Torres Strait - Options to Reduce Regional Carbon Footprint

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Prepared by: CAT Projects

CAT PROJECTS

Australian Government

Torres Strait Regional Authority

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Ekistica Pty Ltd, trading as CAT Projects ABN 74 126 787 853

Section 1: Executive Summary

The Torres Strait Climate Change Strategy (TSCCS) developed by the Torres Strait Costal Management Committee in 2010 presents the urgency of climate change impacts for Torres Strait communities. Many communities are already threatened by the impact of increasing peak tides, and livelihoods in the region are particularly vulnerable to changes in marine ecosystems due to coral bleaching and warmer water temperatures, and increases in extreme heat and cyclone events. [1]

The TSCCS takes a proactive risk management approach to these significant threats and recommends a local greenhouse mitigation program as part of a broad climate action plan. This report contributes to this effort by providing a high level assessment of the regions greenhouse footprint by sector, to inform mitigation planning and decision making, identifying potential avenues to pursue mitigation efforts, and providing an overview of renewable energy options for the region. CAT Projects, working in cooperation with the Centre for Appropriate Technology (CAT), has prepared this report for the TSRA to inform decision making.

The sectoral analysis found that stationary energy and transport both generate significant amounts of greenhouse gas emissions, but that municipal waste is also considerable, and should be incorporated into a mitigation strategy.

Reducing stationary emissions in the region is most effectively achieved through demand side reduction. It is acknowledged that the TSRA's involvement in the Ergon Energy *powersavvy* program already represents the most beneficial first step towards stationary energy emission mitigation.

This report presents renewable energy deployment opportunities to inform a strategy development process. The feasibility of grid connect solar generators are considered through comparative lifecycle analysis, assessed against diesel cost projections subject to current market drivers, and diesel cost projections impacted by peak oil effects.

Strategies to reduce the carbon impact of transport and waste activities through the Torres Strait should be incorporated into a process of general infrastructure planning. It is recommended that this report be subject to review in the next five years, given the rapidly evolving nature of renewable technology markets, and energy markets in general.

This report has been completed with the assistance of base electricity consumption data provided by Ergon Energy.

1.1. Scope and Exclusions

The information presented is a high level investigation, intended to inform a greenhouse mitigation strategy planning process.

The assessments of greenhouse impact by sector do not represent full "lifecycle" assessments of all activities, but assess the greenhouse impact of those parts of the activities that are considered to be directly associated with consumption in the Torres Strait. The definition of this extent is clear throughout the report.

Contents

Section 2: Glossary

Biofuel/Biodiesel – Fuel/diesel made from plant oils, like coconut oil

Carbon Dioxide Equivalent - CO_2e – Different greenhouse gasses (like carbon dioxide, methane, nitrous oxide, ozone) have greater or smaller impacts on climate change. The Carbon Dioxide Equivalent is the mass of pure Carbon Dioxide that would have the same impact as the mixture of gasses emitted by an activity.

Energy – The amount of electricity used over a certain time frame – unit is kilowatt hours (kWh)

Generating Cost Indexation – the percentage that the marginal cost of power has been projected to increase every year.

Greenhouse Emissions – the release of gasses that will contribute to human-induced climate change, including the release of CO_2 through the combustion of fossil fuels.

Grid Connect – A renewable generator (eg. A solar or wind plant) that provides its energy straight into the distribution network. These generally don't require energy storage like batteries.

High penetration renewable generator – a renewable generator that provides a large amount of the electricity, when a renewable generator and a non renewable generator are serving a load

Integration – the technical connection of two or more generators so that they work together to serve a load

Internal Rate of Return – This shows whether a project is a good financial investment –higher values mean better investments. The rate of return is the discount rate, or the percent by which future money is worth less to an investor than money now, that means a project "breaks even" over a certain time period.

Load Profile (Annual/Daily) - The amount of power typically used at different points through a day/year

Marginal Costs of Electricity production – The cost of providing a unit of electricity, without taking into account the capital costs of establishing and maintaining the generation plant. This is a relevant cost to compare the cost of solar against, because in a grid connect system, it's still necessary to upkeep the diesel generation infrastructure.

Modal Average – The modal average is the value that is most common in a group of numbers.

Peak Oil - The point in time at which the rate of oil production decreases due to a depletion of easily-extractable resources, generally leading to an increase in the price of oil and oil-based fuels.

Peak load – The greatest amount of power a load will typically use

Peak sun hours – The amount of sunlight energy available at a location through the day

Power – The amount of electricity used at a moment in time – unit is kilowatts (kW)

Renewable resource (solar, wind, tidal resource) – the source of power for a renewable generator, eg, sunshine for a solar generator – and how much is available through the year.

Roll-on, Roll-off ferry – A ferry that can accommodate cars.

Stationary Energy – Energy used in a building, not for transport

Tidal range – The difference between the high and low tide at a particular place

Utility – The organisation responsible for providing a service like electricity or water, and maintaining infrastructure

Section 3: Background

The Torres Strait Islands span the 220km between Cape York and Papua New Guinea's Western Province, and are home to over 8,000 people living in about twenty island communities. Its disperse, ocean-bound communities present challenges for the provision of infrastructure for essential services. This contributes to high living costs in the Torres Strait, and in some cases, basic services generate a particularly high volume of greenhouse emissions.

At the same time, Torres Strait Islanders experience the impacts of climate change through existing environmental pressures including coastal erosion, high tide events and water security. There is a high level of awareness about human induced climate change in the region, and motivation to act on reducing climate impact.[2]

The Torres Strait Regional Authority (TSRA) is an Australian Federal Government Statutory Authority that represents the interests of the Torres Strait's eighteen island and two Northern Peninsula Area communities. They have engaged CAT Projects, working in cooperation with the Centre for Appropriate Technology (CAT), to undertake a high level assessment of the greenhouse impact of activities in the Torres Strait by sector, and the opportunities to reduce the region's carbon footprint.

The Torres Strait Islands are currently making effective inroads against emissions by participating in the *powersavvy* program, developed by Ergon Energy and Bushlight (CAT) with funding from the Queensland Government through the Office of Clean Energy. This program focuses on a reduction in domestic and commercial electricity production, which is generally the most beneficial starting point in an effort to reduce greenhouse impact.

This report will make a high level assessment of the most logical "next steps" for the Torres Strait Islands, in terms of reducing its own energy consumption.

This will encompass:

- *Assessment of existing power stations and their general capacity for integration of renewable energy systems*
- *Identification of available vacant land for possible potential use as renewable energy system sites*
- *High level assessment of solar and wind resources available*
- *Identification of key barriers to renewable energy installations in the Torres Strait*
- *Identification of possible ownership and financing models*
- *Identification of possible opportunities for capacity building within island communities associated with alternative energy usage models*
- *Assessment of long term viability of renewable energy projects and required levels of subsidy (government or otherwise) for projects to be considered cost-effective*
- *Estimate current greenhouse gas emissions from electricity generation, transport and waste disposal*
- *Estimate predicted reduction in greenhouse gas emissions if renewable energy systems were to be installed*
- *Identification of possible opportunities to improve energy efficiency at a macro level*

This report references and builds on the Torres Strait Sustainable Energy Study Scoping Paper, prepared by the Centre for Appropriate Technology in April 2010.

3.1. Community Overview

3.1.1. Regional map

3.1.2. Torres Strait Settlements and population

There are about seventeen major communities in the Torres Strait, with smaller family outstations established with discrete infrastructure on other islands that are generally outside the scope of this report.

These communities can be grouped according to their locality through the Strait, with the groupings aligning roughly to distinctions in cultural identification and language group throughout the islands, and also to differences in the geological formations of the islands. The Top Western Islands near Papua New Guinea are formed by the aggregation of alluvial sediments from mainland rivers on coral foundations, traditionally populated by hunting cultures. The Inner Western basaltic islands are the exposed peaks of the submerged extension of Australia's eastern coastal ranges. The Eastern Islands are steep volcanic landforms with rich soil and traditional gardening cultures. The Central Islands are coral cays and exposed reefs, with excellent fishing resources.

By far the largest current settlement is at Thursday Island in the Inner Islands group, which serves as the region's service centre. The regional airport is at neighbouring Horn Island. Significant communities have also been established at Bamaga and Seisia on the north of mainland Cape York, formed by settlers from Saibai Island in response to environmental pressures in the 1950s.

This report considers the settlements as they are listed below, according to the maintenance of community power stations by Ergon Energy. There are smaller settlements throughout the region, but these are largely served by discrete infrastructure such as private diesel gensets. The Kubin power station serves the two settlements on Moa Island, Kubin and St Pauls, and the Bamaga power station also serves Injinoo, New Mapoon, Seisia and Umagico.

Population data in the Torres Strait has been identified by the Australian Bureau of Statistics as being particularly difficult to collect and verify. This is due to language and cultural barriers, the small size of settlements, and the population's high levels of mobility. Similarly, it is difficult to determine trends from annual variation, given that most Torres Strait Island populations are too small to demonstrate trends that can be distinguished from statistical noise.

For these reason, power consumption figures have been adopted as a determinant of the effective population, especially in terms of infrastructure demand. This is a useful indicator because of the quality of available electricity consumption data, even though the scope of this report also includes an assessment of transport and waste impacts.

The intrinsic inaccuracies in the population data preclude comparisons in power consumption per capita.

		Residents
Badu Island *Near Western Group*	Badu is a steep basaltic island in the Western Group, adjacent to Moa Island, with Kubin and St Pauls Communities.	915
Boigu Island *Top Western Group*	Boigu is a low-lying sedimentary island off shore from Papua New Guinea's Western Province, formed by alluvial river sediments collected on a coral base. The Top Western Islands are adjacent East West Regional Shipping Channels, which has a strategic significance for Australia.	284
Bamaga & Seisia *Central Group*	Bamaga is a Northern Peninsula Area (NPA) community on the Australian mainland, formed in the 1950s by migrants from the low-lying Saibai Island in the Top Western Group. The power station at Bamaga also services mainland Seisia.	909 195
Poruma Island *Central Group*	Poruma is a coral cay in the Central Torres Strait Islands, home to the Poruma Resort.	194
Erub Island *Eastern Group*	Erub is the largest of the Eastern Islands, volcanic with rich soil and lush vegetation.	365

Dauan Island *Top Western Group*	Dauan Island is a high-elevation granite island in the northern group of mostly sedimentary formations. It is experiencing a higher rate of growth than average in the Torres Strait (2.3 – 6% per year.)	164
Hammond Island (Kiriri Island) *Inner Group*	Hammond Island is a hilly granitic peak adjacent to Horn and Thursday Islands. The community is on a sloping bay to the west of the island and mostly protected from high tides.	244
Moa Island **Kubin & Saint Pauls** *Near Western Group*	Moa Island is a basaltic based island, adjacent to Badu. It hosts two comunities, Kubin and Saint Pauls, both served by the Kubin power station.	228 266
Mabuiag Island *Near Western Group*	Mabuiag is to the north of the other Near Western Islands. It is the northernmost peak of the eastern Australian mountain range, and a smaller, less elevated island than Moa and Badu. It is the only inhabited island in the Bellvue group.	276
Mer Island *Eastern Group*	Is the crown of an extinct volcano, to the east of the archipelago, included culturally in the Meriam group of islands.	545
Ugar Island *Eastern Group*	Volcanic in origin, culturally part of the Meriam group.	85**
Saibai Island *Top Western Group*	Saibai is a sedimentary island that is particularly susceptible to inundation at high tide events. The location has some strategic significance for its proximity to the East West shipping route through the Torres Strait.	394
Thursday Island *Inner Group*	Thursday Island is the administrative centre for the Torres Strait, home to about half the Torres Strait population. It has a large number of government workers, and the region's hospital and TAFE campus.	2717***
Warraber Island *Central Group*	Is a coral cay in the Central Islands.	288
Horn Island *Inner Group*	Horn Island is a larger island in the central group adjacent Thursday Island, and hosts the regional airport. The population includes most of the region's pilots. A ferry service operates between Thursday and Horn Islands.	632***
Iama Island *Central Group*	Iama is an elevated basaltic peak, which is an exception in the coral-based Central Group of islands.	340
Masig Island *Central Group*	Masig is a coral Island in the Central Group.	330

* Australian Bureau of Statistics National Regional Profile, 2009

**Ugar Island was omitted from the 2006 census. The population has been estimated from its diesel consumption, applying an average per capita consumption from other outer Torres Strait islands.

***The populations for Thursday Island and Horn Island are not provided independently by the ABS for 2010, due to its inclusion in the larger Torres Shire. This figure is based on the 2006 figure of 2564, indexed against the respective increase in electricity generation at each island.[3]

3.1.3. Population growth

Population growth trends in the Torres Strait are difficult to establish, due to the same difficulties discussed for total population estimates in section 2.1.1.

However, in general, Torres Strait communities have experienced growth over the past ten years with an annual average between 1 and 8 per cent.

Some communities experience slightly higher relative growth, due to local pressures including the differential threat that rising highest tide events pose to islands with different topography. No communities are yet registering negative population growth, however.

Many islands face imminent infrastructure capacity limitations, for existing housing and land availability, water supply, waste or electrical services.[4]

For the purposes of this report, Island community trends in power consumption described in section 3.1.1.3 will be used to indicate growth in services demand in Torres Strait island communities.

Section 4: Greenhouse Impact by Sector

4.1. Stationary Energy

4.1.1. Consumption

The Torres Strait Islands are currently reducing their domestic and commercial electricity consumption through the *powersavvy* program, an education and energy efficiency program conducted by Ergon Energy in conjunction with the TSRA and local councils. This program was developed with Bushlight (the Centre of Appropriate Technology,) with the support of the Queensland Government Office of Clean Energy.

A pilot project conducted on Horn Island, Thursday Island and the Northern Peninsula Area (NPA,) achieved electricity savings of 15% in total for those who chose to participate. *powersavvy* is currently being extended to the remainder of the Torres Strait communities, with a similar focus on integrated education, voluntary audits and appliance upgrades, and community capacity building[5].

The program's focus on reduced consumption is to be encouraged as the most appropriate way to reduce the greenhouse impact of stationary energy. Behaviour change is the most cost effective way to reduce greenhouse gas emissions, and the option with the most opportunities for wider benefits – such as reduced consumer costs.

Given the scope of the *powersavvy* program, this report does not consider domestic or commercial behaviour change, appliance upgrades or education.

4.1.1.1. Domestic Electricity Consumption

Before implementing energy efficiency measures, *powersavvy* found that domestic electricity consumption at the pilot communities was most typically between 12 to 25 kWh per day (modal average.) A small number of households (3%) were using a very large amount of electricity, between 50 and 60 kWh per day.

This represents significant household expenditure for most Torres Strait Island residents.

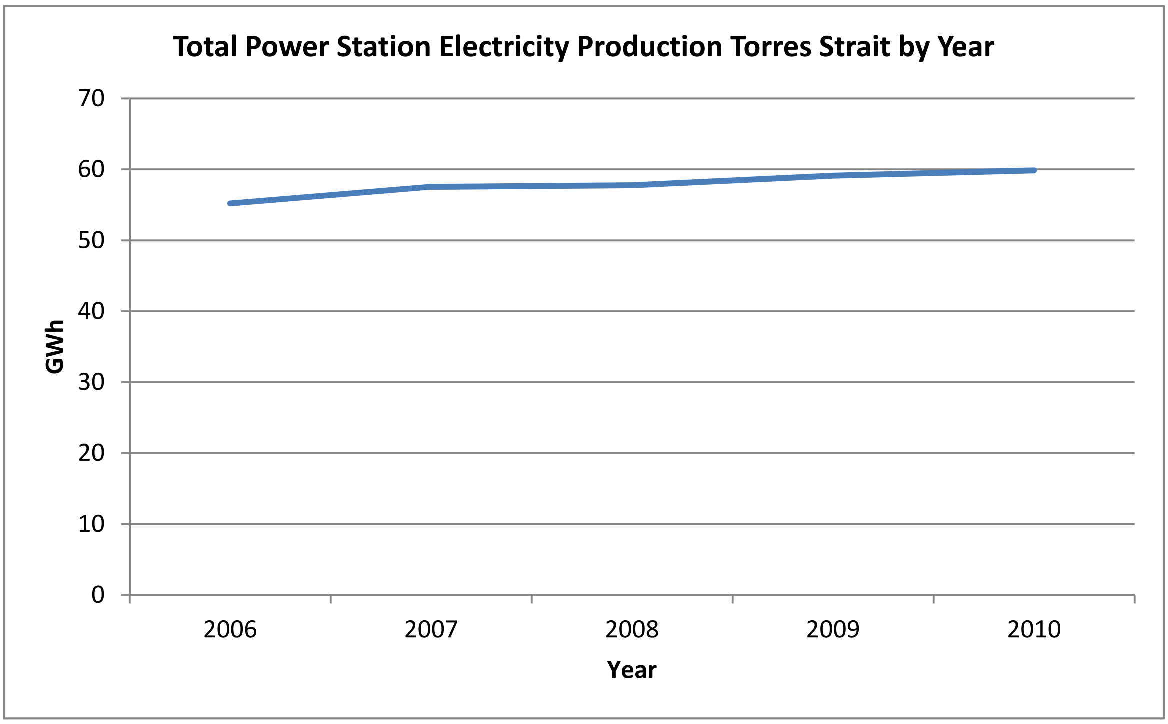
Domestic electricity is purchased by Torres Strait residents as five, ten or twenty dollar powercards, at the standard Queensland unit rate of $0.23 per kWh. The marginal cost of electricity generation in this area is not public information, however applying industry standard costs implies an approximate unit rate of over $0.40 per kWh.

4.1.1.2. Electricity Consumption by Island

The large communities at Thursday Island and Bamaga are the sites of by far the highest energy consumption in the locality.

4.1.1.3. Total Electricity Consumption by Year

The total annual power station consumption of the seventeen Torres Strait power stations shows a steady increase over the past five years. Electricity consumption has increased at an annual average rate of 1.6% per year over this period.



4.1.1.4. Trends by Island

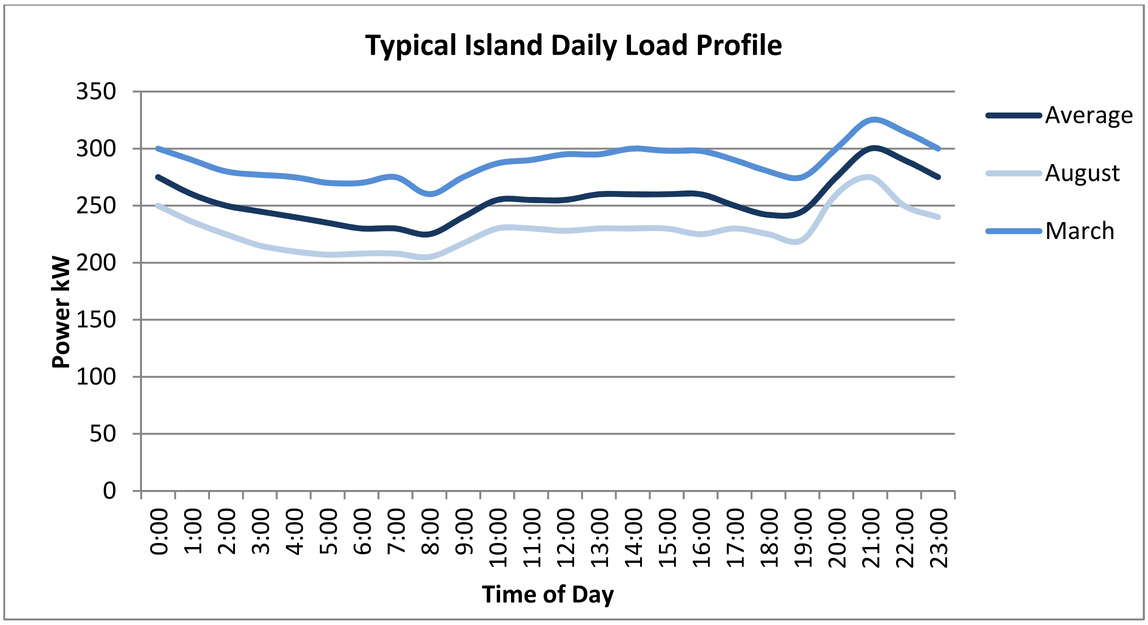
A trend of gradual increase in power consumption is not observed in all islands.

Thursday Island has seen an average annual increase in power consumption of 1% since 2005, whereas the regional average annual increase has been 2%.

4.1.1.1. Load Profile

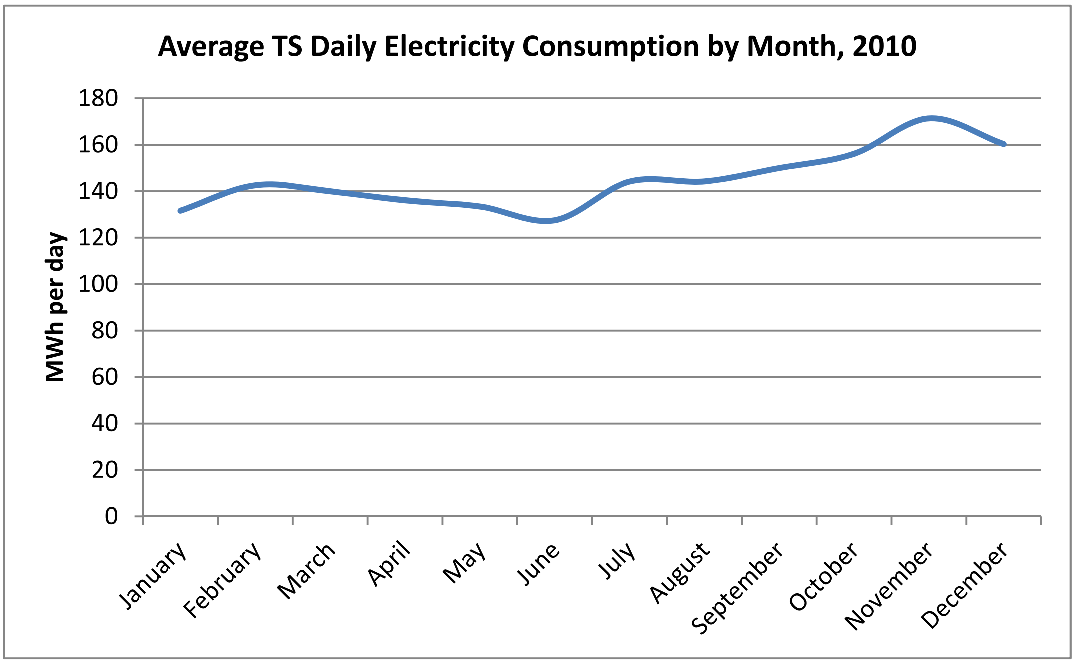
4.1.1.1.1. Daily Load Profile

The daily load profile in the Torres Strait does not significantly alter its trend through the year, in line with the small annual variation in diurnal temperature range. Usage is consistent through the day, dipping before sunrise and showing a moderate evening peak.



4.1.1.1.1. Annual Load Profile

While rainfall and wind patterns vary considerably through the year in the Torres Strait, the annually diurnal temperature stays within a small range. This results in a relatively constant power demand through the year with a peak in November, the hottest month. The load sees a reduction in December and January despite the heat of this period, due to school holidays and lower population numbers.



4.1.2. Greenhouse Impact

Electricity produced in the Torres Strait, excepting the input from a wind plant on Thursday Island and some grid-connect photovoltaic generators, is generated by diesel power stations. This diesel is transported as coastal freight to Thursday Island and barged to the outer Torres Strait Islands.

In 2010 Torres Strait power stations consumed approximately 16 ML of diesel.

This caused the emission of approximately 43,218 tonnes of CO_2-e, according to National Greenhouse Accounts standards[6].

There is also significant transport fuel consumption associated with shipping this fuel from Cairns to Thursday Island, and on to the outer Torres Strait islands.

This has been considered below, because of its contribution to the Torres Strait region's overall greenhouse profile. It should be noted that full lifecycle emissions are not considered for any sector.

Applying a standard Bureau of Infrastructure Transport and Regional Economics figure for the emissions related to the coastal shipping transport of freight by tonne, fuel transport in 2010 in the Torres Strait contributed 255 tonnes of CO_2-e. [7]

4.2. Transport

4.2.1. Transport patterns

Mobility and travel is culturally important to Torres Strait Island residents as it is to many remote indigenous populations in Australia. The regions' two largest industries, fishing and tourism also depend directly on transport.

The Queensland Government through the Department of Transport and Main Roads, commissioned a comprehensive plan for the Torres Strait region's transport infrastructure development in 2006.[8] These findings are assessed here in terms of their greenhouse implications.

Boating remains a central part of life in the Torres Strait, with many families maintaining a dinghy for travel and fishing, and supplies being transported by coastal freighter and barges. Options to travel by commercial sea taxis and ferries are limited and declining, however, due to a combination of safety concerns, the reliability of air transport, and deteriorating boating infrastructure on many islands.[9] The Queensland Government is planning to introduce an airfare subsidy scheme in 2012 for Torres Strait residents.

Air travel has been established as a preferred mode of transport, due to a number of factors including the seasonality and dangers posed by sea passage through many parts of the Torres Strait. Residents depend on air travel for reliable transport to Thursday Island services and the mainland, however a survey of air travellers undertaken in 2006 found that a significant 61% had their flight funded by a government body, generally for employment reasons. [10]

Car ownership is relatively high for island communities, at 39% in the Torres Strait.

Small Vehicle Emissions

The contribution of fishing vessel, ferries, cars and local boats in the Torres Straits has been assessed via the total of bulk fuel consumed, distributed by Reliance Fuel to a distribution station at Thursday Island, and from there through the islands.

2010/11 Small Vehicle Emissions

Fuel Type	Litres 2010/11	CO_2.e (tonnes)
Diesel	2,100,000	5,666
Unleaded Petrol	1,500,000	3,570

4.2.1.1. Ferries

The emissions from ferries are included in the bulk fuel based estimates above. They are not counted twice.

Council-operated ferries between Saibai and Dauan, and between Erub and Ugar and sometimes Masig, had been set up in the past to accommodate the shortfall in aircraft landing facilities at Dauan and Ugar. These were not operating at the time of writing this report, with services suspended indefinitely due to vessel and staff shortfalls.

Commercial ferries were in operation in the inner islands.

Ferries

Carrier	Route	Passengers	Round Trip (km)	Annual Trips	CO_2.e (tonnes)
Peddell's	Seisia/Thursday Island Return	38	60	468	79
Mc Donald Ferry	Thursday/Horn Island return	50	7	4,056	105
Rebel Tours	Thursday/Horn return	36	7	2,808	52
Muralug School Ferry	Muralug/Thursday return	23	7	900	11
Hammond Island Ferry	Hammond/Thursday return	23	2.5	1820	8

*See Appendix 1 Estimating Transport Emission Figures

4.2.1.2. Freight

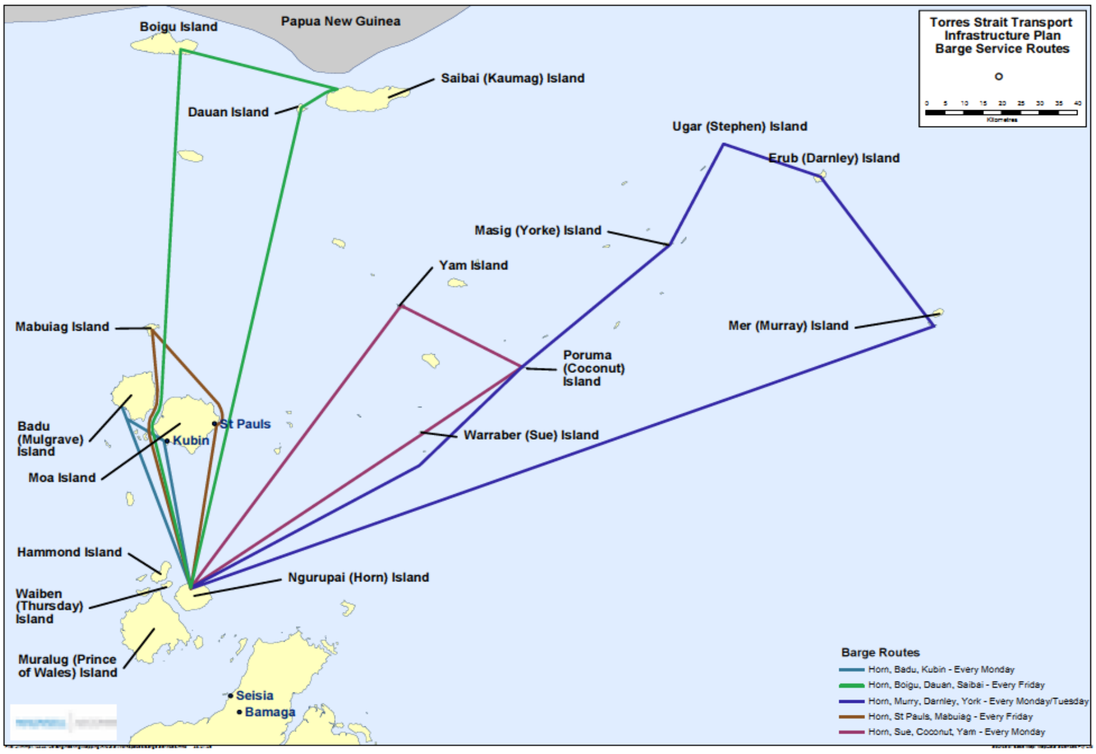
Freight services are supplied by Sea Swift and Silent World to the Torres Strait. Coastal freighters pass through Port Kennedy twice a week from Cairns. On the Friday service, a landing barge transfers supplies to the outer Torres Strait Islands.

Freight emissions calculations are based on full vehicle capacities, due to the unavailability of Sea Swift data.

Sea Swift:				
Type	**Vessel**	**Km (weekly)**	**Weight**	**Emissions** **(annual** CO_2-e **tonnes)***
Large Scale Freight	Trinity Bay	1 000 (Cairns to Thursday Island)	3,000 t max freight, 3,200 t dead weight	6,448
	Newcastle Bay	1 000 (Cairns to Thursday Island)	3,000 t max freight, 2,768 t dead weight	5,999
Barge Freight	Landing barges from scheduled Sea Swift Services	1 295 km (total weekly)	1,500 t max freight Deadweight disconsidered	2,020
Silent World:				
Large Scale Freight		1000 km (Cairns to Thursday Island)	520 t max freight 320 t dead weight	874

*See Appendix 1 Transport Carbon Emissions Estimation Methodology

Torres Strait Barge Service Routes



Reproduced with permission from the Queensland Transport.[11]

4.2.1.3. Air Travel

Scheduled air travel between Horn Island and Cairns is serviced by Qantas according to a minimum service level agreement. Inter Island travel from Horn Island to the outer Torres Strait Islands is delivered by West Wing.

Qantas operates a 50 seat Dash 8 300-series turboprop aircraft on this service, and West Wing flies an eleven seat Cessna Grand Caravan, and a ten seat Britten Norman Islander.

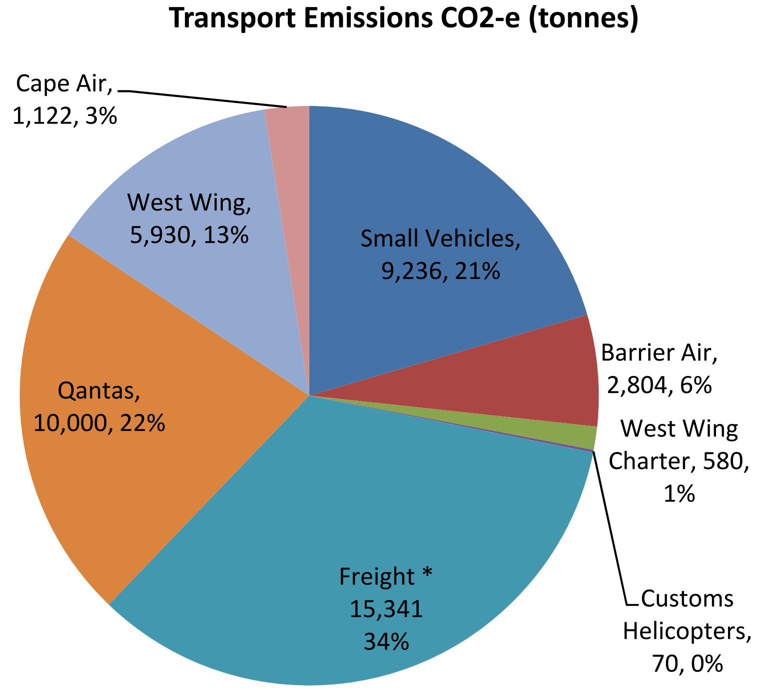
Survey results from the 2006 Queensland Transport Infrastructure Plan found that 61% of air travellers had their trip funded commercially or by the government. 48% of passengers were travelling for work. [12]

Carrier	Route	Aircraft	Distance (km)	No. per week	Emissions (annual CO_2-e tonnes)*
Qantas	Cairns-Horn Island return	Dash 8 Turboprop	1 600	14	**10,000**
West Wing	Horn, Murray, Erub, Masig, Horn	Cessna Caravan 208	500 km	3	620
	Horn, Masig, Erub, Murray, Masig, Horn	C208	500 km	5	1,080
	Horn, Boigu, Saibai, Iama, Horn	C208	350km	4	630
	Horn, Badu, Moa, Horn	Britten Norman	140 km	4	240
	Horn, Badu, Mabuiaig, Moa, Horn	BN2	190 km	4	330
	Horn, Moa, Badu, Horn	C208	140 km	5	370

Carrier	Route	Aircraft	Distance (km)	No. per week	Emissions (annual CO_2-e tonnes)*
	Horn, Iama, Saibai, Boigu, Horn	C208	350 km	3	470
	Horn, Poruma, Sue/Warraber, Horn	C208	240 km	3	330
	Horn, Poruma, Sue/Warraber, Horn	C208	240 km	5	550
	Horn, Moa, Badu, Boigu, Saibai, Horn	C208	330 km	2	320
	Horn, Boigu, Saibai, Iama, Horn	C208	350 km	2	310
	Horn, Sue/Warraber, Poruma, Iama, Horn	C208	250 km	2	240
	Horn, Poruma, Sue/Warrager, Horn	C208	240 km	2	220
	Horn, Poruma, Masig, Murray, Erub, Masig,	C208	470 km	1	220
Total West Wing Scheduled					**5,930**
Cape Air Transport	Charter: reported total annual aviation fuel consumption of 187,200 L				**1,122**
Barrier Air Services	Charter: reported total annual aviation fuel consumption of 468,985 L				**2,804**
West Wing Charter	Total non scheduled				**580**
Customs Helicopter Flights	3 helicopter trips per week, every second week, visiting each island				**70**
Aviation Total					**20,506**

*See appendix 1 Carbon Emission Estimation Methodology

4.2.2. Greenhouse Impact



*Freight is likely to be overestimated, due to the necessity of using full vehicle capacity figures.

4.3. Waste

4.3.1. Municipal Waste Generation and Greenhouse Impact

Given the land constraints and increasing populations on most Torres Strait Island, municipal waste management has been identified as a pressing infrastructure planning issue for most of the region's communities. Most locations have some landfill facilities, with varying management practices. Most landfill is uncovered.

An estimation of the greenhouse impact of current waste management practices will contribute to the waste planning process that is currently underway for Torres Strait facilities.

Waste generation volumes have been calculated according to an assumption of 850 kg per head, annually. This is based studies cited in a Torres Strait Regional Waste Management Feasibility Study Briefing Paper.[13]

850kg per person per year is half the Queensland average for 2006-7, and may be overly conservative. [14]

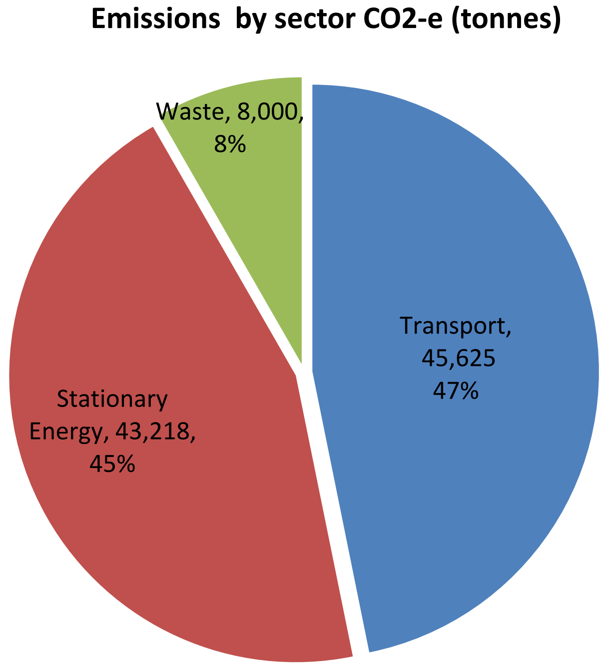
For the estimated regional population of 9,370 inhabitants, this equates to 8,000 tonnes produced annually in the region.

According to National Greenhouse Accounts Factors, this will produce an equal mass of CO_2-e emissions, 8,000 tonnes annually[15]. Burning the waste emits the same volume of CO_2-e, but at a faster rate.

See Appendix 1 for assumptions.

4.4. Comparison

This comparison demonstrates that all sectors represent significant contributions to the region's greenhouse gas emissions, and that achievements in emission reductions in any sector will have an impact on the Torres Strait's total footprint.



Section 5: Infrastructure Overview

5.1. Stationary Energy

5.1.1. Regional Overview

Electricity is provided by Ergon Energy to larger Torres Strait settlements via diesel powered minigrids. Residents purchase domestic electricity at the standard Queensland domestic rate of $0.23 per kWh, via powercards. The recouped funds are less than the generation cost in this region, which incur diesel shipment costs from Cairns.

There has been some grid-connect solar power installed in the Torres Strait, as well as a 450 kW wind generation plant at Thursday Island.

5.1.2. Existing Power Stations

Ergon Energy advises that all powerhouses are fully automated and are capable of scheduling automatically and synchronising to serve the load. Gensets are replaced to a six-year cycle, at which time a system sizing review is undertaken.

In general, automated powerstations of this kind facilitate the integration of grid connect renewable generators such as solar arrays. A “high penetration” renewable generator that is large relative to the rated genset size should be sized to avoid exceeding a 30% contribution to meeting the load under typical conditions, to avoid integration issues.

More detailed assessment of a specific powerstation automation and control system should be undertaken on a case by case basis should a grid connect project progress to feasibility assessment phase.

5.1.1. Thursday Island Wind

Ergon Energy owns and operates a wind generation plant of two 225 kW turbines at Thursday Island, initially contributing an average of 1.22 GWh of electricity generation per year to the Thursday Island minigrid.

Ergon Energy estimates that this provides 5% to 10% of the island's electricity needs and saves approximately 300,000 to 600,000 litres of diesel and a resulting 870 to 1,700 tonnes of greenhouse gases each year.

The generators were installed in 1997, and are nearing the end of their design life. Ergon Energy reports that they are currently investigating the feasibility of replacing and extending the capacity of this facility.

5.1.2. Solar

Some medium-scale grid connect solar generators have been installed through the Torres Strait, including 180kW as part of the *powersavvy* upgrades.

5.2. Transport

5.2.1. Sea

The Queensland Transport Infrastructure Plan for the Torres Strait incorporates a detailed assessment of the status of the region's maritime facilities, roads and air transport infrastructure.

The report identifies some specific shortfalls in maritime facilities that impede the uptake of dinghy and ferry transport, which are a preferred mode of transport in the region. These included a lack of mooring facilities for dinghies at Horn and Thursday Islands, deteriorating ramps, piles and navigational guides at outer Torres Strait Island communities and in some case the need for channel dredging. The report suggests that air service facilities have received substantial relative funding relative to marine services in the region, however it did not claim this was the major impediment to marine travel, citing safety factors such as seasonal tides and strong currents.[16]

5.2.2. Sea Freight

Fuel and grocery requirements are supplied to the islands by coastal freight from Cairns. A large scale freighter is scheduled twice weekly from Cairns to Thursday Island/Horn Island by Sea Swift, with a weekly landing barge distributing cargo to the Outer Torres Strait Islands once a week from a transfer facility on Horn Island.

Port facilities in Queensland are privately owned, and recoup their costs through usage charges. The small number of vessels to use northern ports requires larger usage fees, which sees port facility costs at $20 per tonne of freight for the Torres Strait, compared to $3 per tonne in Cairns. [17]

5.2.1. Air

Flights to and from Cairns operate out of the airport at Horn Island. Outer Torres Strait Islands with significant settlements are served by functional landing and airport facilities, except some smaller islands such as Duaun and Ugar.[18]

5.3. Waste

Badu	Badu landfill is nearing capacity, and will need to be remanaged, and/or relocated posing land tenure issues. Waste is uncovered, and combustible waste is incinerated. Car bodies are a particular issue on Badu, and the Sustainable Land Use Plan recommends introducing a tarrif for their removal.
Boigu	Waste in Boigu is currently delivered to an open waste depot by a mini packer truck. The Sustainable Land Use Plan recommends this is unsustainable, and a landfill site will need to be developed.
Bamaga	A Sustainable Land Use Plan is not available for Bamaga. It is assumed their waste is similarly deposited in uncovered landfill.
Poruma	Cars and bulk metal waste are retrieved and sent to Cairns for recycling. Waste is disposed of according to a trench and cover method within a fenced compound.
Erub	Waste is disposed of according to a trench and cover method within a fenced compound.
Dauan	A fenced compound and trench has been provided for the community to manage.

Hammond	The Hammond Island dump is at capacity and new facilities are required.
Kubin	A fenced landfill compound provides trench and cover facilities.
Mabuiag	Mabuiag has developed a fenced compound, however the current practice is to bury waste in an unmanaged manner in coastal sand areas.
Murray	A trench and cover facility is provided, but requires management and maintenance.
Ugar	The Ugar deposit is a basic trench burn and bury operation, with combustible waste being incinerated.
Saibai	The Saibai site is subject to inundation. No soil is available to cover landfill.
Thursday	Thursday Island waste is barged to the Horn Island landfill site.
Warraber	Warraber is the site of a pilot waste management and separation project. Food and compost are separated and processed. Recyclables are being freighted to Cairns.
Horn	Horn Island facilities are managed by Torres Shire.
Iama	Iama waste depot is subject to inundation. Waste is incinerated where possible.
Masig	Waste facilities are trench and cover, but require improved management.

Section 6: Emission Reduction Opportunities

6.1. Stationary Energy

The stationary energy sector was identified as producing about 50% of the region's green house gas emissions.

6.1.1. Energy Efficiency

6.1.1.1. powersavvy

As mentioned above, the *powersavvy* program is a comprehensive domestic and commercial energy efficiency program currently being rolled out through the Torres Strait.

The *powersavvy* program focuses on:
- working with residents to reduce household electricity use;
- working with business owners and other commercial customers to identify opportunities to reduce electricity use;
- supporting school-based activities to increase students' knowledge of energy efficiency;
- encouraging project managers and developers of new buildings and infrastructure to make these as energy efficient as possible;
- and supporting and encouraging the purchase of more efficient appliances.

It is recommended that the TSRA continue to work with Ergon Energy and other stakeholders to maximise the traction of this program.

6.1.1.2. Other Potential Energy Efficiency Opportunities

Energy efficiency opportunities beyond the scope of the *powersavvy* project could extend and reinforce the impact of this program.
Houses in the Torres Shire are currently managed by Queensland Housing, Department of Communities, with some Outer Torres Strait Island housing currently run by the Torres Strait Island Regional Council. Queensland Housing states that it has a policy of ongoing incorporation of energy efficient elements into its housing stock fabric. The TSRA is encouraged to investigate potential to work in conjunction with Queensland Housing towards implementing environmentally appropriate standard housing. While the impact of housing upgrades is likely to be less immediately measureable than other measures, the program has wider benefits for Torres Strait Island communities such as housing liveability and affordability.

Tangentyere Council in Alice Springs, recently conducted an energy efficiency housing upgrades project, partly funded by Alice Springs Solar Cities, to increase the liveability of Tangentyere Council housing stock and decrease resident electricity consumption.
The results are available at the Tangentyere Council website www.tangentyere.org.au.

6.1.1.3. Solar Hot Water/Heat Pumps

powersavvy completed a project with the Queensland Department of Communities to replace 220 electric hot water systems with heat pumps. The impact of this replacement is being evaluated by Ergon Energy. At present, hot water system replacement is not a standard part of the *powersavvy* program.
Houses in the Torres Shire are currently managed by Queensland Housing, Department of Communities, with some Outer Torres Strait Island housing currently run by the Torres Strait

Island Regional Council. Of their housing stock in the Torres Strait, Queensland Housing estimates that 50% of their houses already operate heat pumps, 20% would have solar hot waters, and 30% would operate electric boosters.
It is Queensland Housing's policy to replace hot water systems with heat pumps as they fail.

Opportunities may exist to work cooperatively with Queensland Housing to investigate opportunities for accelerating the rollout of efficient hot water systems.

6.1.2. Renewable Energy Options

Planning for renewable energy deployment in the Torres Strait Islands should take into account natural renewable energy resources and also the logistics of infrastructure provision to the region.

The Torres Strait has natural solar, wind and also tidal resources that could be used to generate electricity.

However, the logistics of supplying power across a remote archipelago will favour the application of mature technologies with low ongoing maintenance costs – such as grid connect PV and wind turbines. The division of the Torres Strait power between small minigrids, with only Bamaga and Thursday Island exceeding a 1 MW peak load, will, in the near term, preclude the wide scale uptake of emerging technologies such as tidal power or solar thermal.

Grid-connect solar and wind are efficient ways to use renewable energy to reduce the greenhouse impact of generating electricity. These systems do not include battery reserves or other power storage, which significantly reduces upfront capital costs, system complexity and maintenance requirements. The renewable component is sized so that it will always typically be smaller than the load, even when the sun or the wind is strongest. A diesel generator will continue to run at all times – but they will consume less fuel, because the renewable input will be reducing the load.

These systems are best sized so that in typical conditions, they will supply a maximum of 30% of the load. This will mean the renewable input is always fully used. It also optimises integration with the existing automated diesel generator control.

Grid-connect wind and solar generators have different relative advantages that require consideration in planning, beyond a comparison of their generating capacity.

For example solar generators may be more straightforward to maintain, and provide the opportunity for local employment. Wind or solar may more directly match the annual or daily load profile..

To minimise long-term maintenance costs, it is also advisable to apply consistency throughout the region.

6.1.2.1. Grid connect vs stand alone systems

Only grid connect systems have been considered in this report.

Grid connect systems incorporate a renewable generator into an existing power distribution system – or grid. The existing diesel generator continues to operate, and the renewable generator can't provide any power if the diesel generator is not working.

The input from the renewable generator means that the diesel generator does not consume as much diesel, and so the renewable generator represents a direct saving in fuel cost and greenhouse emissions.

Stand alone systems incorporate battery storage, so they can operate without diesel input. These are often used for isolated houses a long distance from the grid. They can sometimes include a diesel generator, but the generator doesn't have to operate for the renewable component and the batteries to provide power.

Renewable generators have decreased in price significantly in the last 5 years, but batteries have remained very expensive. This makes a grid connect system much more cost effective where there is an existing grid. Batteries do not last as long as renewable generators, they are difficult to dispose of safely, and they require a lot more maintenance which is also expensive.

For these reasons, only grid connect renewable generators have been considered in the following discussion of renewable energy options.

6.1.2.2. Tidal

Tidal generators are currently at a development and demonstration phase globally, and should not be deployed in the Torres Strait as a community power solution until they are fully commercialised. HydroGen's proposal to use generated power to desalinate extra water through the test phase is an appropriate way to use the energy generated from a trial site, as the pilot should not supply an essential service.

Tidal power is less intermittent than solar, and is highly predictable.

The Torres Strait has very strong tidal characteristics and shallow waters. The southern part of the Torres Strait has both high tidal current speeds, and a tidal range above 500cm[19] indicating good future potential for tidal power development.[20]

The majority of tidal power technology developed to date is designed for deeper water deployment. There is a niche for shallow water tidal power development that may suit test facilities in the Torres Strait for research and development.

Because of this resource, an Australian submersible turbine development company HydroGen Power Industries is pursuing funding for a pilot of their own shallow water turbine technology at Kiwain Point on Prince of Wales Island, and potentially the development of a testing facility for other tidal technologies.[21]

A lack of data on the tidal resource through the region has been identified as a major barrier to the development of tidal testing efforts. Tidal resources differ significantly over a small distance, and comprehensive surveys are required in planning even trial developments. This is especially true of the Torres Strait, which is the meeting point of different tidal regimes in the Coral Sea and the Gulf of Carpentaria.

Hydrogen's efforts towards developing a tidal research facility at Kiwain Point include proposals for a collaborative survey of the area. Given the apparent significance and potential future value of the tidal resource, especially if proposed distribution networks are extended closer to the Torres Strait, it may benefit the TSRA to continue its involvement in this initiative by offering support.

6.1.2.1. Solar vs Wind

A strategy for deployment of solar or wind generators through the region to offer some standardisation is recommended to minimise ongoing operating costs.

Some of the relative benefits of the two modes are summarised below. Planning should be conducted in consideration of the relative importance of all these factors in the Torres Strait – for example, although the wind resource may exceed the solar resource in the region, the capacity of local maintenance staff, who may be more easily trained to service solar generators than wind, may make solar a more appropriate choice.

	Solar	Wind
Renewable Resource	Good	Excellent
Consistency of Renewable Resource through the Region	Good	Fair
Consistent production through the year	Good	Good
Relative upfront cost to install	Lower than wind	Higher than solar
Ongoing Maintenance Requirements	Low	High
Potential for maintenance by local staff	High	Low
Data collection and modelling for site selection, planning and feasibility	Minimal	Significant
Potential for social opposition for aesthetic factors etc	Low	Higher
Operating life	20 years plus	15 years

6.1.2.2. Solar

6.1.2.2.1. Existing solar systems

180kW of grid-connect solar was implemented during the *powersavvy* project.

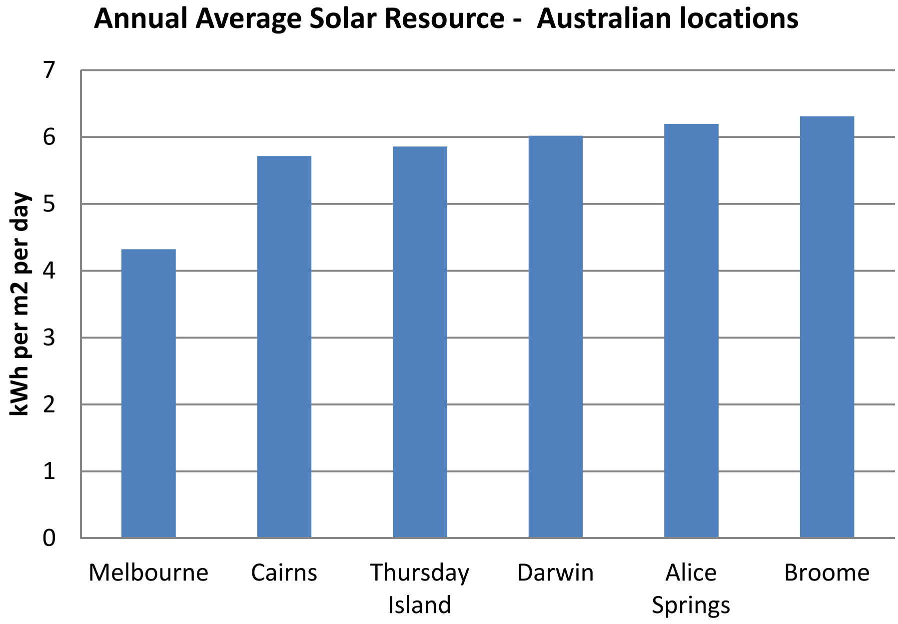
Data from these installations could inform detailed feasibility assessments.

6.1.2.2.2. Solar Resource

Despite overcast conditions through an extended wet season, the Torres Strait has a good solar resource that could be used to generate power.

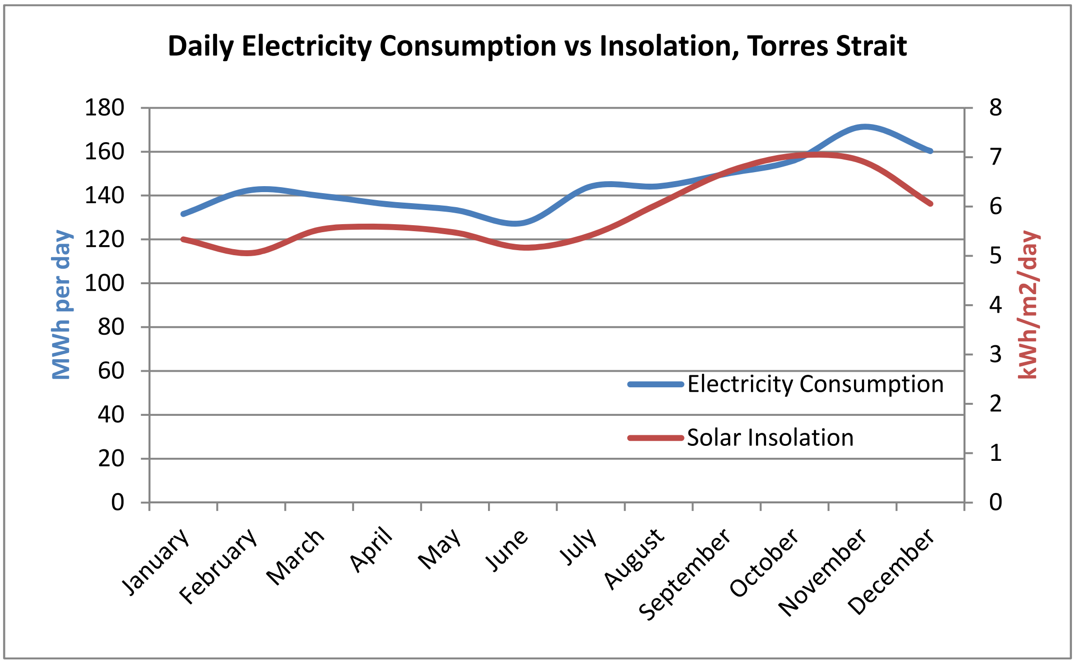
PV panel types that are tolerant to overcast and hot weather conditions are recommended.

The following chart shows how the annual solar exposure of the region compares to other Australian sites[22].



Thursday Island receives an average solar exposure above 5 kWh/m2/day (peak sun hours) all year with a peak in November above 7 peak sun hours.

This profile correlates well with the Torres Strait's consistent annual electricity consumption.



6.1.2.2.1. Indicative Grid-Connect Solar System Parameters

The following table gives an indication of suggested array sizes for grid-connect solar installations at Torres Strait Island power stations. They are suggested maximum sizes for efficient high penetration PV grid connect systems. Smaller systems could also be considered with proportional reductions in capital costs.

Identifying appropriate land for these installations is an important first step in considering a solar array.

The information below makes some suggestions for consideration, indicates the physical size of the array, provides an estimate of system costs and indicates approximate electricity and greenhouse gas savings. Generally, suggested sites are adjacent the existing power station due to the significant cost of reticulation.

These preliminary estimates should be used as a guide in the planning process. Thursday Island has not been included, due to the existing wind generators, existing solar installations and the potential for future expansion of this asset.

	Array size	*Array site requirements*	*Solar Generator Cost*	*Energy produced (annual)*	*GHG Offset (annual CO_2-e tonnes)*
Badu Island	**130 kW**	**1 600m^2**	**\$800,000 - \$900,000**	**195 MWh**	**153 tonnes**
	Potential sites to the north of the existing Ergon Energy power station, or to the west over the road, could be investigated. Both these sites are currently unoccupied and are zoned in the Sustainable Land Use Plan as being intended for conservation, however this may be partly due to their unsuitability for residential use due to noise from the powerstation. The power station has recently been upgraded and is in a zone not threatened by floods.				
Boigu Island	**50 kW**	**600 m^2**	**\$300,000 - \$400,000**	**75 MWh**	**59 tonnes**
	The Boigu powerstation is surrounded by community owned services area, with a pond to the south. Investigate the possibility of reserving some of this area for the installation of solar pv.				
Bamaga & Seisia (NPA)	**600 kW**	**7 400 m^2**	**\$3,900,000 - \$4,000,000**	**900 MWh**	**705 tonnes**
	Investigate potential sites close to the Bamaga powerstation.				
Poruma Island	**40 kW**	**480 m^2**	**\$200,000 - \$300,000**	**60 MWh**	**47 tonnes**
	Electricity is supplied to Poruma from a central power station located next to the lagoon and water treatment plant. Photovoltaic Solar Panels have been installed at Poruma within the water lagoon compound to supplement the diesel generator				

	Array size	Array site requirements	Solar Generator Cost	Energy produced (annual)	GHG Offset (annual CO_2-e tonnes)
	supply. The system is estimated to be about 15 – 20 kW, however the Sustainable Land Use Plan reports its serviceability is unclear. The potential to renovate or extend this site could be considered.				
Erub Island	**60 kW**	**740 m²**	**$300,000 - $400,000**	**90 MWh**	**70 tonnes**
	The power station is located inland, to the north of the community centre. There is clear land adjacent to the power station. The potential to use a site to the north of the Story Place could be investigated. Distance from the power station will add cost to the system. (About 150m to the north east of the powerstation.) Unused land adjacent to the East slopes steeply.				
Dauan Is	**30 kW**	**370 m²**	**$100,000 - $200,000**	**45 MWh**	**35 tonnes**
	Electricity is supplied to Dauan from a central power station located at the west of the village adjacent to the beach. There is vacant community- owned land directly to the north of the power station which is not subject to inundation, or vacant land to the south of vacant lots reserved to the south of the power station. This may be too steep. These vacant lots may not be suitable for residential development, due to their proximity to the power station.				
Hammond Island	**30 kW**	**370 m²**	**$100,000 - $200,000**	**45 MW**	**35 tonnes**
	Based on information in the Sustainable Land Use Plan It is difficult to identify a suitable area for a PV array. The powerstation is sited on the coast, with a steep slope behind it to the north.				
Moa Island	**100 kW**	**1 230 m²**	**$600,000 - $700,000**	**150 MWh**	**118 tonnes**
Kubin & Saint Paul's	Electricity is supplied to Kubin from a central power station located in the town area within the commercial section. The power station also supplies electricity to St Pauls community. Unused land to the north east, past the residential area is earmarked for future residential use. The powerstation is adjacent to a large block of community-owned land. Investigate the potential of using part of this land for a solar array.				
Mabuiag Island	**40 kW**	**490 m²**	**$200,000 - $300,000**	**60 MWh**	**47 tonnes**
	Investigate the possibility of using land to the North, or North West adjacent the existing compound. This land is earmarked for conservation, and subject to native title.				

	Array size	*Array site requirements*	*Solar Generator Cost*	*Energy produced (annual)*	*GHG Offset (annual CO_2-e tonnes)*
Mer Island	**60 kW**	**740 m^2**	**$300,000 - $400,000**	**90 MWh**	**70 tonnes**

The existing powerstation is central to town, between the store and the school. Ergon Energy has obtained a site inland, with works planned for 2014. There is significant undeveloped land adjacent this site that would be suitable subject to land availability and approval. Some vegetation may be required to be cleared.

Ugar Island	**10 kW**	**120 m^2**	**$50,000 - $100,000**	**15 MWh**	**12 tonnes**

Electricity is supplied to Ugar from a central power station located in the town area towards the north western residential section. The powerstation is on a large allotment, with a vacant community-reserved block to the north that would be suitable pending availability for a small installation.

Saibai Island	**50 kW**	**620 m^2**	**$300,000 - $400,000**	**75 MWh**	**59 tonnes**

A site to the west of the existing power station would be appropriate subject to availability. Earthworks may be required, given a steep fall away from the power station to an elevation below the 2008 mean tide level.

Warraber Island	**40 kW**	**480 m^2**	**$200,000 - $300,000**	**60 MWh**	**47 tonnes**

Land on Warraber is very limited, and it is difficult to identify a suitable site, unless a roof mount array on the sports facility to the east was available, and structurally appropriate. Trenching cables would add to the installation's cost.

Horn Island	**150 kW**	**1 900 m^2**	**$900,000 – $1,000,000**	**225 MWh**	**177 tonnes**

Investigate the potential of using space in the existing Ergon Energy compound, and the adjacent area, earmarked for conservation. Part of this area may be subject to future inundation, however, given its proximity to the power station, this issue should be addressed. Alternatively, the roof of the sports stadium is within 70m. A smaller roof mount array could potentially be installed here, given suitability of the roof.

Iama Island	**40 kW**	**490 m^2**	**$200,000 - $300,000**	**60 MWh**	**47 tonnes**

Investigate the potential to use a site to the west of the power station.

	Array size	Array site requirements	Solar Generator Cost	Energy produced (annual)	GHG Offset (annual CO_2-e tonnes)
Masig Island	**60 kW**	**740 m²**	**$300,000 - $400,000**	**90 MWh**	**71 tonnes**

Electricity is supplied to Masig from a central power station located in the town area towards the western residential section. Vacant land across the road to the west is earmarked for conservation use. A smaller array could possibly be installed to the north side of the existing power station lot.

6.1.2.3. Wind

6.1.2.3.1. Wind Resource

Climate data shows a consistent wind resource through most of the year at Thursday Island, with a monsoonal lull through December and January interspersed with squalls. Southeasterly trade winds are strong through winter and spring.

Average wind speeds in the Torres Strait islands (10m elevation) reach 7-8m/s on some islands, with averages between 5-6m/s through the highly populated inner islands.[23]

Diesel consumption data at the Thursday Island power station confirms that the wind generation plant contributes a consistent amount of energy through the year.

Unlike solar, the local topography can significantly impact a particular site's wind resource. Data collection, via a pole-mounted anemometer, is often the most useful early step towards developing a wind generation project. Deployment of anemometers over extended periods (12-24 months or more) are usually required when scoping potential turbine sites to estimate suitability and viability of a number of locations.

6.1.2.3.1. Cyclones

The Torres Strait Islands are categorised by the Australian Buildings Codes Board as non-cyclonic (Region B.) Cyclones have historically travelled south of the Torres Strait across Cape York, with two cyclones passing through Torres Strait in the past 23 years. [24]

There is some evidence that climate change may be increasing the number of cyclones through the region.

6.1.2.4. Ownership and Financing Models – Grid Connect Wind or Solar Generation Plants

The following summaries present alternative ownership structures for supplying electricity to a utility, which present different alternatives for financing and development.

6.1.2.4.1. Developer Ownership and Power Purchase Agreements

In this case, a party other than the government or the utility will fund the development of a renewable energy generation plant. Electricity is generally sold according to a Power Purchase Agreement (PPA), whereby the utility agrees to purchase the electricity produced for a set period, typically 20 or 25 years for a photovoltaic power plant.

A PPA is an arrangement by which the generator owner – often the same organisation that developed the generator – will supply "green power" according to an agreed price for an agreed period of time.

This provides flexibility in the financing arrangements for the capital for the power station. They are often met by the owner/developer.

This has been an effective financial mechanism for solar power developments, because the solar technology provider, with an expertise in developing and operating generators, maintains responsibility for the ongoing performance of the plant.

PPAs can often be put to tender according to performance based specifications that articulate the minimum supply levels required at a site.

Technology providers are able to respond to these specifications with the combination of technologies they feel are able to most efficiently meet demand.

At the end of the PPA period, the asset may be sold or transferred to the utility, or retained according to a revised agreement. Asset transfer terms are specified at the beginning of a PPA.

6.1.2.4.2. Utility Ownership

As part of the Mandatory Renewable Energy Target Scheme, electricity suppliers are required to submit a mandated amount of Renewable Energy Certificates to government agencies. Utilities can purchase these on a market or choose to generate Renewable Energy Certificates themselves by operating an accredited renewable electricity generation plant. This is owned and operated by the utility like any other piece of electrical infrastructure.

Utilities may own, lease or pay an access fee to the property where the development is sited.

6.1.2.4.3. Community Ownership

Community-owned power stations will typically be structured similarly to developer-owned plants, however a community body or consortium will raise funds and maintain ownership in the plant. A model of part community and part private ownership is becoming a common model in some areas.

The Hepburn Wind Project, a community-owned wind generation plant in Victoria, raised funding through a share offer issued with priority given to local residents and some state government grant contribution.

In some contexts this has the potential to support local enterprise development.

6.1.2.4.4. Government ownership

Electricity infrastructure was historically owned by the government in Australia. While the government may retain control of some electrical infrastructure, it would be more likely today for a government-funded project to be developed in partnership with private interests, or to be sold after construction.

6.1.2.1. Lifecycle costs of grid connect solar installations

The economic feasibility of a 130kW array at Badu Island has been considered as an example of system lifecycle costs.

This assessment takes into account the value of the production of RECs, Renewable Energy Certificates (RECs) that are generated by registered renewable energy generators and are able to be sold to electricity retailers. Electricity retailers are able to use RECs to fulfil mandatory specified quotas of demonstrated renewable energy production each year. REC Prices have been modelled at a rate of $40 per REC.

Assumptions:

* This figure is an estimated cost based on industry standards.

General Inputs		
	Generating Cost Indexation	5.00%
	Inflation	2.50%
	Tax	30.00%
	System size (kWp)	130
	System output (kWh/pa/kWp)	1500
	installed cost ($/Wp)	6.00
Capital Cost		
	Power Station	780,000
	Other Costs 1	78,000
	Total Capital	858,000
	Total Proponent Contribution	858,000
Annual Ongoing Costs (initial year)		
	Operating & maintenance	5,000
	Insurance	2,000
	Lease of land	0
Financing		
	Debt	100%
	Interest Rate	9%
	Loan (years)	20
Power Value		
	SPS Output per annum (kWh)	195,000
	REC Price ($/MWH)	40
Useful Life		
	Contract Term	20
	Tax Life	20
	Depreciation per annum	42,900
	Start Date	1-Jul-10
	Terminal Value (% of cost)	0%

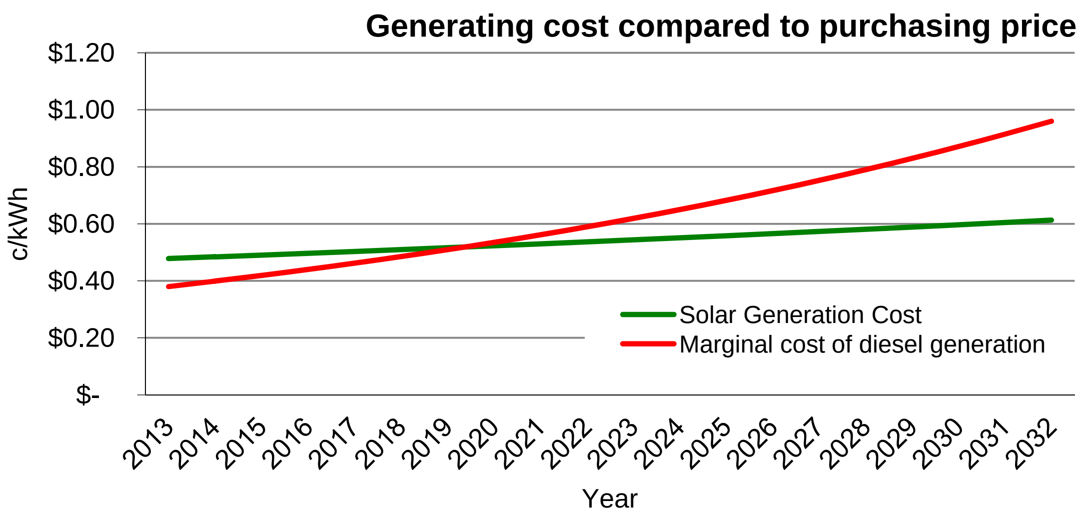
This scenario gives a 9.45% return on investment. This is the “discount rate” required for the project to break even over the 20 years shown – or the rate by which future money is worth less to an investor than money now.

The graph below shows the relative marginal cost of electricity during the life of the asset.

Solar Generation increases slightly, due to a combination of the factors listed above, but primarily because the power station will produce slightly less electricity as it ages, while the financial requirement to repay the capital for constructing the power station is spread over the life of the system.

The marginal cost of diesel production increases more significantly due to forecasted increases in the cost of fuel.

This graph shows that after 8 years, for a system financed according to the assumptions above, each kWh of solar-generated electricity could be produced for less than each kWh of diesel.



6.1.2.2. Peak Oil

Peak Oil – the point at which the rate of oil production decreases due to a depletion of economically extractable resources – has been identified in a Queensland Government commissioned study as a major risk to the region’s energy security through increased fuel costs and disruptions to supply.[25] The Torres Strait, due to its remote location and diesel-based infrastructure is particularly vulnerable to the cost implications of peak oil.

The 2005 Queensland Government's Oil Vulnerability Taskforce Report recommended that in the face of these risks, the state should reduce the consumption of liquid fossil fuels, encourage development and use of alternative fuels, technologies and strategies, and prepare for demographic and regional changes.

The report proposes high, low and medium projected increases in liquid fuel costs in Queensland.

These values have been substituted into the projected diesel cost analysis for the purposes of assessing the comparative lifecycle economics of a grid connect solar power generator under peak oil modelling scenarios.

6.1.2.3. Peak Oil lifecycle cost implications

The general context of declining oil resources contributes to modelling assumptions of ongoing fuel price increases above the consumer price index. The sale price of diesel in the Torres Strait can be expected to respond to a range of interconnected drivers including reduced production of crude oil.

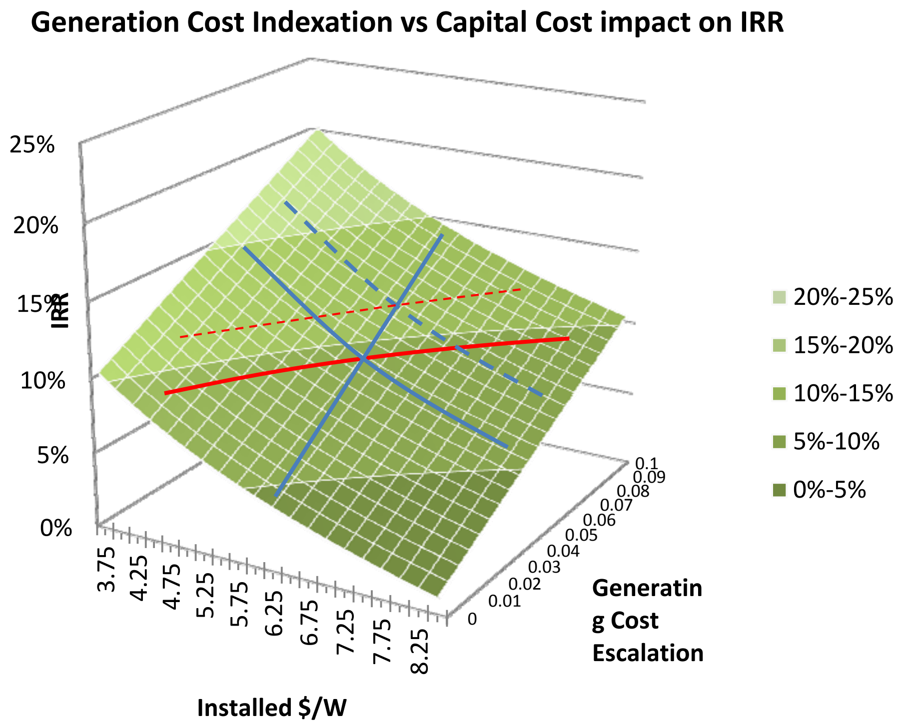
The effect that higher than anticipated diesel price escalation will have on the Rate of Return for a grid connect power station is shown below.

The diesel escalation price is the indexation of the marginal cost of diesel generation, influenced by peak oil and other market drivers. The Internal Rate of Return of the investment will be influenced by this factor, and the capital cost of the solar generator installation.

The graph below shows the sensitivity of the internal rate of return to changes in the initial installation cost per Watt of the solar generator, and the indexation of the marginal cost of diesel generation.

The solid blue lines in the graph below indicate the assumptions made for modelling the return from an installation at Badu - $6 per Watt for installed PV, and 5% increase per year in the marginal cost of diesel generation.

The red line shows that these assumptions correspond to an internal rate of return of 9.45%. The dashed lines show that an increase in the diesel generating cost escalation results in an internal rate of return of close to 12%, and represents a better investment.



The Generating Cost Escalation (inflation in the marginal cost of diesel production) and installed $ per Watt values used for the model above have been marked on this chart (blue lines), to show they generate an IRR of 9.45%. (red line)

This chart shows how the IRR is sensitive to reductions in the installed $ per Watt, or an increase in the Generating Cost Installation.

6.1.2.4. Barriers to renewable energy developments

6.1.2.4.1. Technical Integration

The size of a grid connect power plant, without storage, is limited by technical integration issues. Diesel gensets, controlled automatically in response to changes in load levels, can't respond fast enough to the large immediate changes in load that can happen when renewable generation is interrupted, for example when a cloud blocks the sun.

This leads to integration issues that can lead to interruption in supply, and inefficient and suboptimal operation of genset equipment.

Optimisation of high penetration hybrid renewable diesel minigrid control and automation facilities is still being developed in Australia. High penetration sites generally require remote monitoring capacity, and maintenance.

Sites with renewable penetration that exceeds 30% renewable contribution under normal conditions will generally incorporate energy storage to mediate load fluctuations.

The use of lead acid batteries for this purpose incurs upfront and ongoing maintenance, housing and replacement costs, and introduces OHS implications and hazardous waste.

The installation of Interactive Grid –Connect PV arrays as explored in section 5.1.2.2.1 above does not preclude future expansion to higher penetrations as technology becomes more readily available.

6.1.2.4.2. Land Tenure

The steady population growth on most islands means that available land is in demand.

Much of the Torres Strait Islands is covered by a Deed of Grant in Trust, with the trustee generally being the Torres Strait Island Regional Council, or the Torres Shire Council. Council may issue leases for infrastructure purposes.

Many areas are the subject of successful determinations of native title or pending claims. The Native Title Act 1993 provides a system to facilitate dealings that may affect native title during the claim process and after native title is recognised. Indigenous Land Use Agreements, for the use of land subject to native title rights or claims, must be registered with the National Tribunal. As with any development, issues of native title will need to be explored and managed in good faith. This must be considered in decision making any renewable energy deployment.

6.1.2.4.1. Dispersed population

Most power stations in the Torres Strait serve a population of less than 400 people. Renewable energy developments at these sites will account for a very small proportion of Queensland's total carbon emissions. This will reduce the priority of the Torres Strait as a site for renewable energy development from the point of view of some funding bodies.

The region's significant population, at Thursday Island, already has renewable capacity contributing about 10% of its electricity demand. Opportunities to support the extension of this site should be supported.

6.1.2.4.1. Maintenance Costs

The region's remote location and high transport costs will maximise the ongoing cost of producing renewable energy in the Torres Strait. This will apply particularly to wind generators, which require more involved maintenance that is less likely to be met by local capacity.

6.1.3. Biofuel

There have historically been coconut plantations on some Torres Strait Islands, and coconut propagation is part of traditional gardening in the eastern islands.

Biodiesel has been pursued successfully as a local enterprise in a Pacific Island context.

Biodiesel projects have precedents in the Pacific, including the current The Solomon Islands Electricity Authority (SIEA) trial, Coconut Oil Auki Community Generator[26], and commercial operations throughout the Pacific. Kokonut Pacific Pty Ltd are a supplier of coconut processing equipment who can provide contacts to other enterprise development projects.

While the technical viability of biofuel production enterprises has been demonstrated by projects through the Pacific, the feasibility of biofuel production in the Torres Strait will be dependent on the availability of suitable land under current land tenure arrangements.

6.2. Transport

Strategies to reduce the greenhouse impact of transport should be considered in the context of a wider planning process for regional transport.

Recommendations in the Queensland Government's 2006 Transport Plan include many points relevant to carbon mitigation, including barriers to marine transport and an inter-island ferry network in the region.

The report cites a survey of air travellers finding that 25% claimed they would use a Torres Strait ferry service once a week or more, if one were established.[27]

The report also recommends the consideration of a roll-on, roll-off ferry that could combine passenger and freight transport and minimise barge movements.

A lack of business management and support was cited as a contributing factor to the decline in commercial marine operations, pointing to opportunities for supported local enterprise development.

6.3. Waste

Waste management is a particular infrastructure challenge in the Torres Strait, and it has also been established by this report as a significant contributor to the region's greenhouse gas emissions.

Most of the good waste management practices recommended by the Sustainable Land Use Plans will also work to reduce the greenhouse impact of municipal waste. For example, simple practices like covering landfill will reduce methane emissions by 10%.[28]

However, the proposed alternative to freight waste for mainland processing should be assessed from a greenhouse perspective.

The Sustainable Land Use plans also recommend encouraging waste reduction. A collaborative community based effort towards waste reduction could focus on importing low-packaging products, a car recycling program potentially funded by a levy for importing cars, composting, and community education and incentives.

Section 7: Conclusion

Greenhouse emission mitigation should become part of the Torres Strait Islands strategic sustainable infrastructure planning process.

Stationary Energy, Transport and Waste are all shown to be significant sources of CO2-e to be included in a greenhouse mitigation strategy.

The following recommendations are made:

Stationary Energy

- Continue to support Ergon Energy through the *powersavvy* programme, and work with Queensland Housing to explore energy efficiency measures beyond the scope of this program, that would extend its outcomes, such as promoting solar hot water and heat pumps.
- Work with Ergon Energy towards the end-of-life replacement and extension of the Thursday Island Wind Turbines. Investigate the opportunity to source additional funding to contribute towards this project. The TSRA may be well positioned to assist with community consultation, and promoting local acceptance.
- Consider the potential for grid-connect photovoltaic generators at outer Torres Strait Island power stations, and investigate land availability as a first step towards PV development.
- Investigate possible sources of funding for grid connect renewable deployment. The Torres Strait Islands communities are very small, which may exclude them as a priority from many funding sources.
- Develop a strategy towards the adoption of grid connect PV or wind through the Torres Strait island communities, that explores social and economic benefits, and training local maintenance staff. This could be initiated by the funding of detailed feasibility study.
- Identify promising sites for wind turbine development, and implement wind data logging equipment.
- Consider long term opportunities that would develop community capacity and independence through the Torres Strait
- Support initiatives towards testing tidal technologies where appropriate in the Torres Strait, and initiatives towards detailed tidal resource mapping through the region. View pilot tidal projects as a research initiative, rather than auxiliary power generation source.
- Develop an active and collaborative relationship with Ergon Energy and the Office of Clean Energy on to incorporate the Torres Strait's renewable energy strategy within wider state-based programs.

Transport

- Ensure that greenhouse impact is considered as a factor in strategic transport planning.
- Conduct a detailed assessment, including consultation, of opportunities to reduce air travel by supporting alternative means of transport such as the combination of freight and passenger services.
- Consider investigating a local emissions abatement program for air travel, with funds being contributed to local renewable energy projects, for example.
- Investigate the possibility of using biodiesel for sea transport such as ferries.

Waste

- Ensure that greenhouse impact is considered as a factor in sustainable waste management planning.
- Support waste management improvements that reduce carbon emissions, such as covering landfill.
- Work to reduce waste generation in the Torres Strait.
- Evaluate the carbon impact of recycling and remote waste processing and ensure that greenhouse considerations are factored into decisions about these proposals.

It is also recommended that ongoing strategy be developed with reference to updated information, as renewable energy technology costs, and wider energy cost drivers continue to evolve rapidly. To capture the impact of unforseen market developments, the TSRA could consider undertaking an updated report into reducing carbon footprint in four to five years.

Section 8: Appendices

8.1. Appendix 1: CO2-e calculation Methodology

8.1.1. Estimating Stationary Energy Carbon Emissions

Diesel consumption figures are provided by Ergon Energy. Associated CO2-e emissions are calculated according to the National Greenhouse Accounts Factors.

8.1.2. Estimating Transport Carbon Emissions

Ferry transport, based on fuel consumption figures supplied by Mc Donald's Ferries, are estimated to be 74g of CO_2-e per passenger km. These values are extrapolated to other ferry carriers.

Shipping freight fuel consumption was estimated based on an assumption of 0.2 MJ/tkm, as per Bureau of Infrastructure, Transport and Regional Economics standard values. Emission intensity is estimated at 20g CO2-e /tkm.29 This figure is based on fuel consumption advice supplied by Silent World, and standard figures applied in the Bureau of Infrastructure, Transport and Regional Economics Greenhouse Gas Emissions from Transport Australian Trends to 2020 Report .

Aviation fuel consumption was estimated according to the parameters of the European Organisation for the Safety of Air Navigation developed for monitoring and reporting purposes for small emitters. Trip distances are calculated in great circle distance plus 92km. This methodology is aircraft specific, and recognises the plane types in services in the Torres Strait. They have been confirmed against real world fuel consumption values provided by West Wing.

CO_2-e values are calculated from fuel consumption in line with the National Greenhouse Accounts Factors, with an RFI factor of 2.7 applied, in line with ICCC recommendations.

8.1.3. Estimating Waste Carbon Emissions

The NGA Accounts broad stream municipal solid waste emission factor of 1.0 t CO_2-e /t waste was applied.

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