Appendix J

Greenhouse Gas Abatement

Contents

J1 Greenhouse Gas Abatement

J1.1 Objectives

The overall objective of this section is to provide a preliminary discussion outlining the various options for achieving net zero GHG emissions or reduced GHG emissions through partial carbon offsetting for the project.

The term carbon refers carbon dioxide (CO_2) and the other greenhouse gases released into the atmosphere expressed in the equivalent amount of CO_2, called carbon dioxide equivalent or CO_2-e.

The term 'carbon neutral' refers to either:

- the complete avoidance of greenhouse gas emissions through the use of renewable energy and other technologies that avoid emissions of greenhouse gases;
- or achieving net zero carbon emissions by balancing a measured amount of carbon released with an equivalent amount sequestered or offset.

J1.1.1 Carbon Pollution Reduction Scheme (CPRS)

On 15 December, 2008, the Commonwealth Government released its White Paper on the CPRS. Following the release of its Green Paper in July, 2008 and its economic analysis in late spring, the White Paper is the last step before introduction of legislation to implement the Scheme, expected in early 2009. The White Paper outlines the Australian Government's commitment to reducing emissions by 5 to 15% below 2000 emissions by 2020.

Scheduled to begin in 2010, the CPRS's impact on the operation of plants such as the desalination plant proposed here is not yet determined, however, in general it will depend on:

- the amount of GHG emissions from the facility; and
- the CPRS provisions in the Scheme relating to permit allocation and trading.

The price of these carbon permits will be determined by a trading market and influenced by Government policy objectives through national emissions targets. Currently, permit price projections are estimates only and will vary according to the implementation rules and the interpretation of targets into availability of carbon permits. Treasury modeling suggests that the initial emission price in 2010 could be around \$23/ CO_2-e in the context of a global greenhouse gas stabilisation rate of 550ppm. The starting price is 40 per cent higher to achieve 510 ppm and 110 per cent higher to achieve 450 ppm[1]. The Government will set a price cap on the market at \$40/tCO_2-e.

At this stage it is reasonable to expect that the desalination plant will not have a direct liability under the scheme as its operational Scope 1 emissions will not be expected to exceed the CPRS facility threshold (25kT CO_2-e Scope 1 emissions), however it is also reasonable to assume that the cost of acquiring carbon permits in the fossil fuel intensive electricity sector is likely to be passed through to users. Due to the high energy demands associated with the operation of the plant, the cost of conventional (coal fuelled) electricity is expected to increase. The white paper states that electricity prices are expected to increase around 18 percent and gas prices 14 percent.

Assistance to households, Emissions Intensive Trade Exposed Industries (EITE) and coal-fired generators will be provided. The desalination plant, although being emissions intensive, does not appear to be eligible for this assistance.

[1] Department of Climate Change (2008), *Carbon Pollution Reduction Scheme White Paper.* Department of Climate Change, Canberra.

J1.1.2 Climate Change Impact Statements (CCIS)

In Queensland, the State Government is currently reviewing its ClimateSmart 2050 policy and its ClimateSmart Adaptation Plan 2007-2012.

In addition, early in 2008, the Queensland Government passed a proposal requiring that all Cabinet Submissions include a Climate Change Impact Statement (CCIS). Each CCIS must include two assessments:

1) a mitigation assessment including a carbon footprint and measures to reduce the GHG's from the proposal; and

2) an adaptation assessment outlining the impacts from future changes in climate on the proposal and adaptation measures to reduce the climate risks.

A qualitative CCIS is currently being developed for the proposed desalination plant.

J1.1.3 National Greenhouse and Energy Reporting System (NGERs)

Based on the current projections in Table 1 both of the proposed plant options will exceed both the facility threshold of 25kt CO2-e / 100TJ energy consumption per annum as well as the projected future (2010 to 2011) corporate threshold of 50kt CO2-e / 200TJ per annum (see Figure 1). This implies additional NGER Act reporting requirements for the controlling corporation.

Under the NGER Act, facilities and corporations are required to report all Scope 1 and 2 emissions as well as energy production and consumption. Scope 3 emissions are excluded from the reporting requirements.

Scope 1 emissions describe those greenhouse gas emissions directly resulting from an activity or series of activities. This generally relates to the combustion of fuels for stationary and transport purposes as well as fugitive emissions resulting from releases of greenhouse gases such as refrigerants.

Scope 2 emissions describe those emissions resulting from purchased electricity consumed within an organisation or facility.

Scope 3 emissions are those emissions that occur outside the boundary of a facility but are a consequence of activities at a facility, and are not Scope 2 emissions.

As the proposed desalination plant is expected to trigger either the facility and/or corporate threshold, the following obligations will need to be met:

- Registration of the corporation or facility by August 31st following the reporting year[2]
- Report to Government by October 31st following the reporting year (using an online submission to the Federal Government's Online System for Comprehensive Activity Reporting (OSCAR)).
- Publication of the report by February 28th in the year following the reporting year.

[2] The reporting year corresponds to the financial year in which emissions were produced, ie. July to June.

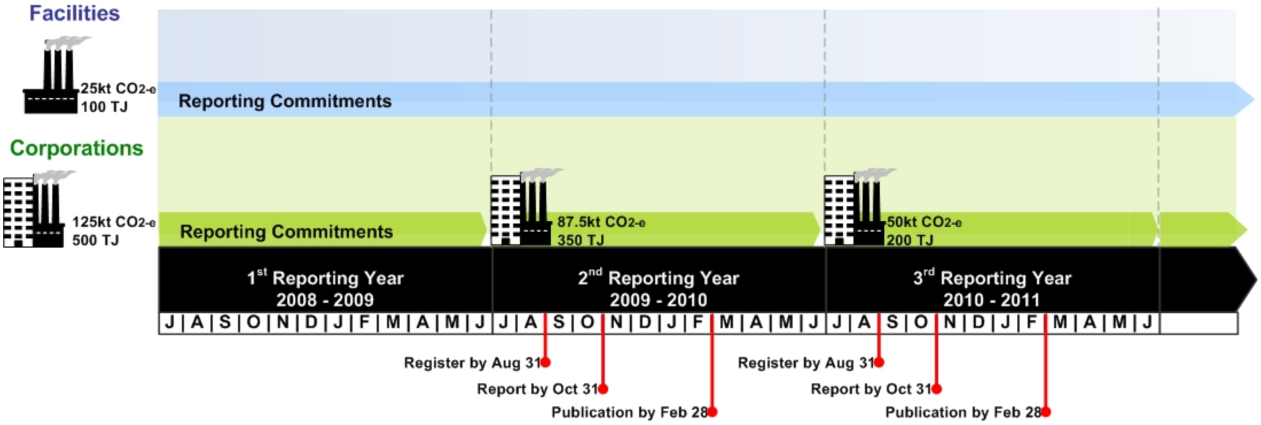


Figure 1 National Greenhouse and Energy Reporting System Thresholds and Timeline

J1.1.4 National Urban Water and Desalination Plan

Under the National Urban Water and Desalination Plan, the Australian Government aims to improve the security of water supplies to Australia's cities without adding to greenhouse gas emissions.

In order to achieve that objective, it will provide financial assistance for capital costs (capped at 10 percent of eligible capital costs up to a maximum of $100 million per project) to projects that meet specific criteria. Capital costs that are eligible for funding include the costs of construction but not the cost of land (which includes clearing, demolition and landscaping costs).

Construction expenditure includes:

- preliminary expenses such as architect fees, engineering fees, foundation excavation expenses and costs of building permits; and
- the cost of the structural features that are integral to the project.
- Note: The ongoing costs, including operation and maintenance, are the responsibility of the project proponents.

To be eligible for approval under the plan QWC must:

1. accept the terms and conditions of the standard funding agreement (attached to the National Urban Water and Desalination Plan);
2. demonstrate a capacity to deliver the proposed project on time and on budget; and
3. be financially viable and compliant with their taxation responsibilities.

Then to be eligible for approval under the plan the proposed desalination project must:

4. provide water to urban populations of at least 50,000 people;
5. be technically sound and able to deliver the identified outcomes with a high degree of certainty;
6. have eligible capital costs of at least $30 million;
7. be financially viable once completed with no further call on the Australian Government for on going funding;
8. be completed by 30 June 2014; and

9. source 100 per cent of its energy needs from renewable sources or fully offset the carbon impact of the project's operations.(Construction emissions not included)
10. comply with the National Code of Practice for the Construction Industry, in accordance with the Australian Government Implementation Guidelines for the National Code of Practice for the Construction Industry, revised September 2005, reissued June 2006
11. only commission contract workers for building work who are accredited under the Building and Construction OHS Accreditation Scheme

Where all eligibility criteria are met, applications will be assessed on merit using the following criteria (explanatory notes are provided as an attachment to the National Urban Water and Desalination Plan):

1. level of contribution to enhancing water supply security within the targeted urban area;
2. cost-effectiveness of the project;
3. cost-effectiveness of the Australian Government contribution;
4. demonstrable evidence that the proposed project is a key strategic element of the preferred long-term water supply plan for the area; and
5. extent of environmental benefits and/or environmental best practice initiatives.

Financial assistance will be:

1. available from the 2009-10 financial year and may extend to the end of the 2013-14 financial year; and
2. provided to successful proponents upon achievement of agreed milestones.
3. provided as a fixed value regardless of any changes to the capital costs of the project.

QWC will be required to declare all sources of funding available to complete the project; including other sources of government funding that have either been requested, approved or received.

The plan notes that projects that are already seeking approvals, funding or have commenced are still eligible to apply for financial assistance. However, in such cases, QWC would need to demonstrate that the project would deliver additional benefits as a result of funding under the plan.

J1.2 Baseline Greenhouse Gas Emissions Profiles

Without considering abatement, the estimated baseline greenhouse gas emissions from the use of energy for the two plant options are illustrated in Table 1. For the 80MW plant, this is 0.1% of the emissions for the State of Queensland (2006 data) and 1% of the emissions from all Queensland industries in 2006.

Table 1: Greenhouse emissions profile of the plant (2008/09 Factors)

Emission Source	Desalination plant 20MW		Desalination plant 80MW	
MWh per annum	175,200		700,800	
QLD Grid Electricity	Scope 2	Scope 3	Scope 2	Scope 3
Emission factors [3] (tCO_2-e/MWh)	0.91	0.13	0.91	0.13
tCO_2-e p.a.	159,432	22,776	637,728	91,104
Total tCO_2-e p.a.	182,208		728,832	

While efforts to reduce energy demands through efficient plant and process design should be considered a priority, the choice of energy source requires consideration as it has a direct impact on the overall greenhouse gas emissions profile of the plant.

Typically, desalination plants have high energy demands. Operating cost structures are dominated by energy costs, which provide an incentive to use efficient processing and operating technology within the plant. Ideally, a source of cheap renewable energy would be found to match the energy loads of the plant. This would reduce the greenhouse gas emission profile for the plant and provide economic benefits for the plant over its lifetime. However, in practice it is not easy to find a high intensity renewable energy source at a reasonable cost.

In developing a strategy to potentially achieve carbon neutrality, capital costs, operational costs and environmental outcomes will need to be balanced. It may be necessary to draw upon a mix of zero or low emission energy sources (such as renewables or gas) as well as GreenPower™ and carbon offset instruments.

This chapter examines the options available, the opportunities that they potentially provide and the barriers and constraints that exist.

J1.3 Embodied Energy and Carbon

Embodied energy refers to the amount of energy that is required to manufacture and supply a product, material or service to its ends use. It takes into account the energy used to extract raw materials, process those raw materials into a commercial product or material and transport them to their final destination. Accounting for embodied energy is becoming increasingly important given the heightened awareness and regulation around greenhouse gas emissions.

The embodied energy associated with civil works and key construction materials such as steel, cement and aluminium is significant. Determining the embodied energy values of these materials and activities is a complex process and estimations can vary widely. However, for any project seeking to claim total (construction and operational) carbon neutrality, calculating the embodied energy associated with its completion is vital.

As an example, recently in Australia, VicRoads used the $13.3 million Mickleham Road duplication as a pilot project to measure the carbon footprint of a typical road construction project. Seventy three per cent (73%) of the greenhouse gas emissions were demonstrated

[3] Department of Climate Change (2008), *National Greenhouse Accounts (NGA) Factors October 2008.* Department of Climate Change, Canberra.

to come from the embodied energy of the materials used for the construction. While the Mickleham project highlights the significance of construction related embodied emissions, there is currently no policy requirement to investigate or report embodied emissions or energy in construction.

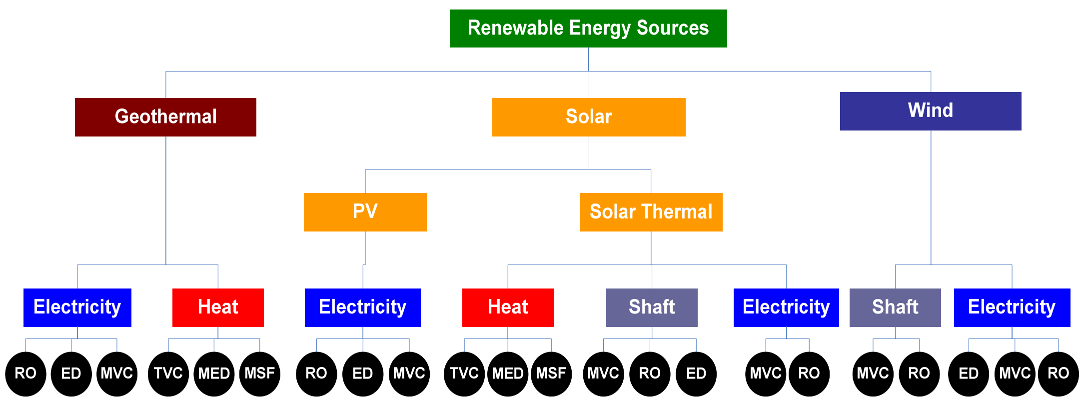
J1.4 Renewable Energy Options

J1.4.1 Renewable Energy Sources

Renewable energy sources such as geothermal, solar, wind, tidal and wave energy have been used on a variety of scales for supply of power direct to desalination plants. While these technologies can effectively reduce or eliminate greenhouse gas emissions, their applicability is heavily dependent on factors including, but not limited to, cost, land availability, water quality, water demand, location, scheduled operation and choice of desalination technology. A more detailed discussion of potential renewable energy sources being used to supply power direct to the sites is discussed in Section J1.6.

Aside from geothermal energy (which is not viable within the siting study), renewable energy sources tend to provide variable power output and usually require some form of storage in order to service constant demand. For a desalination plant designed to provide variable output, it may not necessarily be a significant issue. However, storage or supplementary power needs to be considered for plants designed to produce a constant supply of water4.

Figure 2 illustrates a variety of desalination technologies matched with the renewable energy sources considered generally appropriate for desalination. Table 2 shows the estimated range of unit costs of water production for some of the common renewable energy desalination configurations. The range of costs provided are highly dependent on the specific conditions associated with a given location as well as the scale of the particular projects. Section J1.6 provides a high level investigation into renewable energies and their appropriateness in the South East Queensland region.



Note: RO = Reverse Osmosis, ED = Electrodialysis, MVC = Mechanical Vapour Compression, TVC = Thermal Vapour Compression, MED = Multi Effect Desalination, MSF = Multi Stage Flash

Figure 2 Potential use of various type of renewable energy in desalination process[5]

[4] Barron, O. (2006). *Desalination Options and their possible implementation in Western Australia: Potential Role for CSIRO Land and Water*. CSIRO: Water for a Healthy Country National Research Flagship, Canberra.
[5] Oldach R. (2001). *Matching renewable energy with desalination plants*. Middle East Desalination Research Centre, Report 97-AS-006a

Table 2 Estimated unit costs of water production for some renewable energy sources

Desalination method and energy source	Cost of water product ($/m^3)
Solar Thermal	0.87-5.48
PV-RO	0.56-3.14
W-VC	2.13-2.44
W-RO	1.5-1.77

J1.4.2 Co-generation

While renewable options are effective in achieving carbon neutrality, they can be expensive and locating a suitable site can be an issue. Instead there are some technologies that, while not being renewable, can generate the necessary power at lower emissions and higher efficiency than electricity sourced from the grid.

Co-generation or CHP (Combined Heat and Power) describes the production of heat and electricity using a single fuel. Co-generation systems can operate as grid connected standalone power generators or can be directly integrated into heat intensive industrial processes, including the desalination process (see Section J1.6.8). Co-generation at the site where the energy produced is consumed is can be referred to as co-location. The key benefit of co-location is the avoided transmission losses. At this stage, the quantitative costs and benefits of co-generation and co-location are not readily available. However co-generation and co-location is worth consideration as further investigations are conducted as part of Phase 2 studies.

In Australia, co-generation is typically fuelled by natural gas and is recognised as a cleaner alternative to electricity sourced from the Queensland grid in terms of greenhouse gas emissions. Although it will not eliminate emissions altogether, it may prove to be a significant and cost-effective option within a suite of emissions reduction measures.

Table 3 shows the greenhouse gas implications of standard gas turbines compared to electricity producing co-generation systems in meeting the energy demands of the proposed desalination plant options.

Table 3 Greenhouse gas profile comparison

	Natural gas powered turbine		Natural gas powered co-generation	
Energy demand (MW)	20	80	20	80
MWh per annum	175,200	700,800	175,200	700,800
Assumed Efficiency Factor	40%	40%	70%	70%
GJ input required	1,576,800	6,307,200	901,028.57	3,604,114.29
Scope 1 Piped Natural Gas Emission Factor Error! Bookmark not defined. **(kgCO2-e/GJ)**	51.33	51.33	51.33	51.33
tCO2-e per annum	80,937 tCO2-e	323,749 tCO2-e	46,250 tCO2-e	184,999 tCO2-e

J1.4.3 GreenPower™

GreenPower™ is a government entity which operates the GreenPower™ accreditation program providing a renewable energy product administered and accredited by various state government agencies and departments across Australia. The purchase of 100% GreenPower™ for operational electricity consumption is considered to be operationally carbon neutral.

GreenPower™ products are sold through independent retailers and are audited through the National GreenPower™ Accreditation Program to ensure the products meet the accreditation criteria. Eligible renewable resources are listed below, and are described in more detail in Section J1.6:

- solar power;
- wind;
- biomass (landfill gas, municipal solid waste, agricultural wastes, energy crops, wood wastes);
- hydro-electric power (small-scale or on existing dams) ;
- geothermal energy; and
- wave and tidal power.

Accreditation ensures that the purchased GreenPower™ products meet various standards and requirements, allowing for them to be compared across the market. Energy purchased through GreenPower™ is also checked against the Mandatory Renewable Energy Targets (renewable energy targets imposed on generators) to ensure that the product meets the claim of GreenPower™.

One advantage of purchasing of GreenPower™ is that it allows the proposed project to gain access to renewable energy without the need for additional capital expenditure or modifications to design specifications. It is also possible to select specific renewable sources in making purchasing decisions if desired (although this can be expected to cost more).

Table 4 and Table 5 show the costs of conventional grid sourced (black) power and GreenPower™ for the 20MW and 80MW plan options based on today's costs. The purchase of GreenPower™ roughly doubles the cost of energy but delivers 100% carbon neutrality for the electricity supply for the plant.

Also overtime it is expected that the cost of GreenPower™ is likely to reduce with potential increased supplies.

Table 4 Cost comparison for a 20MW demand

		2009		2010		2011	
Tariffs ($/MWh)[6]	Black	Peak	Offpeak	Peak	Offpeak	Peak	Offpeak
		80	32	85	35	95	42
	Green[a]	Low tariff	High tariff	Low tariff	High tariff	Low tariff	High tariff
		48	65	48	65	48	65
Costs	100% Black Error! Bookmark not defined.	Total Cost		Total Cost		Total Cost	
		$9,600,000		$10,292,000		$11,768,000	
		182,208 tCO2-e [b]		182,208 tCO2-e[b]		182,208 tCO2-e [b]	
	100% Green	Low tariff	High tariff	Low tariff	High tariff	Low tariff	High tariff
		$18,009,600	$20,988,000	$18,701,600	$21,680,000	$20,177,600	$23,156,000
		0 tCO2-e		0 tCO2-e		0 tCO2-e	

[a] GreenPower™ Low and High tariffs represent the estimated upper and lower price range of in the market.
[b] 2010 and 2011 Black carbon emissions are estimations based on current full fuel cycle emission factors (1.04 tCO2-e/MWh for Queensland grid electricity – NGER Technical guidelines 2008)
[c] Based on peak hours: 7am-11pm Monday –Friday

Table 5 Cost comparison for an 80MW demand

		2009		2010		2011	
Tariffs ($/MWh)[7]	Black	Peak	Offpeak	Peak	Offpeak	Peak	Offpeak
		80	32	85	35	95	42
	Green	Low tariff	High tariff	Low tariff	High tariff	Low tariff	High tariff
		48	65	48	65	48	65
Costs	100% Black	Total Cost		Total Cost		Total Cost	
		$38,400,000		$41,168,000		$47,072,000	
		728,832 tCO2-e		728,832 tCO2-e		728,832 tCO2-e	
	100% Green	Low tariff	High tariff	Low tariff	High tariff	Low tariff	High tariff
		$72,038,400	$83,952,000	$74,806,400	$86,720,000	$80,710,400	$92,624,000
		0 tCO2-e		0 tCO2-e		0 tCO2-e	

[a] GreenPower™ Low and High tariffs represent the estimated upper and lower price range of in the market.

[b] 2010 and 2011 Black carbon emissions are estimations based on current full fuel cycle emission factors (1.04 tCO2-e/MWh for Queensland grid electricity – NGER Technical guidelines 2008)

[c] Based on peak hours: 7am-11pm Monday –Friday

[6] Pers Comms, H Price with Tru Energy, Origin, AGL (25/09/08)

The percentage of energy consumption sourced from GreenPower™ is flexible so that a mix of conventional grid (black) energy and renewable (green) energy can be used. This flexibility allows financial and greenhouse gas considerations to be balanced and adjusted as needed. Figure 3 and Figure 4 illustrate this flexibility and shows the achievable emissions reductions in comparison to the cost of energy.

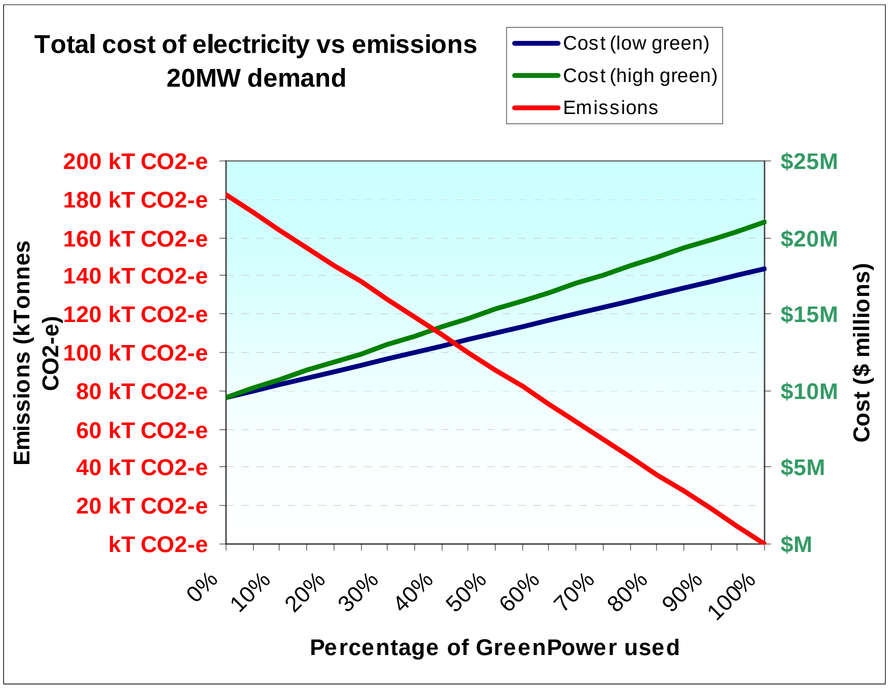


Figure 3 Total cost of electricity vs. emissions comparison for 20MW demand

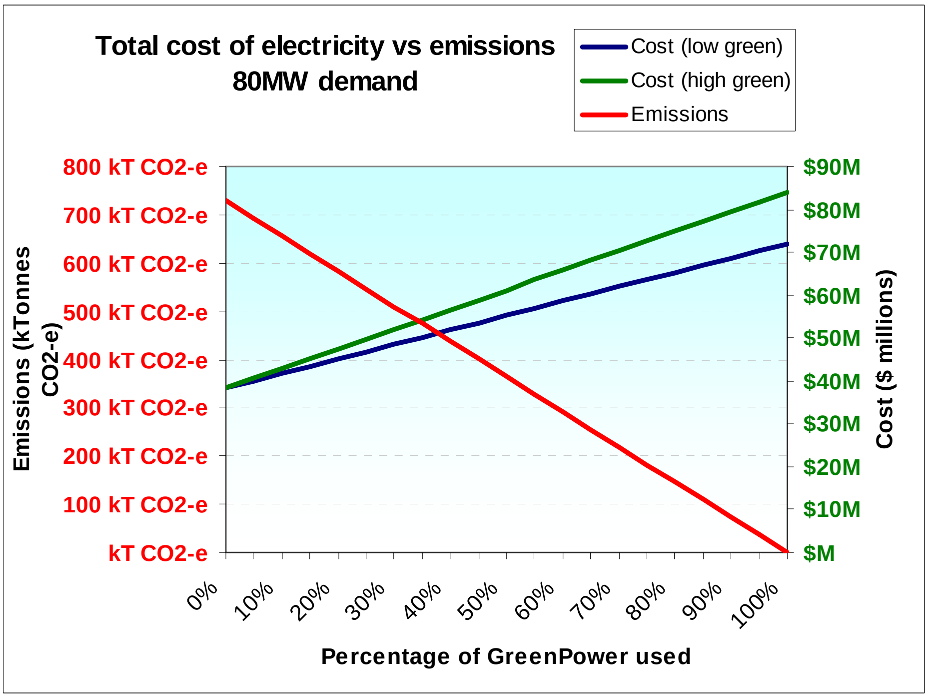


Figure 4 Total cost of electricity vs. emissions comparison for 80MW demand

The cost of GreenPower™ equates to a range of approximately $46.15 to $62.50 per tonne of CO_2-e offset based on current full fuel cycle emission factors for purchased electricity.

J1.4.4 Carbon Offsets

Where renewable energy sources are unable to provide the full power requirements for the proposed desalination plant, carbon offsetting is another practice by which the plant could achieve carbon neutrality. Carbon offsetting involves the purchase of carbon credits generated through third party carbon offset projects. These projects vary depending on the offset company selected. Generally however these fall into three categories:

- Carbon Sequestration (forestry) – this process involves planting trees, creating a carbon sink with the ability to remove and absorb carbon dioxide from the atmosphere.
- Energy Efficiency Projects – investment into energy efficiency programs or projects aiming to reduce the amount of CO2 being produced thereby reducing the carbon impact from the outset.
- Renewable Energy Projects – investment into renewable energy projects which provide zero carbon energy options.

The offsetting of emissions should be considered a final option once all possible reduction measures have taken place; one of the reasons being that the change in market price of carbon offsets/credits presents a risk in contrast to the long term certainty and savings related to pursuing carbon reduction measures. Similar to the waste hierarchy (reduce, reuse, recycle) the carbon management cycle below in Figure 5 demonstrates the priority for different forms of carbon management.

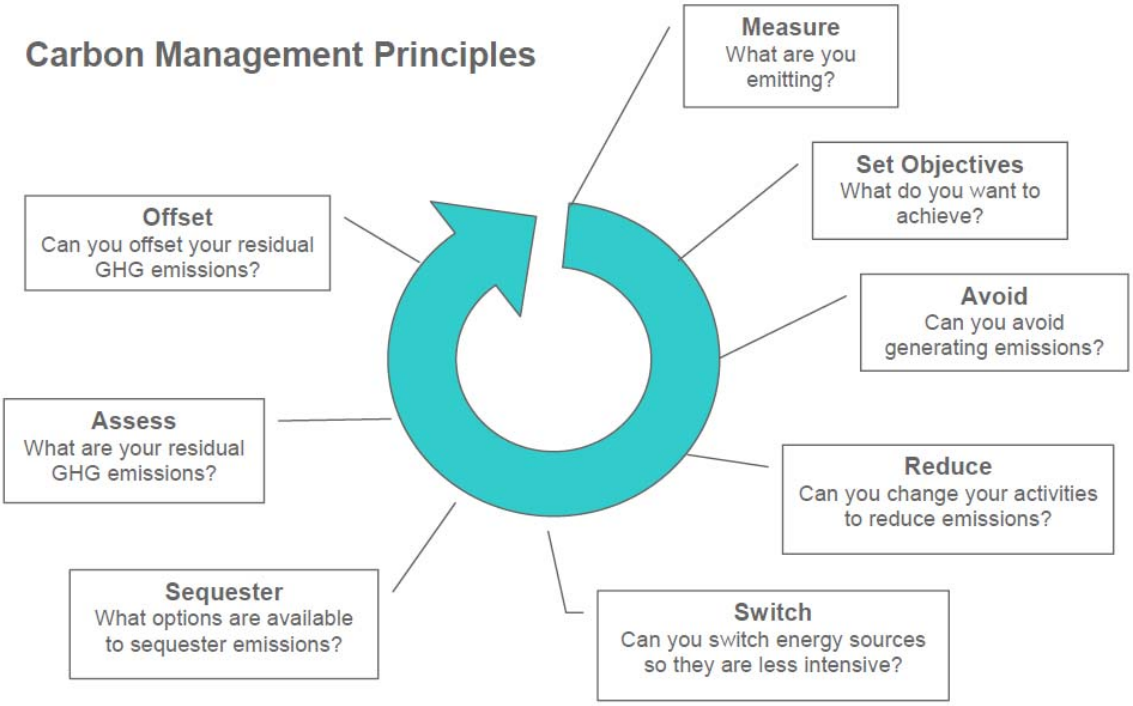


Figure 5 Carbon management principles adapted from the Victorian Environmental Protection Agency[8]

The companies providing these services range from not-for-profit charities through to commercial organisations and government owned corporations. Purchases of carbon offsets from non-for-profit providers are considered tax deductible. There is also a number of different accreditation schemes that organisations can choose to comply with. These too range from international accreditations such as the Gold Standard, through to the NSW

[8] Victorian Environmental Protection Agency, 2008. *Carbon Management*. Viewed January 2009, Victorian Government. http://www.epa.vic.gov.au/climate-change/carbon-management/#principles

Greenhouse Gas Abatement Scheme and the Federal Government's Greenhouse Friendly Program.

Table 6 indicates the prices of some of the many providers offering a range of projects including forestry/bio-sequestration, renewable energy, energy efficiency, and methane flaring among others. Prices per tonne of carbon dioxide equivalent (CO_2e) range from $8 to $75.[9] The more expensive offsets appear to be renewable energy projects that provide renewable energy certificates (RECs).

Table 6 Examples of Australian Carbon Offset Providers, Project Types and Prices

Australian Offset Provider	Project Type	Price per tonne of CO2e
Carbon Neutral	Forestry	AU$18 - AU$19
Carbon Reduction Institute	Renewable energy, energy efficiency & fuel switching	AU$13.20 – AU$16.50
Climate Friendly	Renewable energy & fuel switching	AU$23 – AU$33
CO2 Australia	Forestry	AU$16
Greenfleet	Forestry	AU$11.20 – AU$12.50

The RMIT University/Global Sustainability 2007 report[10] notes a significant difference in price charged per tonne of carbon dioxide (CO_2) offset with generic (plantation) bio-sequestration offsets priced between $9 - $13 per tonne, whilst energy efficiency and renewable energy offsets range from $20 - $40. The difference can be attributed to a number of drivers including the cost of verification and assurance, and the cost of additional benefits such as community education and administrative and marketing functions.

Providers offering forestry/bio-sequestration projects tend to have entered the marketplace earlier than those providing technology-based offsets. However, those providers offering renewable energy and energy efficiency offsets tend to adhere to a recognised assurance scheme.

[9] Carbon Offset Guide (2008), Accessed 03 September 2008 <http://www.carbonoffsetguide.com.au/providers>
[10] Scott H, Ribon L, (2007) *Carbon Offset Providers in Australia 2007*, RMIT University, Melbourne.

Table 7 Examples of Australian Offset Providers, Standard or Scheme, and Offset Projects Offered

Company	Standard/ Scheme*	Forestry	Renewable Energy	Energy Efficiency	Fuel Switching	Flaring
Australian Carbon Traders (Vic)	GF					
BP Global Choice (National)	GF					
Carbon Neutral (WA)						
Carbon Planet(Vic,SA , NSW)	GGAS					
Carbon Pool (NSW)	GF					
Carbon Reduction (NSW)	GS					
Carbon Smart (Vic, NSW)	GGAS					
Climate Friendly (NSW)	GS					
Climate Positive (Vic)	GF					
CO_2 Australia (Vic)	GGAS & GF					
Elementree (WA)						
Greenfleet (Vic)	GF					
Greenhouse Balanced (Vic)	GF					
Neco (NSW)	GGAS					
Origin Energy (QLD)	GF					
Project Andromeda (NSW)	GF					

**GF - Greenhouse Friendly; GGAS - Greenhouse Gas Abatement Scheme; GS - Gold Standard*

While there is no universal accreditation standard, there is a number of different accreditation schemes that carbon offset providers can choose to comply with. Currently, these range from international accreditations such as the Gold Standard, through to the NSW Greenhouse Gas Abatement Scheme and the Australian Government's Greenhouse Friendly Program (see Table 8).

At this stage, there is no mandatory accreditation scheme with which Australian offset providers must comply. However, in 2007 the Australian Labor Party (ALP) promised that a Rudd Government would set up a national standard for carbon offsets to ensure consumer confidence in the rapidly growing carbon offset market. The national standard would build on existing schemes including the Federal Government's Greenhouse Friendly Program, the NSW GGAS and the Renewable Energy Certificates.[11]

[11] www.alp.org.au/media/0607

Table 8 Key Accreditation Programs and Offset Schemes Used in Australia

Standard/Offset Scheme	Summary
Greenhouse Friendly **(GF)**	Products and services which are certified as Greenhouse Friendly are eligible to be labelled with the Greenhouse Friendly Certification Logo. Under a rigorous certification process based on the principles of life cycle assessment, the 'cradle-to-grave' greenhouse gas emissions associated with the production, use and disposal of certified products or services, are fully offset by approved Greenhouse Friendly abatement. Consumer confidence is provided through an objective independent verification process that underpins Greenhouse Friendly certification.
Gold Standard - Voluntary Emission Reduction **(GS VER)**	The Gold Standard is recognised as an independently audited, globally applicable best practice methodology for project development that seeks to deliver high quality carbon credits of premium value. The GS applies only to renewable energy and energy efficiency projects. Established in 2003 the Gold Standard was created by a small group of non-governmental organisations, including the World Wildlife Fund, SouthSouthNorth and Helio International. These groups agree that the Gold Standard principles of environmental rigour and sustainable development represent the true spirit of the Kyoto Protocol. Today, the Gold Standard label receives worldwide recognition and is officially supported by 49 environmental and development organisations.
New South Wales Greenhouse Gas Abatement Scheme **(GGAS)**	The NSW Greenhouse Gas Abatement Scheme (GGAS) commenced on 1 January 2003. It is one of the first mandatory greenhouse gas emissions trading schemes in the world. GGAS aims to reduce greenhouse gas emissions associated with the production and use of electricity. It achieves this by using project-based activities to offset the production of greenhouse gas emissions. GGAS establishes annual state-wide greenhouse gas reduction targets, and then requires individual electricity retailers and certain other parties who buy or sell electricity in NSW to meet mandatory benchmarks based on the size of their share of the electricity market. If these parties, known as benchmark participants, fail to meet their benchmarks, then a penalty is assigned. Monitoring the performance of benchmark participants is undertaken by the Independent Pricing and Regulatory Tribunal of NSW (IPART) in its role as compliance regulator.

Standard/Offset Scheme	Summary
GreenPower™ **(GP)** **(see Section J1.6)**	Although not an offset standard, GreenPower™ is an accredited renewable energy scheme operated by participating governments ensuring that energy suppliers are producing equivalent amounts of nominated energy from renewable sources. Products are independently audited and sourced from an adequate renewable energy source such as wind, solar, hydro and wave projects built after 1997. Products accredited by GreenPower™ are guaranteed to contribute to the installation of new renewable energy projects, therefore avoiding and displacing fossil fuel generated power.
Voluntary Carbon Standard **(VCS)**	The Voluntary Carbon Standard was released in 2006 and provides a global standard for project proponents, valuators and verifiers for voluntary greenhouse gas emissions reduction and removal projects. It uses a number of international standards to provide guidance for the application of the standard. A GHG program is required to demonstrate compliance with the requirements of the VCS program through a gap analysis. The conclusions of the gap analysis are considered and the GHG program approved or not approved by the VCS board.
Community, Carbon and Biodiversity Standard **(CCBS)**	The CCBS identifies land-based projects that are designed using best practices to deliver robust and credible greenhouse gas reductions while also delivering net positive benefits to local communities and biodiversity. They can be applied to any land-based carbon projects that reduce GHG emissions, for example from deforestation or forest degradation to those that remove carbon dioxide by sequestering carbon, reforestation, afforestation, forest restoration, agroforestry and sustainable agriculture.

J1.4.5 ecoFundQ – Queensland Government's Preferred Offset Provider

Established in November 2008 and set to commence operations in early 2009, ecoFundQ, a Queensland Government owned entity, will act as a broker and provider of environmental and carbon offsets. It will provide services on a non-profit-seeking basis and facilitate investment in a range of products to encourage local industry development and positive environmental outcomes in Queensland.

ecoFundQ will provide a range of options to offset carbon emissions:

- Investment in Queensland based bio-sequestration sites (biosequestration is the sequestering of carbon through biological processes such as trees);
- Spot purchases of accredited offsets to match immediate need;
- Portfolio of renewable energy purchases and carbon offsets.

ecoFundQ encourages clients with high and/or ongoing offset demands to take a medium to long-term (10-to-30 year) approach to carbon strategy. This suits the profile of the proposed desalination plant. Depending on the characteristics of the carbon offset option, larger and longer-term projects will be able to achieve lower costs per tonne in a range roughly $18 to $40 per tonne.

Of all of the abovementioned offset providers, ecoFundQ may be able to provide this project with a range of options that could, at minimum cost, achieve operational carbon neutrality while promoting positive environmental outcomes and investment into the state.

J1.5 Comparison of Site Options

The different greenhouse gas implications of the proposed plants at the different site options are directly related to the energy requirements associated with each site as described in Section **Error! Reference source not found.**. In addition, wind power is an option that appears particularly likely in the North Stradbroke island region.

Table 9 and Table 10 describe the different site options in terms of emissions (based on the full fuel cycle emission factor of grid supplied electricity[3]).

Table 9 Total Power Requirement and Emissions - Tunnelled

Site - Origin	100ML/d			400ML/d		
	MW	MWh	tCO2-e	MW	MWh	tCO2-e
A. Marcoola	15	131,400	136,656	70	613,200	637,728
B. Kawana	14	122,640	127,546	66	578,160	601,286
C. Bribie Island	13	113,880	118,435	64	560,640	583,066
D. Lytton	13	113,880	118,435	68	595,680	619,507
E. North Stradbroke	16	140,160	145,766	75	657,000	683,280
F. South Stradbroke	14	122,640	127,546	71	621,960	646,838
H BAC	13	113,880	118,435	71	621,960	646,838
I Fisherman Islands	17	148,920	154,877	69	604,440	628,618

Table 10 Total Power Requirement and Emissions - Sea Bed Laid

Site - Origin	100ML/d			400ML/d		
	MW	MWh	tCO2-e	MW	MWh	tCO2-e
A. Marcoola	15	131,400	136,656	70	613,200	637,728
B. Kawana	N/A			N/A		
C. Bribie Island	13	113,880	118,435	64	560,640	583,066
D. Lytton	13	113,880	118,435	71	621,960	646,838
E. North Stradbroke	N/A			N/A		
F. South Stradbroke	14	122,640	127,546	69	604,440	628,618
H BAC	13	113,880	118,435	73	639,480	665,059
I Fisherman Islands	17	148,920	154,877	70	613,200	637,728

J1.6 Review of renewable energy Technologies Available

J1.6.1 Solar Photovoltaics (PV)

Solar PVs convert solar energy directly into electricity through the use of solar cells. Electricity is generated by sunlight acting on a semi-conductor inside the solar cells which then produces electrical currents[12].

The unit cost of electricity from Solar PVs is higher than other sources of energy due to capital expenditure but they are considered reliable and can deliver energy where power demand is low and grid connections are expensive. All sites included in the study are suitable for PV use although their ability to service overall energy consumption is constrained due to spatial limitations.

The current projections for the cost of Solar PV for industrial purposes, including equipments costs and structures amortised over a 20 year life at 5% per annum, is around

[12] Australian Greenhouse Office, 2003. Renewable Energy Commercialisation in Australia, Australian Greenhouse Office, Canberra

\$0.26/kWh[13]. This places it significantly higher than current peak energy costs from the Queensland grid (roughly \$0.08/kWh)[14].

However, trends indicate that the unit price of Solar PV appears to be decreasing as the market matures and new developments in Solar PV manufacturing technology emerge.

J1.6.2 Solar Thermal

Solar thermal technology involves the concentration of energy from the sun through the use of solar collectors or mirrors which focus energy on a working fluid such as a synthetic oil. The energy captured in the fluid can be converted into electricity or used directly in a desalination process. While solar thermal technologies have historically been applied to desalination on a small scale, the technology for large scale desalination is still in the research and development stage.

In Australia, solar thermal technologies have been shown to deliver roughly 7 to 17kWh/ m² per day. Lack of exposure area is the limiting factor in situations where solar thermal is used for purely electricity production purposes. The proposed project options would require approximately 2.8ha of exposure area to meet 20MW electrical demand and 11.3ha of exposure area to meet 80MW electrical demand.

However, integrated solar thermal desalination systems (see Figure 6) are considered viable in regions with ready access to land. These systems have the capacity to service a variety of demand levels.

Figure 6 is a schematic for a demonstration small scale, integrated solar thermal desalination system consisting of 14 solar collectors, designed to produce $3m^3$ of distilled water per hour of operation.

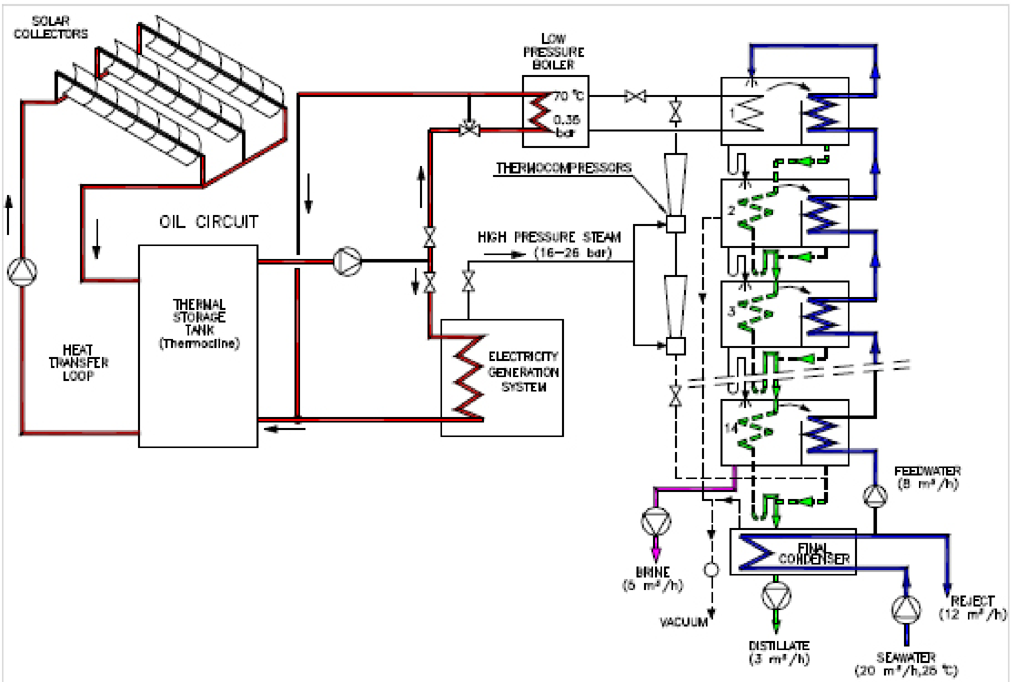


Figure 6 A demonstration small scale (190kW) solar thermal desalination system [15]

[13] SolarBuzz (2008), *Solar Industry Global Benchmark Price Indices*, Accessed 26/09/08, <http://www.solarbuzz.com/SolarIndices.htm>

[14] Quoted from Tru Energy, Bill Sereyas, verbal comms 19/9/08

While not having the capacity to meet the scale of demand required for the proposed project options, integrated solar thermal desalination systems may prove an effective complementary source of energy. Other fuels sources such as electricity, gas or other renewables can be used to supplement solar thermal in configurations called 'hybrid solar thermal'.

Whether solar thermal or hybrid solar thermal is a technically and economically feasible option for this particular project, further investigation is required as the technology has significant implications on the desalination process and plant design.

J1.6.3 Wind

Wind energy is considered to be suitable for electrical rather than thermal desalination technologies and has therefore been used with reverse osmosis desalination units at an approximate cost range of $0.0234-0.1210/kWh (depending on location and turbine type)[16].

Wind generation requires reliable access to high annual average wind speeds in excess of 6m/s to be considered economically viable. The power generated by a wind turbine generally equates to wind speed cubed.

Due to Queensland's geography and weather patterns, few places in Queensland have been found to have average wind velocities exceeding this threshold. However, studies have shown that some Northern coastal areas and parts of inland Queensland appear to have potential for wind generation**Error! Bookmark not defined.**. In fact, some places such as Thursday Island (which has an annual average wind speed of 7.5 m/s) and Windy Hill already have operational wind generators (0.45MW and 12MW respectively).

Within the vicinity of the study area, Stradbroke Island and Lowood have shown annual average wind speeds of 5.7 m/s and 4.7 m/s respectively[17]. Stanwell Corporation is currently proposing a 15MW wind farm on North Stradbroke Island. Whether this can be expanded may be worth consideration as with the potential to investigate offshore wind.

J1.6.4 Tidal generation

Tidal energy, a form of hydroelectricity, is generated by the cycling of tides which rotate the blades of underwater turbines. Many conventional tidal generation systems deliver intermittent supply due to their dependence on tidal patterns, although recent developments have seen the technology becoming more reliable than wind and solar energy.

While tidal generation is a clean and emissions free source of energy, there are concerns over significance of the associated environmental impacts such as disturbance to aquatic habitats.

As a general rule, locations with tidal ranges greater than 7 metres and having high levels of water movement lend themselves to tidal generation. South East Queensland, particularly the study region, experiences an average tidal range of 2.5 metres (see Figure 7). This implies that tidal generation would not be applicable to the proposed project.

[15] Blanco J (2004), *Innovative ideas to reduce current costs of solar seawater based on MED technology*, Centro de Investigaciones Energéticas Medioambientales y Tecnológicas, Spain
[16] Rehman S., Halawani T.O. and M. Mohandes b (2003) *Wind power cost assessment at twenty locations in the kingdom of Saudi Arabia*. Renewable Energy, 28, 573–583
[17] Queensland Environmental Protection Agency (1999) *State of the Environment Queensland 1999,* EPA, Brisbane.

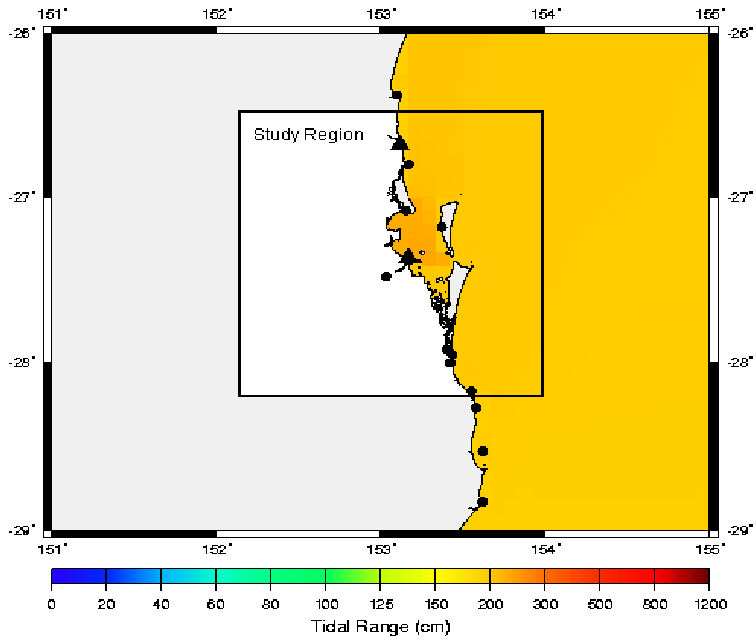


Figure 7 South East Queensland tidal ranges[18]

J1.6.5 Wave

Wave generation differs from tidal generation in that the motion of waves, rather than the flow of tides, is captured. The peaks and troughs of waves cause the movement of buoys which then convert mechanical energy into electrical energy. The technology has historically been suited to shallow areas with constant wave motion although the technology is developing rapidly with research and prototyping being undertaken[19]

Historically, wave pumps have been coupled with reverse osmosis desalination systems for small scale water processing**Error! Bookmark not defined.**. Large scale wave generation is not widely adopted or considered to be a mature technology however research into wave energy is accelerating. Such projects include a 20MW 'Wave Hub' off the coast of the UK to be operational in 2009.

While it may not be immediately feasible for wave energy to entirely service the demands for the desalination plant, the opportunity exists for existing wave technologies to provide clean supplementary energy in close proximity to the plant.

J1.6.6 Geothermal

Geothermal energy is a source of energy derived from the earth's molten interior which ranges from 650 to 7000 degrees Celsius. Through extraction technology, water is added to 'hot rocks' creating high pressure steam capable of servicing high thermal and electrical demands[5].

In the context of desalination, it is suited to thermal processes (Multi Effect Desalination and Multi Stage Flash, see Table 2) but can also provide electricity to power auxiliary equipment such as pumps**Error! Bookmark not defined.**. While it is not as common as solar PV or wind, it is a technology that has been used for many years abroad. At present though, the only existing geothermal power generator in Australia is a small demonstration 80kW generator in Birdsville in South West Queensland.[20]

[18] Bureau of Meteorology, *Tide Predictions for Queensland*, Accessed 26/09/08, <http://www.bom.gov.au/oceanography/tides/MAPS/qld_range.shtml>
[19] Hicks, D., Pleass, C., Mitcheson, G. R. and J. Salevan, (1989). *Desalination*, 73, 81-94.

[20] Geoscience Australia (2008), *Electrical Generation from Geothermal Energy in Australia*, Geoscience Australia, Canberra

Preliminary studies have shown the potential to use geothermal energy in remote Queensland**Error! Bookmark not defined.** although the feasibility of geothermal energy in the study region will require further investigation. In the interim, Figure 8 suggests that geothermal energy is not viable along the Queensland coastal region.

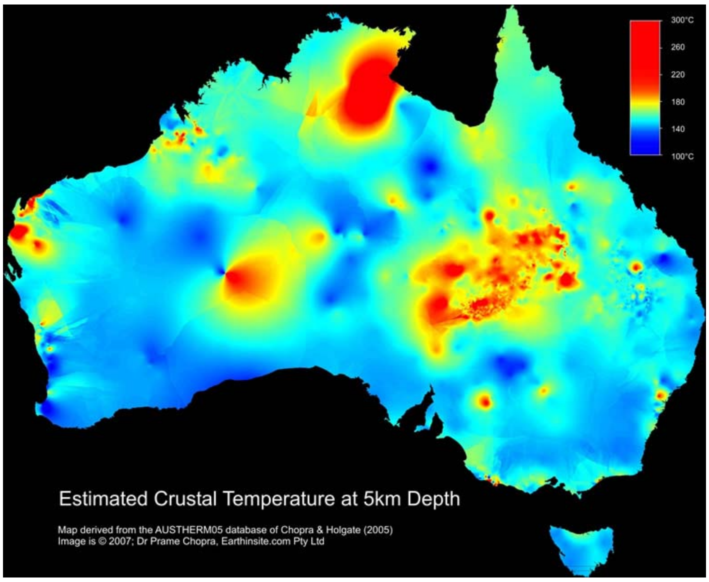


Figure 8 Estimated Crustal Temperature at 5km Depth[21]

J1.6.7 Biomass and biogas

Biomass is the organic matter recently derived from plants. Plants absorb the sun's energy and store it as chemical energy through the process known as photosynthesis. Energy conversion processes, such as burning, releases energy from biomass in the form of heat.

The anaerobic digestion of biomass can be used to produce biogas, a methane-rich combustible gas. Biogas is identified as a clean, easily controlled renewable energy source that can be sourced from landfill sites, livestock manure and sewerage, helping to resolve the problem of waste disposal.

Examples of biogas energy generation from landfills in South East Queensland include the Logan City Council's Browns Plains power station which exports 1 MW of power on an almost continuous basis. In Ipswich, the Swanbank power station also uses landfill gas mixed at a rate of 2% with other fuels to meet the 500MW energy requirements. In Brisbane, a 3.3MW landfill powered generator is in operation in Rochedale.

While the vicinity of the study area does not appear to have any operating landfill sites at present, biogas may still be generated from closed landfill sites decades after their closure. Further investigation is therefore needed to determine the amount of organic matter present at closed landfill sites such as the North Stradbroke Island Landfill.

J1.6.8 Co-generation

Co-generation or CHP (Combined Heat and Power) describes the production of heat and electricity using a single fuel. While not a 'renewable energy' it is significantly more efficient than conventional grid supplied electricity. Co-generation is best suited to applications requiring intense thermal loads through harnessing exhaust heat or steam (see Figure 9).

[21] Chopra, P., and Holgate, F., (2005) *A GIS analysis of temperature in the Australian crust, Proceedings of the World Geothermal Congress 2005*, Antalya, Turkey, 24-29 April 2005

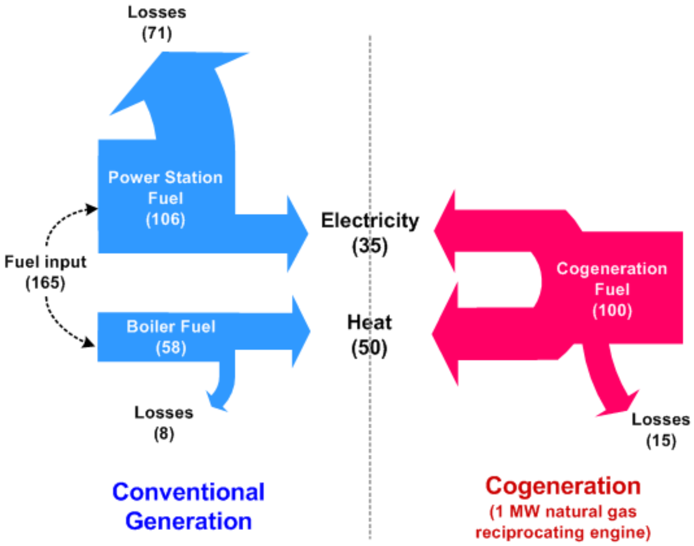


Figure 9 Comparison of losses between conventional and co-generation

Efficiencies of up to 70% can be achieved through the utilisation of waste heat or the conversion of waste heat into electricity (a process called combined cycle co-generation).

Co-generation plants can be built on a variety of scales including that which is required to service the proposed desalination plant options. They can even be directly integrated into heat intensive industrial processes including the desalination process.

The integration of co-generation and thermal and/or membrane desalination is known as hybrid desalination (see Figure 10) and has been effective in providing flexible and optimised water and power production in Europe, North America and Saudi Arabia. With the correct utilisation of waste heat, the costs of co-generation are relatively low compared to conventional generation due to operational efficiency improvements[22] (see Figure 9 and Figure 10).

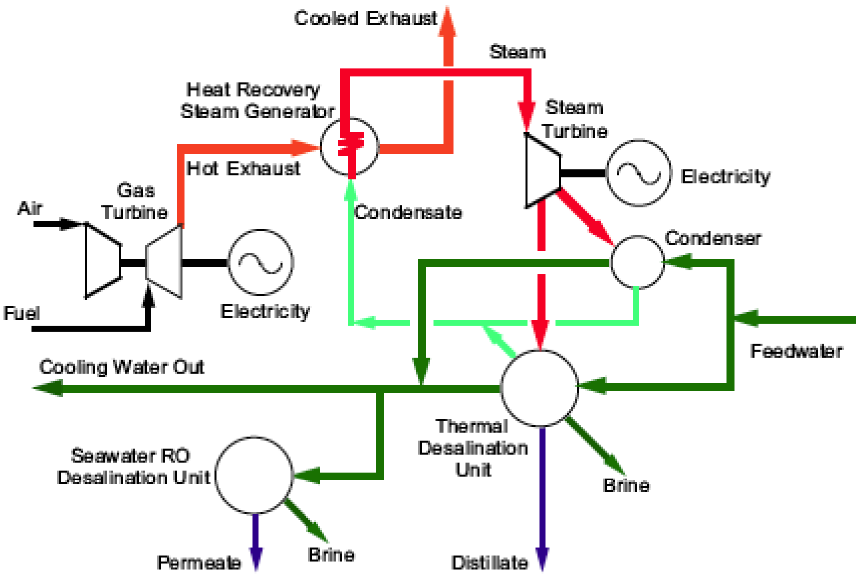


Figure 10 The co-generated (hybrid) desalination process

[22] Tonner, J (2004). *Potential for Thermal Desalination in Texas.* Bienniel Report on Seawater Desalination Volume 2. Texas Water Development Board. Austin, Texas.

Co-generation plants can be powered by a variety of fuels such as diesel, gas and even renewable energy sources. If renewable sources of fuels such as biomass are used, greenhouse gas emissions can be eliminated altogether.

In Australia, co-generation is typically fuelled by natural gas and is recognised as a cleaner alternative to electricity sourced from the Queensland grid in terms of greenhouse gas emissions. Although it will not eliminate emissions altogether, it may prove to be a significant and cost-effective option within a suite of emissions reduction measures.

J1.7 Summary and Recommendations

In developing an approach to managing and reducing greenhouse gas emissions, it should be noted that the most effective solution could involve a mixed approach. This may include natural gas fired co-generation or purchased GreenPower™ which would supply base load. This base supply could then be supplemented by renewable energy on site such as wind, wave or solar. Offsets could then be purchased on the remaining balance to achieve carbon neutrality.

In deciding on the approach to potentially achieving carbon neutrality the following should be considered:

- Whether the plant would be either entirely carbon neutral, subject to a discrete emissions target or whether a percentage of energy would be sourced renewably. In order to receive funding under the National Urban Water and Desalination Plan, operational carbon neutrality will be required;
- Whether co-generation and co-location is technically and economically feasible given access to fuels, site location and budget;
- The full costs of any on-site energy infrastructure;
- Capital costs – land, financing, equipment and labour;
- Operational costs – fuel, operational labour, training, maintenance;
- The life expectancy of any on-site energy infrastructure and the implications on financing;
- The proportion of GreenPower™ to be purchased and the cost implications – whether the budget should be spent on GreenPower™ or whether it should be spent on renewable energy assets should be modelled;
- Whether carbon offsets can be purchased, their market price, quality and availability;
- The impacts on the local environment and community; and
- Projected prices of future energy and carbon.