, as Australia is seen as a leader, both in the regional and in a global context.

3. A significant reduction in Australia's greenhouse gas emissions would impact on the Australian economy and Australia's competitiveness.

It is a widely held belief in government that increased energy costs could reduce Australia's competitiveness in a global economy. Adopting practical measures to reduce GHG emissions domestically, brings with it several challenges. Primarily, the most important challenge facing the government is the prospect of trading-off prosperity against emissions reduction, which may result in higher energy costs on the domestic front, thereby making the nation uncompetitive in a global market. The federal government therefore perceives its first priority in developing a response to climate change to be to protect the Australian economy and its competitiveness.

In August 2006, the Prime Minister claimed that while no one in government was questioning that large cuts in greenhouse gas emissions would eventually be required (around a 60% reduction by 2050), to achieve such large cuts it would be necessary to impose a carbon tax and that would have enormously damaging impacts on Australia's economy. He was of the view that the evidence for the need for such cuts needed to be compelling before action was taken [13].

4. Coal is Australia's largest export commodity and it will be critical for the Australian economy to develop ways of reducing emissions from the use of coal (i.e. so called "clean coal" technologies).

The coal industry as a whole continues to oppose any mandatory CO_2 emission limits, in fear that it will be an economic loser under such a regime. Modest fuel switching is beginning to occur, as existing energy utilities and their customers come under increasing pressure to address CO_2 emissions. Technologies that burn coal more efficiently, capture the carbon dioxide released and geo-sequester it are seen as the

best solution to the coal industry's problems. Very significant amounts of federal government, state government and industry funding are therefore being invested in the development of these technologies.

5. **It will be necessary to reduce greenhouse gas emissions by approximately 60% by 2050 but this will require the use of technologies such as nuclear power.**

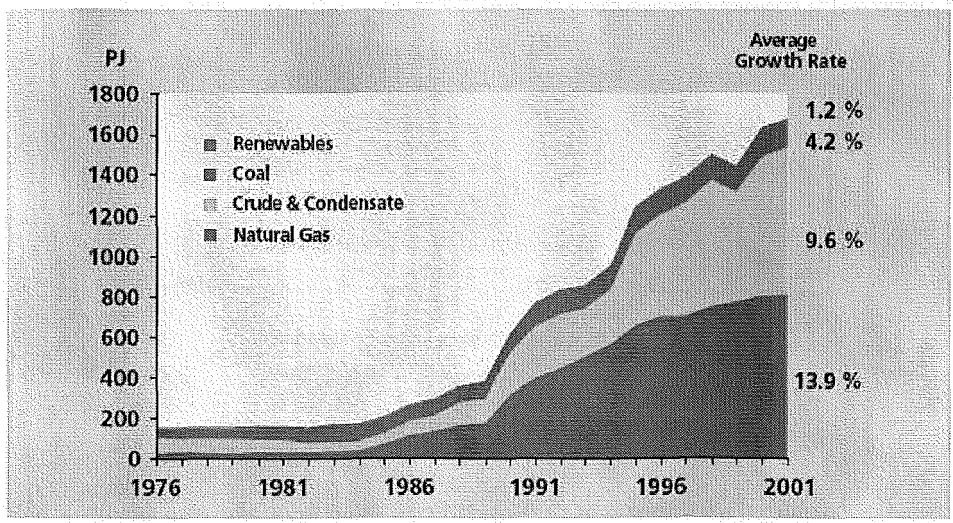
The federal Government recently appears to take the view, that wide adoption of nuclear power represents the only possible way to reduce greenhouse gas emissions 'without a substantial fall in living standards' [14].

WESTERN AUSTRALIA

The Western Australian Economy and Energy Consumption

Western Australia's energy supply and use situation differs from that of the other Australian states and territories in a number of ways. Fossil fuels (natural gas, oil and coal) account for a large portion (over 99%) of Western Australia's total energy use. Renewable energy accounts for less than 1% of primary energy production and approximately 3% of final end use. This low reliance on renewable energy is due primarily to the lack of low cost hydro-electricity resources in the state.

Unlike most of the Eastern Australian states, where coal is the dominant source of energy, Western Australia's energy use is characterised by high use of natural gas and the proportion of energy supplied by natural gas is increasing more rapidly than are other forms of energy (Figure 5).



Source: Office of Energy estimates, based on Australian Bureau of Agricultural and Resource Economics data.

FIGURE 5. Energy Consumption in Western Australia.

Another difference between WA and most other states is the rate of growth in energy use. Energy consumption in Western Australia has risen by an average rate of around 4 per cent a year over the past 15 years and this rate of growth has been outstripped by only one other state, Queensland. This increase has been driven primarily by economic growth resulting in the expansion of energy intensive industries and to a lesser extent by population growth. Mining and minerals processing contribute significantly to WA's economic output and a boom in the mining sector has contributed to a rapid increase in energy demand over recent years.

These factors all contribute to the fact that while Western Australia accounts for 9.9% of Australia's population (Figure 6), it accounts for 14.2% of national energy use (Figure 7). WA's per capita energy use is 384 GJ/capita/year (Figure 8), making it the second highest of the states and territories and 12.1% of Australia's total greenhouse gas emissions.

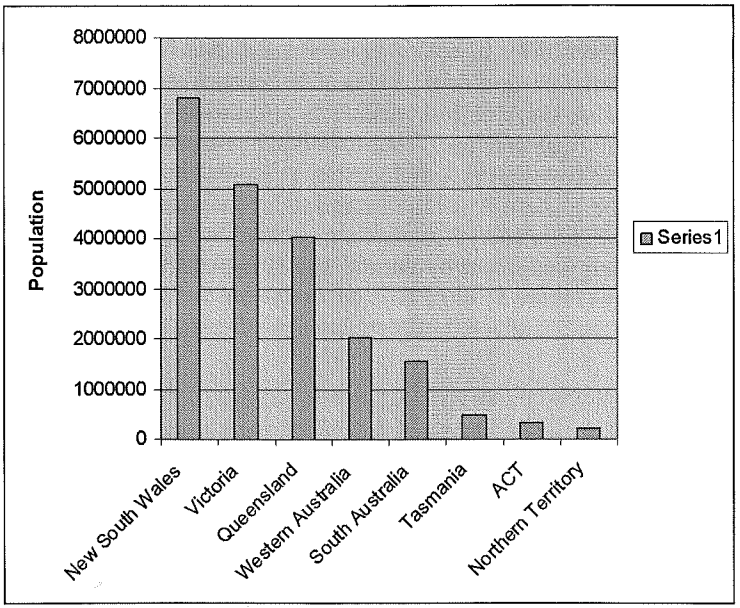


FIGURE 6. Australia's population by state/territory.

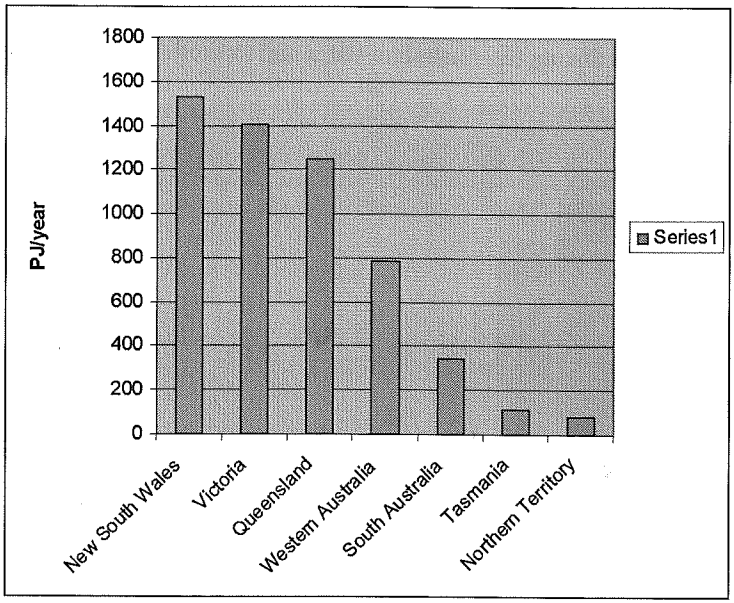


FIGURE 7. Annual energy use by state/territory.

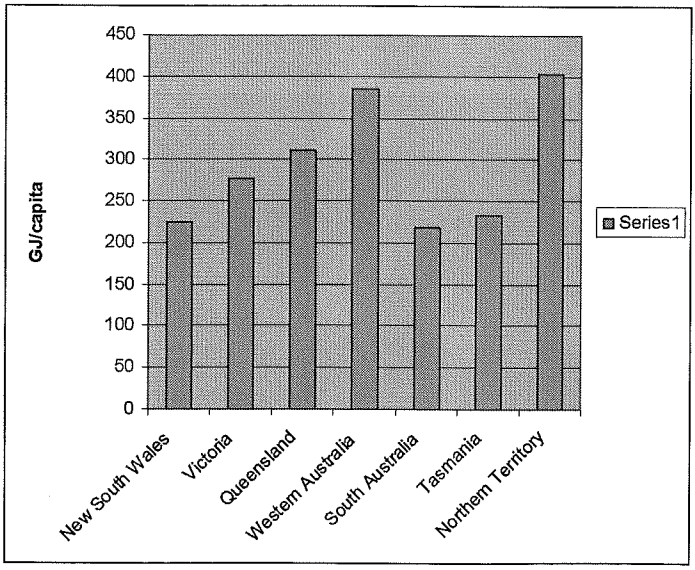


FIGURE 8. Per capita energy use by state/territory.

WA's greenhouse gas emissions of 68.5 MT $CO_{2\text{-}e}$/year make it the 4th largest greenhouse gas emitter among the Australian states and territories (Figure 9).

WA's per capita greenhouse gas emissions of 33.5 t $CO_{2\text{-}e}$ per capita per year make it the 3rd largest emitter among the Australian states and territories (Fig. 10).

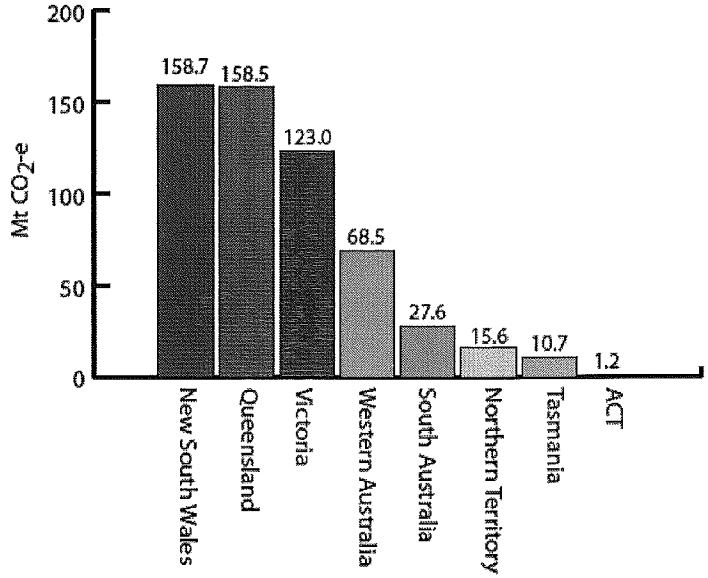


FIGURE 9. Greenhouse gas emissions by state, 2004[15].

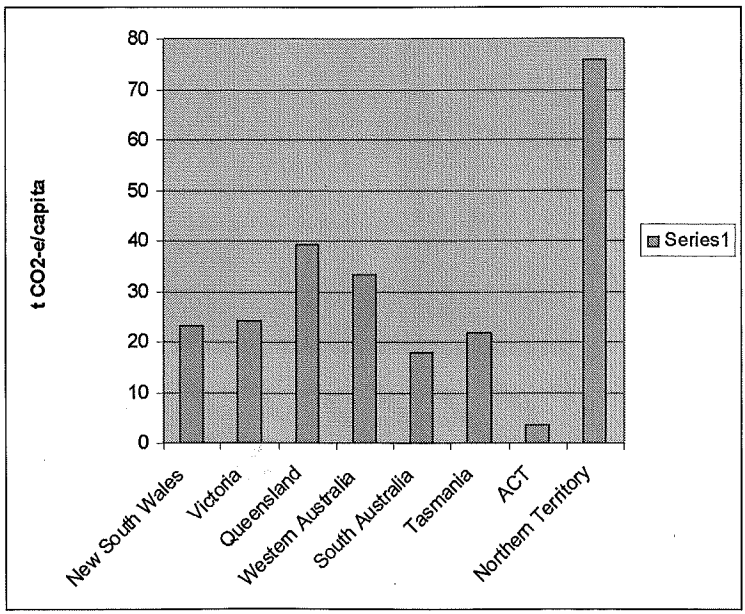


FIGURE 10. Per capita greenhouse gas emissions by state/territory.

The sectoral composition and amount of GHG emissions in WA as reported by the AGO is given in Table 1 below.

TABLE 1. Sectoral composition and amount of GHG emissions in WA [16].

Sector	1990 (Mt CO_2-e)	1995 (Mt CO_2-e)	2002 (Mt CO_2-e)	% increase over 1990
Energy	31.9	39.6	46.6	**46.4%**
Industrial Processes	1.1	1.0	3.2	**189.8%**
Agriculture	16.1	16.1	18.8	**17.0%**
LUC&F	12.7	3.7	0.3	**-97.9%**
Waste	1.0	1.1	1.4	**44.3%**
Total Net	62.8	61.6	70.4	**12.1%**
% increase over 1990	0%	-1.8%	12.1%	
Total (excluding LUC&F)	50.0	57.9	70.1	**40.1%**
% increase over 1990	0%	15.7%	40.1%	

In 2002, WA emitted 70.4 Mt CO_2-e, an increase of 12.1% over 1990 levels. If land management emissions and sequestration are omitted from the State's inventory, emissions rose by 40.1% over the 12-year period of to 2002. At this rate, WA's gross GHG emissions will double by 2024 to 143.2 Mt CO_2-eq [16].

Renewable energy accounts for less than 1% of the State's primary energy supply. Most of this renewable energy is used in electricity production. In 2005-06, an estimated 26,411 GWh of electricity was generated in WA, most of which was produced from natural gas and coal. The South West Interconnected System (SWIS) is the main electricity grid in the South West of the State, accounted for approximately 55% (14,467 GWh in 2005-06) of the State's electricity generated. Figure 11 shows the total electricity generated in 2005-06 in WA by energy source [16].

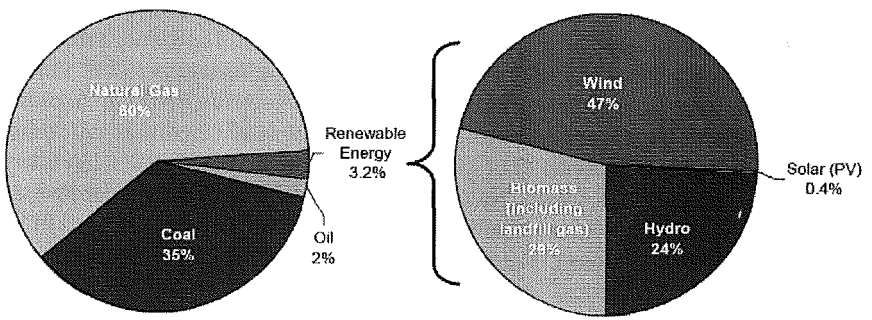


FIGURE 11. Shares in Western Australian Electricity Generation in 2005-06 by Energy Source.

Though, electricity generated from renewable energy in the SWIS has quadrupled in recent years, it still represents a relatively small fraction of total generation. Presently, wind power accounted for approximately half of the electricity generated from renewable energy sources (3.2% of total electricity).

The State's growing greenhouse gas emissions and how these can be effectively reduced has been the subject of considerable debate. Various assessments of the costs and technical potential to reduce emissions from the stationary energy sector using various technologies and fuels, including increased efficiency of energy end use, have been made. Despite the recognition of the scale of reductions required, no policies are in place as yet to achieve such large reductions in emissions.

WA's high energy sector and per capita energy sector greenhouse gas emissions mean that any effective greenhouse reduction strategies will need to focus on the stationary energy sector. Increased reliance on renewable energy has not been seen by the WA government as a strategy that should be relied on for reducing greenhouse gas emissions. The State government has set a non-mandated target of 6% of electricity generated on the SWIS be produced from renewable energy resources by 2010. As almost 5% of energy generated on the SWIS is currently produced from renewable energy sources, this target should be relatively easily achieved without changes in policy. A Bill was tabled in the upper WA parliament in 2006 by the Greens proposing that the proportion of electricity in the stated be mandated to increase to 20% by 2020. The Bill has yet to be debated in the lower house of the Parliament.

Increased reliance on renewable energy has been dismissed as an option for reducing greenhouse gas emissions for the following reasons:

1. A large proportion of WA's energy requirements are met from natural gas.

Sixty percent of WA's electricity is currently being generated by the use of natural gas, and only 35% from coal fired power plants (Figure 12). Using natural gas to generate electricity produces less carbon dioxide per kWh electricity generated than does generating electricity from coal. An argument that is commonly used by the WA government is that if the State relied on coal to generate electricity, its greenhouse gas emissions would be higher and that WA has therefore effectively reduced its greenhouse gas emissions by using natural gas instead of coal. The flaw in the above argument, however, is that it is based on a hypothetical comparison rather than on actual or absolute greenhouse emissions. In reality, WA's very high per capita energy use more than offsets the benefits of using natural gas. Nor is it true that WA's high reliance on natural gas represents fuel switching. No coal fired plants have been displaced by natural gas fired plant. Natural gas is not used instead of coal and as a result the use of natural gas has not resulted in any real reduction in emissions. In fact it represents an additional energy source and the means of massively increasing the State's greenhouse gas emissions.

Furthermore, the importance of fossil fuels to the industrial and post industrial economy of WA has meant that the corporations that supply the fuel and those that use it extensively have developed unrivalled political influence. Today, we see the strength of the fossil fuel lobby has defined the essential political dynamic of the

climate change debate, not just in WA or in Australia, but in almost all countries around the world.

2. Renewable energy represents a high cost means of reducing greenhouse gas emissions and lower cost options need to be used to protect WA's economy.

Given that a large portion of the State's emissions are produced form the stationary energy sector, it will be necessary to reduce emissions from this sector to achieve significant greenhouse gas reductions. The technologies are available for doing so are discussed below.

Energy Efficiency

Increasing the efficiency of energy use is considered by the WA government to be a lower cost means of reducing greenhouse gas emissions from the stationary energy sector than is increased reliance on renewable energy. While some consider significant technical potential to increase the efficiency of end use in the State to exist, the strategies currently in place to achieve those energy efficiency improvements are however limited and are unlikely to result in significant greenhouse gas reductions. Furthermore, the actual scope for increasing end use energy efficiency has not been accurately assessed and some reports have questioned whether the actual scope is as significant as is often assumed, implied or suggested [17]. One of the reasons for this is that the gap between the technical and the economic potential for energy efficiency improvements is known to be large but notoriously difficult to bridge. The take-back effect further reduces the real potential to reduce greenhouse gas emissions via energy efficiency improvements.

The principal 'no regrets' opportunity for the state government is to pursue the path of energy efficiency. By focusing WA's low-emission technology effort on improved efficiency in the immediate and short-term, the state can secure competitive advantages over the longer-term. The recently released Clean Energy Futures report indicates that 85% of savings in the short to medium term can be achieved by three sectors: mining, commercial and residential. Introducing energy efficiency measures without factoring in any carbon price signal has the potential to reduce energy use below projected business-as-usual by between 12% (low scenario) and 28% (high scenario), with cumulative greenhouse emission reductions of 9.4 Mt to 21.6 Mt respectively by 2030 [18].

TABLE 2. Emissions projection and potential emission savings with a 6-year payback at various carbon prices (Mt CO_{2-e}) [18].

Carbon price $/t CO_2e	Scenario	2009-10	2014-15	2019-20	2024-25	2029-30
BAU Emissions (Mt CO_2e)		46.7	53.1	59.3	64.0	70.8
0	Low savings	0.6	2.0	4.0	6.4	9.4
	High savings	1.4	4.8	9.0	14.8	21.6
20	Low savings	0.8	2.7	5.3	8.5	12.4
	High savings	1.9	6.4	12.0	19.5	28.6
40	Low savings	1.0	3.3	6.4	10.2	14.9
	High savings	2.3	7.7	14.5	23.6	34.4

"Cleaner Coal" Technologies

Carbon Sequestration is seen by many in the coal industry as a method to remove GHG emissions from the use of fossil fuels by accelerating their natural rate of removal from the atmosphere. However, practically, this technology is only feasible for CO_2. It is not only viewed as a promising approach to mitigating climate change, but also viewed as an approach that can have significant co-benefits such as improved soil and water quality, restoration of degraded ecosystems, and enhanced oil recovery. Recent studies have shown that geo-sequestration results in the formation of carbonic acid, in regions where water may be present, resulting in the erosion of the rocks, ultimately releasing the sequestered CO_2 back into the atmosphere. Furthermore, according to research by Dr Ben McNeil from the Centre for Environment Modelling and Prediction at the University of New South Wales, indicate that at best, only a reduction by 7% of CO_2 emissions by 2020 is achievable by geo-sequestration technology.

This technology is currently only at the demonstration phase. Elements of CO_2 capture and geologic storage techniques have, however, been demonstrated at commercial scale in a number of countries. In the North Sea, Norway's Statoil natural-gas platform, Sleipner strips carbon dioxide out of the natural gas geologically sequesters the carbon dioxide. Sleipner reduces emissions of carbon dioxide by approximately one million tonnes a year. In Western Australia, this technology is being adopted for use in the Gorgon project on Barrow Island.

Distributed Energy

The scope for distributed energy to provide an alternative to high cost electricity infrastructure upgrades to meet peak loads overseas has generated interest in the use of distributed energy in Australia. Photovoltaics and Combined Cycled Gas Turbines are seen as having an important potential role to play in WA. Current targets in Australia by catalysing the introduction of emerging and existing distributed energy technologies into the Australian energy network, such as biogas, gas engines, micro-turbines, photovoltaics, smart intelligent distributed agents and wind power, obtained from CSIRO's Flagship's Low Emissions Distributed Energy (LEDE)

program aims to facilitate greenhouse gas reductions of 5 per cent by 2020, 14 per cent by 2030 and 22 per cent by 2050.

Nuclear Energy

In recent months, there has been resurrection of the nuclear debate within Australia, primarily because Australia holds approximately 30% of world reserves and the global warming debate.

Proposals for nuclear power in Australia are still considered to be contentious and economically questionable. Of particular significance in this debate is the question - Should Australia embrace a wide range of functions within the nuclear fuel cycle - mining, enriching, using and storing waste products from uranium? Since 2005, a number of senior government ministers have begun to speak more openly in favour of this as an option.

Apart from the disadvantages of large lead times required for the construction of nuclear power plants, others such as the GHG emissions produced during the construction and decommissioning, security concerns of both the plant and the fuel raise, the mismatch between the scale of nuclear plant and WA's grid and the costs of nuclear power, raise serious questions about the viability of such an option. However, the irony is that only if a global carbon tax or carbon trading were established or nationally if Australia were to levy a carbon tax, would domestic nuclear production become economically sustainable. Without such measures, or significant subsidies by government, domestic nuclear power would not be in a position to compete with low-cost electricity generated with coal [19].

3. Renewable energy should not be used as a major greenhouse reduction strategy as the renewable energy business development opportunities in WA are limited.

This argument is based on the preference for greenhouse reduction strategies to provide the State with benefits in terms of the development of new industries that would provide the State with a competitive advantage for using those technologies. It is true that the opportunities for developing renewable energy businesses in the State, such as PV or wind turbine manufacturing are limited. This is also true, however, of most other energy technologies. Relying on only those energy technologies that provide new business opportunities for the State is likely to seriously limit the options available to WA and is unlikely to represent the basis for successful greenhouse reduction strategy. WA was once regarded as the leader among the Australian states and territories in pioneering new renewable energy technologies and businesses. Current policies, however, have seen the closure of renewable energy businesses in the State.

The heating and cooling sector accounts for approximately 40%[1] of overall WA final energy consumption and offers a largely cost-effective potential for using

[1] Note: This is a guesstimate figure, as much of the data is aggregated and it is difficult to disaggregate information to get an accurate figure.

renewable energies, notably biomass, solar and geothermal energy. As a result of the inertia in the heating and cooling sector, even where some of the technologies are cost competitive, the lack of an appropriate policy including targets and the inability to remove administrative barriers and provide consumers with information on available technologies and inadequate distribution channels very little progress has been achieved in this sector.

The Department of Housing and Works is leading a bid for funding from the Commonwealth Solar Cities program to develop and manage a Solar Cities trial in Western Australia. As of 31st October 2006 no announcement by the Australian Government had been made on the outcome of the Perth Solar City bid.

4. Competitive electricity reforms will support growth in reliance on renewable energy.

The WA Government introduced competitive electricity reforms in early 2000 by segregating the State-owned vertically integrated electricity supply company into three State-owned businesses and creating a framework for private companies to enter the generation and retail electricity markets. One of the arguments used in selling the reforms to the public was that renewable energy would be the big winner. It is highly questionable, however, whether the reforms have resulted in any real increase in investment in renewable energy in WA to date. This is not surprising given that the driver in Australia for renewable energy was the MRET scheme. Creating a competitive electricity market on its own is not sufficient to drive investment in renewable energy.

It is also possible that electricity reforms will result in increased greenhouse gas emissions from the stationary energy sector. The reason is that the primary purpose of electricity reform was to force down the price of electricity supply through competition. Driving down the price of electricity use drives up demand and therefore the emissions. This is precisely what was found to occur as a result of electricity reforms in the eastern states. The creation of the NEM in the eastern states resulted in significant increases in greenhouse gas emissions. A consultancy report produced for the WA government when it was debating the benefits of electricity reforms predicted that electricity reform in WA would result in a 7% increase in greenhouse gas emissions from the electricity sector by 2010 [20].

What is the real role of renewable energy?

This paper began by looking at the two diametrically opposed views on the future role that renewable energy will need to play in sustainability. A third view is represented by the study by Pacala and Socolow, which argues that all available technologies will be required to achieve global climatic stabilization at 500 ppm[21] and this is likely to represent a more realistic view that either of the two extreme diametrically opposed views .

If sustainability means anything it means human survival and it is imperative to slow climate change. It is unlikely that this will be possible without relying on a number of technologies, including renewable energy. The extent to which it will be

necessary to rely on renewable energy is unclear but it is likely to be significantly higher than is envisaged in current policy. In WA's case, the arguments for reducing greenhouse gas emissions from the stationary energy sector are very strong and contrary to what appears to be the current policy position, it will not be possible to do so without relying to a much greater degree on renewable energy. As it is likely that the "toolbox" of energy technologies available for reducing emissions will be more limited in WA's case than in North America and Europe, at least in the near to mid terms, the need to rely on renewable energy technologies in WA will be magnified.
The transport sector in WA accounts for approximately 20% of the State's GHG emissions and the vehicle fleet in Western Australia increased by 29% or by an average annual growth of 2.6% in the ten year period 1993-2003[22]. The transportation sector involves long-lived capital equipment and infrastructure. Fuel switching (CNG and LPG); the adoption of new technologies such as fuel cells and the use of renewable energy such as bio-fuels will all be required to reduce emissions from this sector. Some of the options for doing so pose significant challenges in terms of the "chicken and egg problem" with the lack of infrastructure and the lack of adequate vehicles using these alternative fuels posing a significant obstacle to their widespread adoption in the state.

Presently, biofuels cost more than other forms of renewable energy. But they are currently the only form of renewable energy which can address the energy challenges of the transport sector, including its near complete reliance on oil and the fact that greenhouse gas reductions in this sector are particularly difficult to obtain. Given the precarious security of supply situation for oil (and thus for the transport sector) and the fact that the WA economy is heavily dependent on (private) vehicles, the WA government should consider implementing a biofuels directive, with the objective of boosting both the production and consumption of biofuels in WA. The production of biofuels is fraught with a number of issues, including forest clearing and low energy output to energy input ratios, hence the government should carefully evaluate their use from a life cycle perspective.

Apart from the most obvious advantages that renewable energy technology offers and the abundance of various renewable energy resources in WA, one of the most significant factors why the WA government should adopt renewable energy is the employment that such projects provide over their lifecycle (Table 3).

TABLE 3. Average employment for various types of electricity generation [23].

Energy Technology	Average employment over the life of a facility (jobs/MWa)		
	Manufacturing, Construction, and Installation	Operations, Maintenance, and Fuel Processing	Total
Photovoltaic	6.2–5.8	1.2–4.8	7.4–10.6
Wind	0.43–2.5	0.27	0.71–2.8
Biomass	0.40	0.38-2.4	0.78–2.8
Coal	0.27	0.74	1.01
Gas	0.25	0.70	0.95

HEALTH IMPACTS

Environmental change in a globalized economy are altering traditional locations of outbreaks and their severity, with children, the elderly and particularly the poor, being the most vulnerable to the risks posed to human health as a result of climate change. As a result, local vulnerability to infectious diseases has global implications.

The effects of climate change, coupled with man-made environmental degradation have created ideal conditions for the spread of infectious diseases and their vectors, the world over. Furthermore, climate change has also resulted in a shift in the predator prey balance, with predators perishing, resulting in the proliferation of pests and pathogens. Whilst, the range of infectious diseases is restricted by climate, weather affects the timing and intensity of outbreaks. Warmer and wetter weather has the potential to extend the range of infectious diseases beyond regions, where they are endemic. Increasing temperature has resulted in the spread of disease vectors, insect bites and the maturation of microorganisms.

Insect vectored infectious diseases, such as those that are mosquito driven, are expanding their range and are moving to higher elevations, due to a warming planet, which has also resulted in a proliferation of infectious diseases, as the influence of adverse environmental conditions has increased the propensity of diseases such as malaria, schistosomiasis and other vector-borne diseases, chronic respiratory diseases and childhood infections. Since it is directly transmitted through air, health experts view influenza as a "pandemic in waiting" (for the right conditions) [24]. An influenza pandemic today could have catastrophic consequences, as a result of the magnification of its impacts, due to the rapid movement of people and goods, as was evident from the SARS pandemic in 2002-03.

The spread of (infectious) diseases could affect world trade, travel and tourism. The impacts of disease on humans, agriculture and livestock are costly, with the indirect costs often far exceeding the direct costs. Estimates of the economic impacts of SARS range from approximately $11 to 15 Billion in Asia, excluding, Japan, Australia and India, while the global estimates of SARS range from $30 to 50 Billion. However, if one were to take into account the indirect costs, then the figure could easily be in excess of $150 Billion [25]. Infectious diseases like SARS have the potential to cause major disruptions to the global trading system as was evident by the 1991 cholera epidemic, which cost Peru over US$1 billion in lost seafood exports and tourism, or the Indian plague in 1994, which cost the airline and hotel industries over US$2 billion in lost revenues [26].

Extreme droughts and fires resulted in the increase in the incidence of respiratory illness, cardiovascular disease and eye irritations. The forest fires that occurred in Indonesia during 1997 provide a good example of transboundary air pollution. The fires not only caused widespread destruction of forests but also produced air pollution that had serious health related impact on numerous cities in the Asian region. Increased levels of air pollution were detected as far away as Australia, with the final estimated cost of the 1997 haze valued at US$300 Million [27]. Studies have shown an increased propensity of respiratory diseases with air pollution levels, with children particularly between the ages of 3-12 have showing a higher propensity of

hospitalization from acute asthma, as a result of the haze. One estimate puts the total estimated costs of PM air pollution in Singapore as high as US $3,662 Million [28].

LIFE CYCLE ANALYSIS

Sustainability is about having consideration for the next generation whether by ignorance or by political will. Intergenerational considerations must apply to energy creation, consumption and disposal and this can only be accomplished by adopting Life Cycle Analysis (LCA). Often referred to as the "cradle to grave" approach, LCA provides a comprehensive view of the environmental aspects of the product or process from the perspective that they are interdependent, thereby providing a more accurate picture of the true environmental trade-offs in the selection of a technology. As a result, one can analyse the cumulative environmental impacts resulting from all stages in the product life cycle (raw material extraction, material transportation, product disposal[29].

In a Life Cycle Impacts Assessment (LCIA), impacts are defined as the consequences that could be caused by the input and output streams of a system on human health, plants, and animals, or the future availability of natural resources [29]. By identifying the advantages and disadvantages of proposed alternatives, the LCA process provides decision-makers with a better understanding of the environmental and health impacts associated with each alternative and the relative magnitude of each type of impact in comparison.

The challenge is to integrate effective and appropriate responses to climate change in all relevant policy areas. As a result, energy policy needs to be integrated with policies for other sectors such as transport, urban development, land use and clearing, employment etc. to optimize positive synergies, so as to combat the negative effects of climate change, whilst not jeopardizing (economic) development.

CONCLUSION

Mitigating climate change impacts will be challenging. The global economy is fundamentally based on fossil based energy production that inherently produces GHG emissions, with all major sectors of the economy significantly contributing to the problem. As a result, no environmental challenge is more difficult to tackle. The consequences of continued increases in emissions are inevitable and will further exacerbate the problem. Delay in adopting significant emissions reductions, will make future solutions more costly and disruptive. Changing the energy system to operate with lower CO_2 emissions can provide significant benefits. Time matters; the longer WA procrastinates, the more expensive the investment required becomes and the greater the risk that critical ecosystems will be eroded beyond the point at which they can easily recover. Thus, how WA responds will be of great importance not only for the State but also for Australia as a whole. Failure to act resolutely may have much greater long-term costs in WA than in other regions.

WA has significant renewable energy resources, which are already cost-competitive in certain applications, even though their lower CO_2 emissions attributes are not currently valued in the current electricity/energy market due to the lack of an emission trading regime or a carbon tax being levied. Renewable energy policy is a contrast between past and future energy practices and the failure to translate rhetoric to reality is not peculiar to the situation that exists in WA. Ultimately, the true value of renewable energy will only be realised by the adoption of a global carbon trading market, where in a carbon constrained world, significant income may be generated by WA government businesses selling credits. The question now is what constitutes the local, state, national, regional and global interest and has WA identified the problem?

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