The sustainability of desalination plants in Australia: is renewable energy the answer?

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INTRODUCTION

Most of Australia's large urban population centres are currently experiencing water shortages. Australia's four largest urban centres have water storage volumes less than 50% of their capacities. This is due to an expansion in total urban water demand, in large part due to population growth, combined with reduced inflows to storages due to the ongoing drought in many parts of Australia. A drought many regions, such as Sydney, are now claiming as one of the worst on record (NSW Government, 2006).

As a result, there is a renewed focus on increasing water supplies for our urban centres. At the same time, traditional options for expanding urban water supplies are being questioned because of increased awareness of the significant environmental impacts. Furthermore, physical and economic limits are being reached in terms of greater river flow and groundwater extraction. For example, both the NSW and Victorian Governments have ruled out constructing new water supply storage infrastructure for Sydney and Melbourne.

Desalination is now being proposed for a number of urban centres as a supplement to existing infrastructure. Previously in Australia, large desalination plants were used only in the mining and power generating industry. Desalination for urban water usage was restricted to small isolated urban communities with access to no other water supply, such as Kangaroo and Rottnest Islands (AFFA, 2002). The ability to produce potable water independent of rainfall is seen as the major advantage of desalination (for e.g. NSW Government, 2006, Victorian Government, 2006). Furthermore, the cost of seawater reverse osmosis plants have fallen by 300% over the last 15 years (Leslie, 2004).

Large-scale desalination does, however, raise a different set of sustainability issues than those associated with our established urban water systems. In particular, desalination is very energy intensive and its use will drive significant greenhouse emissions from the fossil-fueled generation that dominates Australia's electricity supply. Furthermore, there is a growing view that reductions in dam inflows may be associated with climate change, so a solution to these shortfalls that increases emissions raises some difficult questions. A number of State governments have therefore proposed methods by which they plan to address the greenhouse implications of any desalination plants they build.

In this paper we consider the challenges of such 'offseting' approaches. We first outline current State Government plans for desalination and consider its energy intensity in comparison with conventional urban supply options. The current greenhouse emissions of the Australian electricity industry are reviewed and then a range of existing schemes and possible approaches for offsetting emissions are considered. Sydney and Perth are presented as case studies, as they are two of the largest urban areas in Australia and they have progressed the furthest down the desalination path. Finally the wider sustainability implications and limits to offsetting of emissions are discussed.

DESALINATION - CURRENT PROPOSALS AND THEIR GREENHOUSE IMPLICATIONS

Desalination is under serious consideration for all of Australia's large urban centres except Adelaide – see Table 1. A number of smaller regional urban areas such as the Central Coast in NSW are also planning desalination plants.

Table 1 Water supply capacity and desalination status for some Australian urban centres

Urban Centre	Population	Water Supply Capacity	Desalination
Sydney and Wollongong	4.41 million	39%	Design of a desalination plant up to 500 ML/d with a trigger for construction of 30% supply availability
Melbourne	3.6 million	43%	Currently undertaking a feasibility study into desalination for supply augmentation
Brisbane and Gold Coast	2.77 million	25%	Approval granted for a 120 ML/d plant at Tugun to be connected to the SEQ grid.
Perth	1.46 million	31%[1]	Construction of a 130 ML/d plant at Kwinana. Expected to be operational by 2007. Second 130 ML/d desalination plant proposed as alternative supply option for future growth.
Adelaide	1.12 million	57%[2]	The Waterproofing Adelaide strategy does not consider desalination as a prominent option
Central Coast	0.3 million	17%	Approval being sought for the use of temporary desalination plants with capacity of up to 10 ML/d

[1] Perth uses 50 to 60% groundwater as well
[2] 40% of Adelaide's water use is from the Murray River in an average year

Desalination uses significantly more energy than our traditional storage and pipe network systems and more energy than is required to recycle wastewater to a level fit for reuse – see Table 2. Although energy use is system-specific and so water supply options will use different amounts of energy in different locations, the data presented in Table 2 are broadly applicable to other Australian cities. Note also that water efficiency options save both energy and water.

Table 2 Water supply and operational energy use in selected Australian locations (Note that these estimate are for operational energy only. Embodied energy within the distribution and treatment processes can also be significant).

Water Supply Option	Energy Use (kWh/kl)
Warragamba and other Water Storages	0.25 (Sydney Water, 2002)
Access "deep storage"	0.4 (Leslie, 2004)
Shoalhaven inter-basin transfer	2.4 (Anderson 2006)
Residential wastewater reuse (greenfields)	1.2 (Anderson, 2006)
Large Scale Indirect Potable Wastewater Recycling	2.8-3.8 (NSW LC, 2006)
Desalination	5.4 (NSW LC, 2006)
Residential Indoor Retrofit (that reduces hot water use)	-32.6 (White, 2006)

Large desalination plants are likely to be connected to the State electricity grid. The Australian National Electricity Market (NEM) is an interconnected network joining the power systems of Queensland, NSW, the ACT, Victoria, Tasmania and South Australia. Western Australia has the South Western Interconnected System (SWIS). Usage patterns can vary greatly across location and time, so total electricity demand is somewhat unpredictable. A large desalination plant represents a significant amount of potential peak demand and energy consumption. Important operational questions include the actual duty cycle of the desalination plant in operation, and its flexibility.

Over 85% of electricity generation in Australia is provided by large coal-fired power stations. Gas generation contributes around 7% but is more significant in some states (including Western and South Australia) while hydro generation from the Snowy Scheme and Tasmania contributes another 7% or so (ESAA, 2005). Overall, the greenhouse intensity (kgCO_2/MWh) of the Australian electricity industry is amongst the highest in the world due to this reliance on coal. New renewable energy sources with no operational greenhouse emissions such as wind are now making a growing contribution to Australian electricity supply. For example, there is now around 800MW of wind installed around the country, and proposals for significant additional projects. Such renewable electricity, however, has higher direct costs than conventional generation sources and therefore requires additional cash flows that acknowledge its contribution to reducing greenhouse and other pollutant emissions.

Because of electricity's unique physical characteristics, electricity supply must exactly match electricity demand at all times and at all points within a network. Furthermore, it is not possible to direct electricity flows from a particular generator to a particular load – the network effectively combines all electricity from all generators. The concept of reducing or eliminating the emissions from a grid connected desalination plant is therefore necessarily somewhat abstract. For example, a desalination plant might be claimed to be greenhouse neutral if additional renewable generation is supplied to the network equivalent to the electricity consumption of the desalination plant over time.

This renewable generation would have to be additional to what would have happened otherwise due, for example, to other policy drivers; again a somewhat abstract concept. Alternatively, emissions might potentially be lowered through use of additional gas-fired generation. Here, an assessment of Business-as-Usual generation is even more problematic because gas-fired generation is currently cost-effective as baseload in some networks such as Western Australia, and cost-effective in shoulder and peaking roles across Australia. Finally, there are possible options for offsetting emissions associated with a desalination plant through actions outside the electricity sector such as ecosystem sequestration through changed land-use activities including tree planting. We now consider these options in more detail.

REDUCING GREENHOUSE EMISSIONS FROM ENERGY USE

A number of schemes are available to reduce the greenhouse emissions associated with energy use in Australia. The Mandatory Renewable Energy Target (MRET) requires electricity suppliers to source additional renewable energy where compliance is tracked using Renewable Energy Certificates (1 REC = 1MWh). RECs can only be created by 'new' renewable energy generators that either started operation after 1996 or undertook efficiency improvements, operational changes or plant upgrades that increased generation above their baseline (MRET Review, 2003). Use of MRET and hence RECs to ensure use of renewable energy by a desalination plant would require a retrospective audit to ensure that for every MWh of electricity used, the operator of the plant had purchased a REC, which was then surrendered to ORER for extinguishment and not used by retailers to meet compliance with MRET targets. Unfortunately MRET exhibits some design deficiencies in its treatment of pre-existing hydro and solar hot water that may have allowed a significant amount of non-additional renewable energy to earn RECs. The price of RECs has, indeed, fallen by more than half over the last two years due to expected oversupply of permits.

The Victorian Renewable Energy Target (VRET) requires Victorian electricity suppliers to source additional renewable energy where compliance is tracked using Victorian Renewable Energy Certificates (1 VREC = 1MWh). Participating generators must be located in Victoria and can't create both a REC and a VREC for the same MWh of electricity. It appears Green Power cannot be used to meet VRET liabilities (BCSE, 2006).

A NSW Renewable Energy Target (NRET) was announced on the 9th Nov 2006, but is not yet legislated. Although details are yet to be finalised, it is likely the NSW scheme design will be similar to the Victorian scheme, and retailer compliance is to be tracked using NRECs (1MWh). The main difference to date is that eligible generation for the NSW scheme can be anywhere in the National Electricity Market (NSW Gov, 2006). The VRET and NRET schemes could be used in much the same way as MRET for a desalination plant in Vic and NSW. In other states it may be possible for VRECs and NRECs to be bought by other parties, such as the owner of a desalination plant, then surrendered to the Victorian Essential Services Commission or the NSW equivalent for extinguishment, and not used to meet a legislated liability.

Accredited Green Power enables electricity customers to voluntarily pay a premium for a certain percentage of their electricity to be generated from accredited renewable sources. Electricity supplier compliance is tracked using both RECs and Green Power Rights, and is independently audited each year (GPAA, 2006). Green Power could be purchased by the desalination plant operator, and the auditing process would ensure that as much 'new' renewable energy was generated as was used by the desalination plant. Green Power excludes RECs from pre-1997 hydro generation and solar hot water heaters because of 'additionality' concerns with those renewable energy sources. Note that there is also a market for non-accredited Greenpower in Australia. In this case, however, the renewable generation is generally from hydro power stations that have been operating for decades or more, and there is no additional emissions reduction associated with its purchase.

The NSW Greenhouse Gas Abatement Scheme (GGAS) imposes mandatory greenhouse gas benchmark targets on all NSW electricity retailers and certain other parties for electricity consumed in NSW. These parties demonstrate compliance with their targets by annually surrendering an appropriate number of NSW Greenhouse Gas Abatement Certificates (NGACs), each representing an imputed one tonne of CO_2-e of 'avoided' GHG emissions, or pay a penalty. NGACs created through the NSW GGAS might also be used to 'offset emissions from a desalination plant, however, the actual abatement driven by the scheme can be questioned because the scheme's rules don't properly test the additionality of claimed reductions (Passey et al., 2004; MacGill et al., 2004). If this is the case, and a price is placed on greenhouse emissions in the future, the owner of a desalination plant reliant on NGACs to offset its emissions may face significant carbon price exposure.

Other abatement options may be available in the future. Australia's State and Territory Governments have expressed an interest in developing a national emissions trading scheme (ETS) in Australia, possibly by 2010. The State and Territory Governments taskforce have released a Discussion paper which canvassed the option of offsetting Australian emissions through the Kyoto Protocol's Clean Development Mechanism (CDM) (NETS, 2006). The CDM essentially allows countries that have ratified the Kyoto Protocol to pay for projects that reduce emissions in 'host' developing countries. This creates Certified Emission Reductions (CERs) that can then be used to offset the emissions of the funding country. Certificates created through a national ETS, as well as fungible certificates such as CERs, could be used to 'offset' emissions from a desalination plant in Australia. However before such a scheme's design rules have been finalised, it is not possible to determine how effective it will be, and so again, reliance on such a scheme could result in unexpected exposure to a carbon price.

Private organisations in Australia offer to offset emissions using the above schemes as well as other approaches such as tree planting and Kyoto Protocol Emission Reduction Units (ERUs). Their efficacy depends entirely on the schemes used. Note there is significant concern over the use of biosequestration to offset fossil fuel emissions. This is primarily because biosequestered carbon is at continuous risk of being reemitted into the atmosphere. In the Kyoto Protocol biosequestration is only issued with temporary certificates and the European ETS does not currently credit biosequestration at all.

All of the above examples highlight the challenges of effectively offsetting the emissions from a desalination plant using the environmental markets currently established in Australia. An alternative to the above schemes is to construct a renewable energy project in tandem with the construction of a desalination plant sized to offset the expected emissions from desalination, and avoid participation in any of the environmental markets noted above.

SOME AUSTRALIAN CASE STUDIES

Perth Desalination Case Study

Perth is currently constructing a 130 ML/d desalination plant at Kwinana, which will be its largest single point source water supplier and will meet up to 17% of its water needs. The plant will cost approximately $350 million to construct and annual operating costs are projected to be in the order of $20million per year, adding about $45 to the average household water bill (Water Corporation, 2006a). The plant will require about 26 MW of power to run and will hence consume an expected 185 GWh of energy per year (Water Corporation, 2004). This is a 50% increase in the Water Corporation's energy needs across WA and equates to approximately 4.1 kWh/kL of water supplied (Water Corporation, 2006b). The plant will be run continuously generating a constant baseload electricity demand (Water Corporation, 2002).

The Water Corporation and the West Australian Government have advertised widely that the desalination plant will be powered via the Emu Downs wind farm (EDWF) (Water Corporation 2006b; Gallop, 2005a). The former Premier of Western Australia stated that "this is a brilliant example of sustainability being put in to practice...the pairing of the desalination plant and wind farm is a win for the environment (Gallop, 2005b).

However, this "pairing" is uncertain. The Water Corporation has stated that it "will pay for electricity at Emu Downs and fed in to Western Power's grid…and will draw out the equivalent amount of electricity from the grid on an annual basis" (Water Corporation, 2006b). The RECs will actually be purchased by Western Power and surrendered as part of their requirement under the MRET scheme (Llewellyn, 2005). As outlined above, for the EDWF to be 'effectively' powered by renewable energy the Water Corporation would have to purchase the RECs as well as of the generated electricity. Use of the RECs to meet Western Power's MRET liability means that the corresponding renewable energy would have been produced regardless. The key point here is that for any new installation to meaningfully claim it will be powered by renewable energy, *additional* renewable energy must be generated.

Sydney Desalination Case Study

Sydney Water and the NSW Government are proposing to build a reverse osmosis desalination plant with up to 500 ML/d capacity or a third of Sydney's current water demand (Sydney Water, 2005). It is proposed that the desalination plant be built in 125 ML/d stages, with the surrounding infrastructure to connect to the existing water supply to be sized for a capacity of 500 ML/d. Electricity for the desalination plant is likely to be met from the grid (Sydney Water, 2005). A 125 ML/d plant would require 30MW and a 500 ML/d would require 110 MW, or 225 GWh/yr and 906 GWh/yr respectively, much greater than the current energy requirement for water supply in non drought years of approximately 150 GWh/yr (Sydney Water, 2002).

The desalination plant may operate only as a contingency drought measure. Sydney Water (2005) has stated that water production from the plant may be reduced or suspended and this was reiterated in the Metropolitan Water Plan in 2006[1]. However, while there may be greenhouse gas and cost incentives to only use the desalination plant during periods of drought, economic considerations may drive continuous operation (White, 2006). For example, the RO membranes' lifetime decreases with intermittent operation and the cutoff for economic use of plants is reported to be 70% of capacity (DNRM, 2003).

Operation of the plant accounts for 95% of its lifecycle greenhouse emissions and Sydney Water initially committed to reduce these by 50%. This was later increased to 100% renewable energy by the NSW Government (2006). There has been no decision on how this will be sourced but the Environmental Assessment (Sydney Water, 2005) states that purchase of RECs and baseload gas-fired generation are possible, and that biosequestration could be used to offset emissions.

Use of certificates from VRET and probably NRET, combined with a retrospective audit, should ensure that additional renewable energy was used to power this desalination plant – as long as these certificates are not used to meet any of the schemes' pre-existing liabilities. Note that this depends entirely on the robustness of the scheme design.

A retrospective audit of a baseload gas-fired plant could be used - again to ensure this generation was in addition to any existing schemes and the higher cost was borne by the desalination plant. However it is very difficult to calculate additionality for existing gas plant given continued load growth. Use of 'baseline and credit' emissions trading schemes should be avoided because of the inevitable abstractions between abatement and credit creation, resulting in uncertainty and hence risk – well illustrated by the NSW GGAS.

For both Perth and Sydney, construction of a renewable energy plant that sells electricity directly to the desalination plant is likely to be much more transparent, and therefore will, beyond doubt, avoid additional greenhouse emissions. This does not require the plant to be physically connected and only *excess* renewable energy beyond the requirements of the desalination plant should be used to create RECs for sale on the market.

THE WIDER CHALLENGE OF ENERGY SUSTAINABILITY

The context for considering greenhouse offsets for desalination plants is the growing global concerns about climate change. Recent work suggests that avoiding dangerous climate change of more than 2^{o}C will require global emissions to peak within 20 years and then fall by 60% or more by 2050 (DEFRA, 2006). Industrialised countries have much higher per-capita emissions than the developing world and greater capability to act, and therefore need to begin reducing emissions immediately and achieve much deeper cuts. Australia has the highest per-capita emissions in the world – some twice the *industrialized* world average – and the electricity industry contributes over one third of these emissions.

To reduce emissions by 60% by 2050 represents an enormous challenge and will almost certainly require major cuts in energy consumption. There are almost certainly practical limits to how much of a contribution renewable energy can make to electricity provision.

[1] No operating rules are discussed, however, the Shoalhaven Transfer operating rules are an interesting comparison.

While our solar and wind resource potential is very large there is a range of physical, technical and economic constraints on its deployment including possibly conflicting land-use needs, the challenge of integrating very high levels of intermittent renewables such as wind into power systems, and the current high costs of some other renewables such as photovoltaics.

Hence, there are limitations in the ability of emissions offsetting approaches to allow us to continue to build energy intensive infrastructure. Even if the most rigorous carbon offsetting approach is adopted it is not possible to escape the issue that in a future carbon constrained world, choices about what we use energy for will become ever more critical. Desalination therefore represents another significant increment in electricity demand that makes the task of developing a sustainable energy system that much harder. Furthermore, growing competition between different energy uses for a limited supply resource might see desalination plants several decades from now competing against a wide range of high value uses of electricity including cooling, lighting, IT and specialised industrial processes.

WIDER SUSTAINABILITY ISSUES FOR DESALINATION

Concurrent with the emergence of desalination there is now an increased understanding of the need for a paradigm shift in management of the urban water cycle. Sub-optimal outcomes have resulted from the traditional compartmentalisation of the three urban water streams, water supply, wastewater disposal and stormwater (Wong, 2006; Mitchell, 2006). Integrated urban water management (IUWM) approaches attempt to achieve multiple system and environmental objectives by re-defining the traditional boundaries of the urban water streams. As Mitchell (2006) has stated the “primary aim of IUWM is to enable multi-functionality of urban water services to optimise the outcomes achieved”. The new paradigm of IUWM challenges the idea that once through systems are preferable to multiple uses of water (Coombes and Mitchell, 2006). It also challenges the idea that the *amount* of water demand is the only parameter relevant to water supply infrastructure choices and that all water is treated to potable quality and disposed of (Pinkham, 1999). Instead water demand is multifaceted and water demand should be met according to fit for purpose principles (Holt, 2006). Furthermore, human waste and stormwater are not nuisances to be disposed of, but valuable resources (Pinkham, 1999)

A desalination plant embodies the traditional paradigm of urban water supplies and contrasts with the emerging IUWM paradigm: it is a large centralised, once-through system, providing potentially large volumes of potable water with limited complexity. A desalination plant might well entrench the traditional urban water supply paradigm because the economic size and nature of desalination plant means that they are “option foreclosing”. It prevents the entrant of other alternate water supply options because of the large volume of water that it will provide effectively increasing our supply availability many years into the future. For example, for Sydney, a 125 ML/d plant could potentially ‘secure’ the water demand for the future growth to 2021. If a 500 ML/d plant is built this could take the city’s water supply reliability out to beyond 2051.[2] This is both the attraction of desalination for its proponents and a major road block to the proponents of IUWM.

Desalination plants implicitly limit multi-functionality and are unlikely to provide optimal solutions for an integrated urban water system in the Australian context. Other water supply options, such as demand management, stormwater and wastewater reuse following the central principles of IUWM are likely to achieve higher *integrated* system

[2] Both figures are based on the Metro Plan for Sydney moderate growth rates and a water supply of approximately 56 kl/yr (with 40% reduction achieved by BASIX) and assume the desalination plant runs continuously.

efficiencies due to their ability to achieve multiple social, economic and environmental outcomes. Some of these potential multi-functionalities include economic benefits such as avoided costs, deferred costs and reduced developer service charges, environmental enhancement such as ecosystem protection, biodiversity, nutrient recycling and pollution minimisation, as well as social outcomes such as flood control, community participation, affordability and recreation.

Water supply options such as desalination need to be assessed in terms of these wider sustainability criteria. A Californian Recycled Water Task Force investing alternative water supply options argued that economic assessment that does not include the non-market benefits of projects can be an impediment to analysing the projects' feasibility. The task force identified the need for a "consistent economic feasibility analysis framework" to support an appropriate evaluation of these projects (Rosenblum, 2005). Mitchell (2006) came to the same conclusion noting that the lack of a commonly agreed assessment tool to evaluate alternative water servicing options against these wider sustainability criteria is a key issue.

CONCLUSION

Desalination is an emerging option to help address severe water supply shortages in urban centres around Australia, primarily because of its independence from rainfall. Desalination is energy intensive, and so to be considered sustainable, needs to offset its greenhouse emissions. However, abstraction in the offsetting process creates complexities which need to be carefully considered to ensure that a scheme is in fact "greenhouse neutral". The key issue is additionality – is the new renewable generation or other abatement activity used to offset emissions additional to what would have happened anyway? Under current arrangements this does not appear to be the case for Australia's only large urban desalination plant to date, in Perth.

Furthermore, there are fundamental limitations to offsetting emissions from desalination or, more generally, any of our uses of energy. As a result, we may face increasingly difficult choices on allocating energy resources that will dramatically change current estimates of the value of energy.

There are no perfect water supply options, with the possible exception of cost-effective water efficiency, and the ultimate savings from water efficiency are inherently limited. IUWM approaches are likely to achieve more sustainable outcomes and should be considered as an alternative to centralised desalination options. A broad framework to assess and compare these less than perfect options will help to achieve optimum sustainability outcomes

This paper has considered in a preliminary form the fundamental question of whether desalination linked to greenhouse gas offsetting approaches can be made sustainable in the broadest sense of the term and over the longer-term. The answer has immediately obvious and far-reaching implications for the direction of the water supply industry.

REFERENCES

Agriculture Fisheries and Forestry Australia (AFFA) (2002)*, Introduction to Desalination Technologies in Australia*, ACT.

Anderson (2006) Integrating recycled water into urban water supply solutions, *Desalination*, Vol 187, pp 1-19.

BCSE (2006) *Carbon Markets Report 2006*, Business Council for Sustainable Energy, Melbourne, Australia.

Coombes and Mitchell (2006) Urban Water Harvesting and Reuse, in *Australian Runoff Quality*, Wong (editor), Crows Nest.
DNRM (2003), *Desalination in Queensland*, Brisbane.
DEFRA (2006) Avoiding Dangerous Climate Change, Report from the Scientific Symposium on Greenhouse Gases, Exeter, UK.
ESAA (2005) Energy Supply Association of Australia, *Energy 2005*.
Gallop (2005b) *Wind farm chosen to power Perth's desalination plant*, Media Statement Released 26th July, 2005.
Gallop G. (2005b) Presentation to Australian Water Foundation , Perth.
GPAA (2006) *National Green Power Accreditation Program Annual Audit*, National Green Power Steering Group.
Holt (2006) Decision making framework for selecting sustainable wastewater reuse treatment technologies, First Australian Young Professional Conference, UNSW.
Leslie (2004) *Desalination: Its place in meeting our fresh water needs*, Presentation to Institute of Energy Australia, 15 November, 2004.
Llewellyn, P. (2006) "Desalination Plant, Renewable Energy", Parliamentary Questions to the Minister for Energy, Western Australia Parliament, 16th August 2005.
MacGill I., Outhred H. and Nolles K (2006) "Some design lessons from market-based GHG regulation in the restructured Aust. electricity industry," Energy Policy, 34 (1), pp. 11-25.
MacGill, I., Passey, R., Nolles, K. and Outhred, H. (2005) *The NSW Greenhouse Gas Abatement Scheme: An assessment of the scheme's performance to date, scenarios of its possible performance to 2012, and their policy implications.* Discussion Paper DP_050408, Centre for Energy and Environmental Markets (CEEM), University of NSW.
Mitchell, G. (2006) Applying Integrated Urban Water Management Concepts: A Review of Australian Experience, *Environmental Management,* Vol 37, No 5, pp 589-605.
MRET Review (2003) *Renewable Opportunities: A Review of the Operation of the Renewable Energy (Electricity) Act 2000*, Australian Greenhouse Office, Canberra.
NSW Government (2006a) *2006 Metropolitan Water Plan*, Sydney.
NSW Gov (2006b) *NSW Renewable Energy Target Explanatory Paper*, NSW Government.
NSW Legislative Council (2006) *A Sustainable Water Supply for Sydney*, Sydney.
Passey, R., MacGill, I., Nolles, K. and Outhred, H. (2005) The NSW Greenhouse Gas Abatement Scheme: An analysis of the NGAC Registry for the 2003 Compliance Period. Discussion Paper DP_050405, CEEM, University of NSW.
NETS (2006) *Possible Design for a National Greenhouse Gas Emissions Trading Scheme*, A discussion paper prepared by the National Emissions Trading Taskforce.
Pinkham, R. 1999. 21st century water systems: Scenarios, visions and drivers, Colorado.
Rosenblum (2005) "House Rules: Environmental Ethics for a Sustainable World", Ozwater 2005, Brisbane.
Sydney Water, (2002) Towards Sustainability Report, Sydney.
Sydney Water (2005) Environmental Assessment of Desalination Concept Plan, Sydney.
Victorian Government (2006), Central Region Sustainable Water Strategy, Melbourne.
Water Corporation (2002) Perth Metropolitan Desalination Proposal, Perth.
Water Corporation (2004) Metropolitan Desalination Proposal: Section 46 Review, Perth.
Water Corporation (2006a) Perth Seawater Desalination Project, Available at: http://www.watercorporation.com.au/D/desalination.cfm, Accessed 30 November, 2006.
Water Corporation (2006b) The Perth Desalination Proposal: Wind Power, Perth.
White S. et. al. (2006) Review of the Metropolitan Water Plan: Final Report, Sydney.
Wong T. (2006) "Introduction" in Australian Runoff Quality, Wong (editor), Crows Nest.