Northern Territory Government

AN EVALUATION OF THE RELATIVE MERITS, FEASIBILITY, AND LIKELY COSTS OF THE POTENTIALLY AVAILABLE RENEWABLE ENERGY TECHNOLOGIES TO BE USED IN THE NT, INCLUDING GEO-THERMAL, SOLAR, BIOMASS AND TIDAL

REPORT 2

BY THE GREEN ENERGY TASKFORCE

COVER PHOTOS

Main Photo and inset Photo:

"Uterne" (meaning bright sunny day in local Arrernte language), 1MW solar power station.

In 2011 Power and Water Corporation and SunPower signed the first utility backed Power Purchase Agreement for Uterne, Australia's largest solar tracking device.

Photos courtesy of Power and Water.

1. EXECUTIVE SUMMARY

The Government's 2009 Climate Change Policy established a Green Energy Taskforce to provide expert advice on strategies, incentives and pathways to encourage the growth and funding of the renewable and low emissions energy industry in the Territory as well as assisting the Territory in meeting its goal of having 20% of its electricity demand met by renewable and low emission sources by 2020. Its Terms of Reference identified priorities for the Taskforce's first two reports, as follows:

1. Develop a detailed proposal for substituting a large component of diesel generation with renewable and low emissions energy in remote communities, including financing and funding options; and
2. Prepare an evaluation of the relative merits, feasibility and likely costs of the potentially available renewable technologies to be used in the NT, including geothermal, solar, biomass and tidal.

The Taskforce delivered on the first of these objectives, through its report *Roadmap to Renewable and Low Emission Energy in Remote Communities*, delivered to the Chief Minister in July 2010.

In preparation of the Second Report, the Taskforce considered a variety of data sets and information sources, as documented within the balance of this report and associated appendices, and has developed a series of conclusions underpinned by the following assessment of the existing energy market:

- Within the regulated energy market (Darwin-Katherine Integrated System [DKIS], Alice Springs, Tennant Creek), there is enough existing and planned generating capacity to meet anticipated demand for peak load and energy beyond 2020;
- Liable entities within the NT, predominantly PWC, have a renewable energy target (RET) obligation that rises to approximately 20% of demand by 2020 (approximately 300 GWh), and the cost will be passed through to all consumers, subject to regulatory approval;
- The obligation exists only for retailers within the DKIS;
- PWC, or other liable entities, could meet that obligation by generating renewable energy itself, buying renewable energy from other parties (located in the NT or elsewhere), or Large Generating Certificates (LGCs)on the market: regardless of the source of the LGCs, it is estimated that by 2020, the direct cost of meeting this obligation will be between $12M and $21M annually; and
- Generation Utilities, utilising fossil fuels, including natural gas, will have an obligation to purchase emissions permits under the proposed Clean Energy Act 2011 (initially at the rate of $23/t of CO^2e). This will increase electricity generation costs this cost increase will also be passed through to all consumers.

The NT Government has expressed a desire for the RET obligation to be met from sources within the NT, in order to maximise the benefit to the NT of expenditure required to meet these obligations, and has sought advice from the Taskforce to facilitate the uptake of renewable energy.

The analysis conducted by the Taskforce of the current and near-term status of the technologies suggests that:

- Wind, although relatively mature, is likely to be of marginal value due to the relatively low quality of the resource in the NT;

- Geothermal has significant long-term potential for the NT, but is relatively immature and it is considered unlikely that this status will change sufficiently in the medium-term for geothermal to be able to make a material contribution toward the 2020 objective;
- Hydro is undeveloped and, even if the environmental implications could be managed, would at best be considered a marginal technology for NT, due to both terrain and the seasonal variability in rainfall;
- There is reasonable effort being undertaken to pursue tidal energy within the NT; however, it is unlikely to be sufficiently prospective in the medium term to meet the target;
- Biofuels and biomass have a number of technical and economic hurdles to overcome that would mean that they are unlikely to contribute at commercial scale in the medium term;
- Solar thermal is approaching a stage where it could be deployed in the NT: the best prospects would be in combination with gas generation (to overcome the intermittency). The costs are still high; however, they are decreasing; and
- Solar PV is relatively developed and the NT has an abundance of the solar resource: intermittency and cost remain the major barriers to widespread uptake in the short term

Further to the technical and resource barriers noted by above, additional conclusions reached by the taskforce were as follows:

- The overall regulatory and resource environment is not specifically restrictive to the uptake of renewable energy, nor is it specifically attractive for renewable energy proponents;
- There are, however, a number of policy areas that may need to be addressed in the longer term if some of the renewable energy technologies are to be further developed. These include:
    - » “Right of Access” sources of renewable energy as part of the planning scheme;
    - » Land Tenure and Land Use limitations;
    - » Environmental assessments for renewable energy projects;
- To date, it appears that PWC has shown a willingness to undertake renewable energy projects, within the framework of a power purchase agreement (PP), when a fair and competitive price is offered. A general barrier to determining a fair and competitive price by renewable energy technology proponents and developers is the limited understanding of the real marginal costs of generation within the NT energy markets;
- The NT has high energy generation costs already and a substantial Community Service Obligation (CSO) budget commitment thus providing significant incentive to explore opportunities for reduction in energy consumption and pursuit of alternative generation sources;
- In areas, such as mine sites or large commercial buildings, where the marginal costs of supply would otherwise be considered to be high enough to support the uptake of renewable energy, other constraints exist, including access to capital and overall project risk, that have limited the uptake of renewable energy;
- Significant contributions of energy from intermittent renewable sources such as solar photovoltaic (PV), where storage is not included at single locations could present significant network stability issues for the network operator, implying that distributed, smaller sources would be more effective;
- In 2011, the cost of the most developed renewable technologies, relative to the marginal cost of generation within the regulated market, means that the NT Government would have to provide a substantial subsidy, by way of capital injection or ongoing price support, to meet the objective of meeting the RET obligation from NT sources by 2020; and

- It is estimated that the cumulative value of this subsidy between 2013 and 2020 would be between $60M and $110M[1] . This may change in the medium-longer term as the renewable technologies develop further and the cost of fossil fuels rise with global forces and emissions constraints; and
- Given the time frames for infrastructure planning, investment and construction, action to develop and implement a policy intervention, should it be required, would need to commence by 2015 in order for it to be fully implemented and the benefits realised by 2020.

In this light, it is the view of the Green Energy Taskforce there is a strong likelihood that the attractiveness of various renewable technologies will materially increase over the coming years and that, subject to removal of identified non-economic barriers, there is a reasonable probability that either:

a) There will be a natural increase in the uptake of renewable energy as a result of increasing economic viability; or

b) If the level of investment is still not sufficient to meet the entirety of the 2020 RET liability from NT sources, the cost of intervening will be substantially lower than at present;

Beyond the specific challenges of meeting the RET obligation by 2020, it was noted that the NT has unique access to renewable resources such as solar and, as such, the NT Government can play an important role in facilitating and enabling the development of renewable energy technology through research and demonstration.

Given the conclusions noted above the Green Energy Taskforce recommends that the Northern Territory Government:

1. Not intervene directly to subsidise renewable energy in the medium term (3-5 years). Rather it should continue allow market participants to make commercial decisions in the context of the RET and emissions trading legislation. This would mean not actively pursuing, through direct financial support, the objective of meeting the 2020 RET target from NT sources at this time;
2. Support the development of a detailed strategy for engaging and developing an active partnership with the Commonwealth Government in order to ensure that the NT is able maximise the leveraging of Commonwealth funds from programs, including the Australian Solar Institute (ASI), the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC), for investors in renewable energy within the NT. Outcomes of this strategy should specifically include the following:

   a) Active facilitation and support for a large solar project that is able to meet the eligibility criteria for Round 2 of the Solar Flagships program, including, where necessary, advocacy for program criteria that accommodate the specific challenges of developing large projects within the NT; and

   b) Development of innovative investment support structures that, in conjunction with the CEFC, seek to remove risk barriers in environments that would otherwise have compelling economic justifications for renewable energy , namely sites with high marginal costs of supply such as mine sites, hotels, warehouses and shopping centres.
3. The Government should maintain a formal watching brief on technology developments for solar PV, solar thermal and geothermal as well as monitoring other drivers of the NT energy market, including natural gas prices and movements in LGC and Emission Trading Scheme (ETS) permit prices. Such developments will require a detailed review of Recommendation 1. This should be facilitated through a detailed review and revision of this report in the following years:

1. Note: these figures are currently only indicative and should be confirmed or amended on the basis of additional review and modelling. Were this further review to suggest that the subsidy is more likely to be at or below the lower figure, then the Taskforce would recommend that the Government intervene to specifically subsidise solar thermal or solar PV, to address its twin objectives of meeting the RET liability from NT sources and developing the Territory's renewable energy industry.

a) 2013 – with a view to monitoring the impact of the carbon tax and the establishment of ARENA and the CEFC, and making a detailed assessment of those technologies that have proceeded further in the development cycle, most specifically solar thermal as well as a concurrent assessment of the broader community benefits of investment in renewable energy generation; and

b) 2015 – with a view to developing a detailed costing framework for intervention and support of renewable energy to achieve the 2020 RET target, where there remains a gap in investment or an imperative to close such a gap.

4. Support the development of a comprehensive R&D strategy for renewable energy within the NT, with a view to making the NT a Centre of Excellence for Renewable Energy deployment in tropical and arid environments, including:

   a) Support for existing research into potential bio-fuel sources such as Pongamia;

   b) Support for ongoing research into implications of higher penetrations of intermittent renewable energy such as PV on grids;

   c) Positioning the CDU as a hub for warm water tidal and wave power research

   d) Develop a working group within the NT to monitor technology development and investment flows in order to ensure the NT is able to respond rapidly;

   e) Work with Geosciences Australia, CSIRO and AEMO to develop and maintain extensive resource datasets for the NT including biofuels and biomass, wind, and particularly geothermal;

5. Create an effective and attractive investment environment by:

   a) Continuing to work with the Utilities Commission to ensure the efficient development of the electricity energy sector within the NT, allowing for fair competition across technologies and removing any barriers to entry to new technologies and/or market participants;

   b) Actively engaging with the Commonwealth Government to ensure that programs such as Solar Flagships are able to be implemented within the NT;

   c) Developing an appropriate regulatory framework for encouraging new mine sites to adopt renewable energy as part of their power generation capacity; and

   d) Work with native title agencies, NGO's, government departments and other land management stakeholders to develop an effective regulatory framework to support land and resource access for renewable energy, in particular

      i. Marine access rights for tidal and wave power generation; and

      ii. Reducing land use restrictions for pastoral lands where biomass or bio fuel could be generated

The above recommendations are based on the absence of an over-arching policy rationale to subsidise renewable energy in the Territory; however, should the Government determine that it does wish to actively intervene in the energy market to ensure that the 2020 RET liability is met from NT sources, the Taskforce recommends that the Government:

a) Utilise an open tender/bidding process for supply of renewable energy systems able to meet some or all of the RET liability at 2020;

b) Ensure that the tender/bidding process allows for any renewable technology, subject to technical requirements for connection and integration, but noting that it is considered likely that solar PV, possibly thermal could emerge as the most likely candidates; and

c) Leave the structure of its support (e.g. block grants, tariff support, loan guarantees) open to proponents in order to ensure that the most efficient and lowest cost outcome is achieved.

CONTENTS

2. MESSAGE FROM THE CHAIR

The Northern Territory Green Energy Taskforce was appointed by the Chief Minister to provide expert advice to assist the Northern Territory Government to support the development of renewable and low emission energy and products in the Northern Territory and to assist the Territory in meeting its goal of having 20% of its electricity demand met by renewable and low emission sources by 2020.

Through the Northern Territory Government's Climate Change Policy , the Government committed to supporting the green energy industry, reducing greenhouse gas contributions and where possible meeting Power and Water Corporation's (PWC) Renewable Energy Target (RET) obligations from local sources.

The Taskforce reported on its first term of reference in mid 2010. That report addressed replacing diesel as a primary source of power generation for remote towns and communities.

The Taskforce's second report addresses the second term of reference which required the Taskforce to:

- prepare an evaluation of the relative merits, feasibility and likely costs of the potentially available renewable technologies to be used in the NT, including geothermal, solar, biomass and tidal.

I commend the Taskforce on their commitment and energy in working through a process that has delivered both the evaluation required of potentially available renewable technologies and a recommended pathway forward. Each of the Taskforce members has bought a high level of experience and skill to the work. The report represents a synthesis of their broad range of perspectives.

I would particularly like to recognise the significant work undertaken by Lyndon Frearson of CAT Projects.

I would also like to thank those staff in the Chief Minister's Department that have provided ongoing support to the work of the Green Energy Taskforce. In particular, I would like to acknowledge the considerable effort behind development of the comprehensive background brief that formed the basis for much of this second report.

The Taskforce noted that there is considerable variation in the state of maturity and market readiness of renewable technologies. Geothermal has the significant long-term potential for the Northern Territory; however, it is relatively immature compared with solar PV which is relatively well-developed.

When considering the role of government, the Taskforce identified a number of policy areas that could be addressed to ensure available technologies are able to be implemented when ready. These include addressing access to the sources of renewable energy, land tenure and land-use, and environmental assessments for renewable projects.

The Taskforce recommends that the government support market developments in renewable energy rather than direct financial intervention at this stage. This will require the pursuit of an active partnership with the Commonwealth Government on implementation of renewable energy solutions, maintaining a watching brief on technology developments and supporting the development of a comprehensive research and development strategy for renewable energy within the NT. The Government also has a key role in creating an effective and attractive investment environment for renewable energy.

I am pleased to deliver the Second Report of the Northern Territory Green Energy Taskforce.

Professor Christine Charles
Chair

Northern Territory Green Energy Taskforce

3. BACKGROUND

3.1 ACRONYMS

AC	Alternating Current
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
ASI	Australian Solar Institute
CCS	Carbon Capture and Storage
CDU	Charles Darwin University
CEFC	Clean Energy Finance Corporation
COAG	Council of Australian Governments
CSIRO	Commonwealth Science and Industry Research Organisation
CSO	Community Service Obligation
EPCC	Energy Policy and Climate Change Unit of the Department of Chief Minister
ETS	Emissions Trading Scheme
FIT	Feed in Tariff
GETF	Green Energy Taskforce
LCOE	Levelised Cost of Energy
LGC	Large Generation Certificates
NEM	National Electricity Market
NG	Natural Gas
NTG	Northern Territory Government
ORER	Office of Renewable Energy Regulator
PPA	Power Purchase Agreement
PV	Photo Voltaic
PWC	Power Water Corporation
RE	Renewable Energy
RET	Renewable Energy Target
RRPGP	Renewable Remote Power Generation Program
SHW	Solar Hot Water
SRES	Small-scale Renewable Energy Scheme
STC	Small Technology Certificates
TOR	Terms of Reference
WACC	Weighted Average Cost of Capital

3.2 TERMS OF REFERENCE

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1. Develop a detailed proposal for substituting a large component of diesel generation with renewable and low emissions energy in remote communities, including financing and funding options; and
2. Prepare an evaluation of the relative merits, feasibility and likely costs of the potentially available renewable technologies to be used in the NT, including geothermal, solar, biomass and tidal.

The Taskforce delivered on the first of these objectives, through its report *Roadmap to Renewable and Low Emission Energy in Remote Communities,* delivered to the Chief Minister in July 2010. The Roadmap recommends supplementing existing generation with the rollout of an additional 10 MW of solar PV, to significantly reduce reliance on diesel generators in remote communities. It also recommends designing, constructing and evaluating an advanced pilot renewable energy power station, tailored to the environmental, social, demand/supply and other variables characterising the community at the chosen site. This power station would be built using a Territory-developed methodology and modeling tool to identify the best combination of renewable energy and low emission options for application at other sites in the Territory.

The current report addresses the second objective, which includes characterising Territory's renewable energy resources (including mapping and costing) as a basic prerequisite to attracting investment.

3.3 RATIONALE AND OBJECTIVES

While the terms of reference for the Green Energy Taskforce are quite succinct, the Taskforce determined that a thorough understanding of the rationale behind the establishment of the Taskforce was necessary in order to ensure that the recommendations and conclusions were framed within the correct context.

Consequently the Green Energy Taskforce, in consultation with the Energy Policy and Climate Change Unit of the Department of Chief Minister, undertook an industry roundtable consultation session in September of 2010. This led to the identification of a number of supporting justifications and objectives for the stated terms of reference. These were distilled into the following six priorities:

- Minimising the negative revenue/investment flow impact of national legislative and regulatory frameworks, such as the RET legislation (i.e. maximising investment in the NT in meeting the RET);
- Managing and meeting energy demand
- Developing increased diversity and security of supply
- Industry development
- Pollution reduction
- Positioning the NT for a carbon constrained future

While the points noted above are not an explicit extension of the original Terms of Reference, they seek to recognise that the development of a comprehensive response to the Terms of Reference will necessarily require consideration of how the outcomes of the report may impact other policy measures or areas of converging interests within the NT. Consequently the report has not sought to specifically respond to each of the justifications or objectives noted above in its recommendations. Rather, these priorities have served as an additional verification and validation measure for the various assumptions and conclusions that have been made within the report.

These points are expanded upon below.

3.3.1 MAXIMISING NT INVESTMENT IN MEETING THE RET

A consequence of nationally imposed legislative and regulatory frameworks such as the RET, particularly market based mechanisms, is that the least cost approach to compliance may result in negative cashflows from the NT. For example, it is currently cheaper to purchase LGCs from wind farms in Southern Australia than investing in renewable power infrastructure in the NT, with the implication that the purchase of the certificates acts as a net drain on revenue within the NT, rather than providing an investment stimulus for renewable energy activities within the NT.

Whilst, the Chief Minister has enunciated an explicit objective for the Territory to meet RET obligations from NT sources, the existing regulatory regime prevents the government from mandating that this occur; therefore, a range of alternative market interventions may be required to ensure that RET obligations are able to be met from the NT.

3.3.2 MANAGING AND MEETING ENERGY DEMAND

The Northern Territory is currently faced with a ‘trifecta’ of challenges within the energy market:

- Underlying market prices for fuel, including diesel, bunker oil, kerosene and natural gas are either increasing or are forecast to increase (not withstanding existing long-term natural gas contracts in place with PWC);
- Per capita energy consumption is increasing; and
- The overall population is growing, with the population of the Top End alone forecast to increase by 70,000 by 2030.

Further to this, the growth of the off-grid energy sector will be a critical determinant in the support and management of remote communities, including the 20 Growth Towns, while access to reliable and efficient energy services is a key constraint to the development of new mining ventures, particularly within the North East Barkley Region.

The implication of these challenges is that managing energy demand and developing mechanisms to ensure adequate and efficient supplies are developed will become increasingly challenging in the years to come.

3.3.3 INCREASED DIVERSITY AND SECURITY OF SUPPLY

The principal fuel sources within the NT are currently:

- Natural gas (regulated grids and some off-grid areas);
- Heavy fuel oil (Gove); and
- Diesel (remote communities, mine sites and pastoral stations).

Concurrently with this, the availability of reliable energy is a key driver of much activity within the NT and as a result, the NT, of all States and Territories within Australia, has an economy that is uniquely exposed to external variances in global liquid fuel prices, most particularly diesel.

In order to effectively manage this potential risk, strategies that either diversify the energy sources available, and/or more efficiently utilise existing fuel sources will become an increasing priority for policy makers within the NT.

3.3.4 INDUSTRY DEVELOPMENT

Given its relatively small population, the NT already has a significant local capacity within the renewable energy industry relative to other areas of Australia, particularly within the solar industry; however with the significant investment that is occurring within other States presently, without active consideration of opportunities for further industry development, the existing skill base may decline in the face of competition from growing capacity elsewhere, particularly Queensland.

Further to this, the development and deployment of renewable energy supply has the potential to not only retain the existing skill base but to also deliver a nett increase in jobs. For example, the construction of large-scale solar thermal farms and geothermal power plants will require the development of a skilled labour force to construct and maintain such installations.

3.3.5 REDUCING POLLUTION ASSOCIATED WITH STATIONARY ENERGY

Although the pollution associated with the consumption of natural gas is relatively low compared with other fuel sources for stationary energy such as brown coal, the particulate matter associated with diesel consumption is recognised to have more negative health consequences relative to that of natural gas. As a result, measures that reduce overall diesel or heavy fuel oil consumption may have an increased benefit for the health of communities surrounding the respective power stations.

3.3.6 POSITIONING THE NT IN A CARBON CONSTRAINED FUTURE

It is generally recognised that the prevailing international and national dialogue regarding energy will be increasingly framed within the context of climate change and more specifically carbon abatement. Additionally, various models indicate that increased consumption of oil, on a global level, may result in higher costs and constraints for fuels such as diesel. Consequently, there is significant merit in ensuring that there is active policy development within the framework of an energy market that is carbon constrained.

Further, the comparative advantages in solar, tidal and geothermal energy can provide a basis for R&D activity in the Territory. In the short term, collaboration with the entities such as the Australian Solar Institute and the Australian Centre for Renewable Energy could help deliver this activity to the Territory, positioning the NT to capitalise on technology advances and break-throughs as well as generating valuable intellectual property (IP).

The above factors could further lead to local industry development with a range of expertise that will be in demand both locally, interstate and overseas. This expertise would include the design, construction and maintenance of renewable energy facilities, with a specific focus on sparsely populated regions and remote communities.

3.4 REPORT METHODOLOGY

The Taskforce structured its approach to the Terms of Reference by undertaking four discrete bodies of work:

1. **NT Energy Market:** An analysis of the existing and potential future energy market and the underlying drivers and constraints within it, including the legislative and regulatory framework covering the NT energy market;

2. **Renewable Energy Cost Trends:** An assessment of the likely cost trends for a variety of renewable technologies relative to the existing energy generating technologies;

3. **Technology Assessment:** An analysis of the various renewable technologies, their development status and trajectories, and their relative merits for application within the NT; and

4. **Options:** An assessment of policy options for direct market intervention.

The bodies of work noted above have been documented and summarised in the following sections. While they have specifically been analysed within the context of the various perceived barriers noted previously, the summaries do not always directly reference each perceived barrier. Rather, each of the following sections of the report include break-out boxes noting potential barriers or opportunities for increasing the uptake of renewable energy within the NT.

International studies have identified six types of barriers to renewable energy: market factors; financial and economic factors; institutional factors; technical factors; social and cultural factors; and community engagement factors.

Independently, the Department of the Chief Minister and the Green Energy Taskforce hosted a forum and undertook industry surveys to further explore the nature of these challenges and identified nine types of perceived barriers, which are defined below as either primary or secondary barriers:

Primary Barriers

1. **Legislative and Regulatory.** These barriers include matters relating to compliance with regulatory requirements, e.g. number of contracts and legal agreements required to secure sustainable feedstock and income streams;
2. **Market/Cost.** These barriers relate to the commercial viability of renewable energy compared to other projects and technologies and access to multiple revenue streams. Renewable energy projects potentially have access to the electricity market, renewable energy certificate (REC) market, Green Power and carbon offset markets;
3. **Technical Maturity.** These barriers relate to the feasibility, maturity and ability to apply the technology; and
4. **Resource Availability.** The availability and prevalence of various renewable resources.

Secondary Barriers

1. **Infrastructure.** Distance and proximity to essential infrastructure comprises another obstacle, as do grid integration and the intermittent nature of some renewable energy generation;
2. **Cultural.** These barriers include perceptions of risk, and the ability of a renewable energy technology to meet needs and be consistent with the attitudes of the community;
3. **Policy landscape.** The stop-start nature of Government policy and program support comprise another obstacle to the development of renewable energy;
4. **Skills.** These barriers relate to the availability of skills to design, manufacture, develop and maintain a project; and
5. **NT specific issues.** Remoteness, huge differences in population density throughout the NT, and climate also comprise challenges to development of renewable energy in the NT

The Taskforce noted that the barriers detailed above had been identified as only having been *perceived* to exist and it was the purpose of this report to determine the extent to which the barriers actually existed or were merely masking a more significant underlying barrier or perceptions.

4. NT ENERGY MARKET

4.1 MARKET SEGMENTATION

The NT energy market is similar to that of Western Australia in that it is dominated by a large number of smaller isolated grids and remote power systems with no external access to generation capacity or support through the National Energy Market; however, the impact of mining and remote Aboriginal communities within the NT is such that the unregulated portion of the energy market is disproportionately high relative to other states, including WA.

The NT energy market is comprised broadly of the following categories:

- Regulated[2]
  - Darwin Katherine Interconnected System (DKIS)
  - Tennant Creek
  - Alice Springs
- Off-Grid
  - Gazetted townships (PWC)
  - Aboriginal Communities (Indigenous Essential Services P/L, IES)
- Pastoral Properties
- Mines

Additionally there is a small market associated with road houses and Aboriginal Outstations.

The relative contributions from each of the sectors to the total stationary energy production within the NT can be seen below.

TABLE 41 – *NT Generation Sources, 2010 Calendar Year (EPCC Unit, 2011)* [3 4]

TOTAL GENERATION BY GRID CLASSIFICATION	MW	GWH	
Darwin-Katherine Regulated Network (DKIS)	433.1	1,544.9	45.9%
Tennant Creek Regulated Network	16.7	31.1	0.9%
Alice Springs Regulated Network	72.5	186.7	5.6%
Off Grid (PWC and IES)	90.8	125.6	3.7%
Pastoral Properties	31.0	241.2	7.2%
Mines	430.7	1,228.7	36.5%
Other	3.0	4.8	0.1%
Total Regulated	522	1,763	52.4%
Total UnRegulated	555	1,600	47.6%
Total Regulated and Unregulated system	1,078	3,363	100.0%
NT TOTAL BY FUEL - REG and UNREG	**MW**	**GWH**	
NG	673.6	2,160.5	64.2%
Diesel	197.0	874.5	26.0%
NG/Diesel/CNG	64.6	201.6	6.0%
Heavy Fuel Oil	105.0	101.5	3.0%
Renewable	8.2	21.5	0.64%
Kerosene	30.0	3.1	0.092%
Total Fossil Fuel	1,078	3,341	99.4%
Total Generation	1,078	3,363	100%

2 Within the specific context of this report the phrase "regulated markets" refers to the areas covered by the Network Access Code as described within the Utilities Commission Act (2000) Section 5(1) "The Network Access Code applies to the electricity networks prescribed by the Minister by notice in the Gazette." This currently includes only those areas noted in the body of the document.

3 Due to variations in reporting mechanisms the table was developed from a variety of data sources utilising different reporting date baselines. Consequently some values have been prorated to provide a best estimate of the 2010 Calendar Year generation

4 The off grid market includes both regulated gazette townships operating on diesel, and unregulated communities managed by Indigenous Essential Services Pty Ltd on behalf of the Department of Local Government and Housing.

4.1.1 REGULATED MARKET

The regulated market within the NT has historically been managed and overseen by the Power and Water Corporation (PWC), an NT Government owned corporation. PWC was initially established as the NT Power and Water Authority and operated as a public utility, providing services across the Northern Territory for over 50 years.

In 2001, consistent with nationwide trends associated with microeconomic reform, the Northern Territory embarked upon a long term strategy of opening up electricity markets within the NT to competition with a view to ensuring the most economically efficient supply arrangements were in place for the Territory.

During establishment of a strategy for energy competition, it was necessary for the NT Government to determine which areas of the Territory would be open regulated markets and which would be constrained by other operating principles. Key factors in this determination were:

- The size of the potential markets;
- The status of tenure of various communities; and
- The role of independent power producers in certain areas such as mines.

Consequently the regulated market, which represents nearly 50% of total energy consumptions within the NT, was defined as being within the gazetted townships and surrounding areas associated with the following grids:

- Darwin Katherine Interconnected System;
- Tennant Creek Grid;
- Alice Springs Grid; and
- Some remote gazetted townships such as Borroloola, Yulara and Eliot.

As noted within the table above, the predominant fuel source within the regulated market is natural gas (NG), although there is a marked increase in the role renewable energy in some portions of the regulated market, including[5]:

- 1MWp Tracking flat plate PV system at Uterne Solar Farm, Alice Springs305kWp Fixed flat plat PV system at Crowne Plaza Alice Springs
- 235kWp Tracking concentrated PV at Alice Springs Airport
- 190kWp Combination fixed and tracking PV at the Desert Knowledge Australia Solar Centre
- Over 500 household PV systems in Alice Springs averaging 1.5kWp in size
- Over 20 commercial PV systems in Alice Springs averaging 10kWp in size
- Over 200 household PV systems in Darwin averaging 1.2kWp in size
- 1.1MW of landfill gas from Shoal Bay landfill

Specific detail on the natural gas infrastructure within the NT and the breakdown of the various generating can be found in Appendices 8.1 Gas Energy Infrastructure.

5 Alice Solar City and Power Water Corporation (2011)

4.1.2 UNREGULATED MARKET: REMOTE COMMUNITIES (IES)

Although the Power and Water Authority had traditionally had responsibility for provision of essential services within the NT's 72 designated Aboriginal Communities, with the establishment of regulated markets within the NT, and the subsequent corporatisation of the Power and Water Authority into Power Water Corporation, responsibility for essential services was transferred to the NT Department of Housing, Local Government and Regional Services (DHLGRS).

With the establishment of Power and Water Corporation, all existing assets in the 72 remote communities were transferred to a non-profit entity, wholly owned by PWC, called Indigenous Essential Services Pty Ltd (IES).

DHLGRS subsequently contracts IES, on a rolling 5-year engagement, to provide essential services within remote communities. IES then sub-contracts PWC to operate and maintain the IES assets in remote communities in order to meet the contractual obligations associated with the DHLGRS contract.

The predominant fuel source in remote communities is diesel, although recently some communities have been connected to existing natural gas fired grids, and several have significant renewable energy systems integrated into them, including:

- Hermannsburg – Concentrating dishes
- Lajamanu - Concentrating dishes
- Yuendumu – Concentrating dishes
- Bulman – Fixed flat plate
- Jilkminggan – Fixed flat Plate

Further development of renewable power systems is presently underway at:

- Ti Tree – High Penetration PV
- Lake Nash – High Penetration PV and Wind
- Kalkarindji – High Penetration PV

4.1.3 UNREGULATED MARKET: MINE SITES

The NT has 14 major mine sites with a further 11 sites being actively pursued and/or developed. The predominant fuel sources for these mines are:

- Diesel;
- Heavy Fuel Oil (Bunker Oil); and
- Natural Gas

The mine sites generated a combined total of 1,284GWh in 2010 with an installed generating base of 430MW, representing 37% of the energy generation/consumption within the NT[6].

6 NT Generation Data Set (EPCC Unit, 2011)

More significantly, however, is that while the mines represent 37% of the energy generated within the NT, they represent nearly 40% of the carbon emissions within the NT, from stationary energy and nearly 50% of the expenditure on energy (excluding capital expenditure [CAPEX] and non-fuel operational expenditure [OPEX]). This is illustrated in the graphs below:

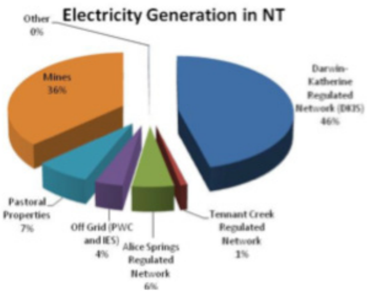


FIGURE 4-1: *NT Generation Sources (EPCC, 2011)*

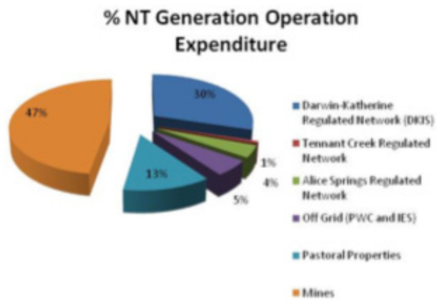


FIGURE 4-2 *Energy Source Costs Emissions (EPCC Unit[7], 2011)*

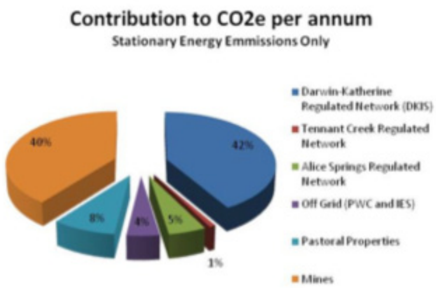


FIGURE 4-3 *Energy Source Emissions (EPCC[8],2011)*

The significance of the graphs above is that they illustrate the differences in relative impact the various sectors have on NT emissions from, and expenditure on, stationary energy relative to the proportion of energy delivered. This in turn highlights areas in which renewable energy may have the highest relative value. For example, although DKIS is responsible for approximately 45% of stationary generation within the NT, it contributes only approximately 42% of emissions, and consumes only 30% of operational expenditure for generation: therefore, for each MWh of renewable energy generated on the DKIS, you will receive a lower marginal benefit in emissions and operational savings than if the MWh of renewable energy had been generated on a mine site, for example.

7 Estimated operating costs used to determine relative percentages have been calculated utilising "Commercial in Confidence" data supplied by PWC, IES, EPCC Unit (Department of the Chief Minister) and SKM-MMA.

8 Estimated emissions have been calculated utilising the Australian Government Greenhouse Gas Reporting Factors and Methods Workbook values for the respective generations sources

> **Opportunity:** *Given the relatively high marginal cost of generation, the higher per unit emissions from mine sites, and the significant exposure to increased generation costs associated with future oil price rises, alternative energy services may be more readily developed within this sector.*

An important characteristic of mine sites, in contrast with mainstream settlements, is that investment in any infrastructure is able to be made only within the context of the mining lease and resource potential that the mining company has assessed for a particular site. Further to this, advice provided by miners to investors is heavily governed by the Australian Securities and Investments Corporation.

Consequently investment in energy infrastructure at mine sites, where the investment is made on the basis of a forecast return (i.e. from fuel savings), must be able to demonstrate that the entirety of the savings can be achieved within the stated mine life. This is true even in circumstances where the mine may continue to operate for many years beyond the originally stated mine life.

> **Barrier:** *More capital intensive energy sources such as sSolar PV are relatively less attractive for mining operations with shorter mine life expectancy, i.e. a mine with a stated life of 5 years, may not recover the capital cost of a solar PV system designed to operate for 25+ years.*

4.1.4 UNREGULATED MARKET: OTHER OFF GRID (INC PASTORAL)

Beyond the market segments noted above are three smaller sectors, generally grouped within the generic title of non-IES/PWC off-grid. These areas include:

- Cattle Stations;
- Road Houses;
- Aboriginal Outstations; and
- National Parks.

Generally these sites utilise diesel as a primary fuel source although there are a large number of stand-alone and hybrid solar PV systems in existence as a result of the Bushlight program in 50 outstations, and the Australian Government's Renewable Remote Power Generation Program (RRPGP) grants for hybrid PV systems on pastoral properties

4.2 NT POLICY FRAMEWORK

4.2.1 ENERGY POLICY

The Northern Territory Government does not have an existing energy white paper or formalised energy policy specifically addressing the stationary energy sector. As a result there are a variety of competing influences within the development and implementation of energy policy within the NT.

The existing paradigm has been largely influenced by the micro-economic reform agenda established in the late 1990's, coupled with a recognition of the need to manage energy costs at a household level across the NT along with historical legacies associated with the development of energy services in remote areas. Details of the existing energy infrastructure, including gas supply network, are included in Appendix 8.1.

4.2.2 REGULATORY FRAMEWORK

On 1 April 2010, full retail contestability commenced in the NT Electricity Market to encourage new retail competitors to enter the market, thereby providing all electricity customers with a choice of retailer. In February 2011, a second Retailer (QEnergy) was granted a Retail Licence by the Utilities Commission to sell electricity in the Northern Territory. In simple terms, this will require Q Energy to develop contracts with PWC's Generation Division (or other licensed generators where they exist) for the energy to be supplied to end customers as well as an agreement with PWC's Network Division to gain access to the "poles and wires," in the form of network access charges. The rules framing these contracts are administered by the Utilities Commission.

A program of additional reforms is required to support the development of competition, including developing a Community Service Obligation (CSO) negotiation framework that could be accessed by other retailers. A two year 'Grace Period' applies until 1 April 2012, during which time newly contestable customers (such as domestic customers) will continue to be protected by their current tariff arrangements.[9] More specifically, the existing CSO arrangements have been constructed where there is a relatively simple relationship between NT Treasury, the Utility Commissioner and PWC. With the onset of competition, NT Treasury and the Utility Commissioner will need to develop a CSO arrangement to cover multiple energy retailers.

On 1 April 2012, the Grace Period expires and customers who became contestable on 1 April 2010 (and have not already accepted market contracts) will be transferred to a Standing Offer Contract. Although the terms of this contract may be developed under the National Energy Customer Framework (NECF) and will differ from the existing Power and Water customer contract, pricing can be as specified in the current Pricing Order which expires in July 2013.[10]

> **Barrier:** *The existing market framework makes it potentially difficult for the NTG to directly intervene in the operations of PWC, notwithstanding its sole shareholder status with PWC.*

4.2.3 COMMUNITY SERVICE OBLIGATIONS

The Northern Territory Government provides community service obligation payments to the Territory's government business divisions (GBDs) and government owned corporations (GOCs).

Where Government specifically requires a GBD or GOC to carry out activities which the GBD or GOC would not elect to do on commercial grounds or would only undertake commercially at higher prices, such functions are designated as CSOs. CSOs allow the Government to achieve identifiable community or social objectives which would not be achieved if left to economic or market forces. Government CSO policy is aimed at identifying the noncommercial functions performed by GBDs and GOCs, making the functions transparent and their delivery accountable to the community. To ensure that non-commercial functions do not adversely impact the financial performance of the GBD or GOC, the policy provides compensation through the provision of the CSO.

The provision of CSOs by the 'purchasing' agency through budget funding or acceptance of a lower shareholder return has three important implications:

- the promotion of a commercial culture within GBDs and GOCs;
- transparent budget funding and reporting provides confidence to competitors that CSOs are not being used to underwrite commercial operations at the expense of competitors; and
- it provides an opportunity for regular review of activities funded as CSOs.

9 Utilities Commission, Final Report, Review of Full Retail Contestability for Northern Territory Electricity Customers, December 2009, paragraph 1.38, pg. 7.
10 Utilities Commission , Final Report, Review of Full Retail Contestability for Northern Territory Electricity Customers, December 2009, paragraph 1.40, pg. 7.

The Power and Water Corporation will receive CSO payments for 2011-12 from the purchasing agencies presented in the following table.

Purchasing Agency	Purpose	2011-12 Budget ($000)
Northern Territory Treasury	Gazetted (Uniform) Tariffs (through Pricing Orders)	61,257
Department of Health	Pensioner Concession Scheme	9,608

Northern Territory Treasury provides CSO funding to the Power and Water Corporation (a GOC) in accordance with Government policy regarding the provision of services in urban areas of:

- electricity supply to domestic customers, small businesses and other organisations across the Territory at uniform tariffs;
- electricity supply services to tranche 4 electricity customers (primarily mediumsized businesses and other organisations) at a subsidised tariff; and
- water and sewerage services to all customers at uniform tariffs.

CSO funding for gazetted tariffs in urban areas is budgeted to be $61.3 million in 2011-12. This delivers an average subsidy of $820 per household.

The Power and Water Corporation also receives CSO payments from the Department of Health to fund subsidised electricity, water and sewerage tariffs for pensioners and seniors under the Pensioner Concession Scheme ($9.6 million in 201112).

In addition to the CSO provided in urban areas, the Territory also subsidises utilities services in remote areas through the Indigenous Essential Services (IES) grant paid by the Department of Housing, Local Government and Regional Services. In 201112, the IES grant is $80.6 million. A grant of $17.8 million will be made for the new Wadeye gas-fired power station in 201112, in addition to the $2.1 million in 201011 to connect Ampilatwatja to the Arlparra grid.[11]

The CSO for the provision of Gazetted Tariffs and the Pensioner Concession Scheme is paid to Power and Water's Retail business to subsidise the gap that exists between the cost of electricity (including the cost of generation and network services) and the price at which it can be sold to customers.

Barrier: *The existence of approximately $60M in direct support to electricity consumers has resulted in the NT having the second lowest Uniform Tariff in Australia. This may make policy interventions such as Feed In Tariffs less viable as there is the potential for the subsidies to work against each other creating a non-efficient outcome.*

Barrier: *The presence of CSO and universal price determinations masks the differential costs of supply for different locations, thus reducing the effectiveness of price signals that may otherwise encourage reduction in household energy consumption or installation of lower cost sources of supply (such as distributed renewable energy generation) at high cost locations, and consequently reduction in the longer term RET liability*.

11 NT Budget 2011-12, Budget Paper No. 3 The Budget, Part 2: Community Service Obligations, pp. 3-5.

4.2.4 CLIMATE CHANGE POLICY

Further to the policies noted above, in 2009, the NTG released its NT Climate Change Policy. This policy articulated a detailed framework for how the Territory should manage issues surrounding climate change given that the Territory is uniquely placed to be both burdened by, and a beneficiary of, the broader response to climate change. For example, the impact of climate change in the sustainability and viability of remote communities, which are already burdened by extremes of temperature and rainfall, may be more significant than in other states; however, were a price on carbon to be introduced, due to the use of natural gas as primary generation fuel, the cost of a carbon tax per unit of electricity within regulated networks will be lower than for states such as Victoria.

The Climate Change Policy covers a broad range of areas, including savannah burning, transport, agriculture and infrastructure. Critically, it recognises that stationary energy is an industry sector that contributes substantially to the overall emissions within the Territory, while also being heavily influenced by external policies and variables, including potential carbon trading schemes and oil prices.

Additionally, beyond the establishment of the Green Energy Taskforce, there are a few specific additional policy measures in the underlying energy policy paradigm within the NT, including[12]:

- NT Government to be Carbon Neutral by 2018;
- Reduction in diesel use in remote communities by 50%; and
- Development of Alice Springs as a Best Practice Exemplar of Solar Energy.

How these objectives will be met has not yet been clearly stated and so are not explicitly dealt with in the context of this report.

4.3 EXTERNAL POLICY FRAMEWORK

4.3.1 RENEWABLE ENERGY TARGET (RET)

The Renewable Energy Target (RET) scheme has been in place in Australia since 2001. Designed as a market mechanism, it was a world first and has since been replicated internationally.

The RET is designed to deliver 20 per cent of Australia's electricity supply from renewable sources by 2020, increasing renewable electricity generation from large scale sources: 12,500 GWh in 2010 to 41,000 GWh in 2020 (roughly 20 per cent of total consumption). The target will remain at 41,000 GWh from 2020 to 2030. The scheme will end in 2030.

As a market mechanism, the RET employs both incentives and penalties. Demand is regulated by requiring the electricity retailers to meet a share of the target annually. Renewable sources include wind, biomass, hydro, geothermal, landfill gas, and sewage gas. Natural gas and coal seam methane are not included.

On 1 Jan 2011, the RET was split into a Large scale Renewable Energy Target (LRET) and aSmall scale Renewable Energy Scheme (SRES). The LRET obligations may be met only by the surrender of Large Generation Certificates (LGC) which are able to be generated only from registered and accredited Renewable Energy Power Stations. The prices of LGCs are determined by the market and have an upper effective value of $92/Certificate (MWh). The SRES supports the development of small renewable generating units (SGU's) such as home PV systems and solar hot water units through the creation of Small Technology Certificates (STC's) and have an upper value of $40/Certificate (MWh). There is no mandatory target for the generation of STC's.

12 NT Climate Change Policy (NTG, 2009)

The implication of the RET for the NT is that energy retailers such as PWC, and other retailers who enter the market, will be required to surrender an aggregate number of permits equivalent to 20% of the energy retailed within the DKIS by 2020. This estimated to equal 300GWh of renewable generation, of which at least 270MWh will need to be met by the surrendering of LGCs. In practice this is calculated by multiplying the total target at 2020 (41,000GWh) by the percentage of total NT retail energy sales from liable entities as a portion of total national retail energy sales from liable entities.

Simple multiplication of the expected target for each year by the forecast LGC price indicates the aggregate cost impost to NT Energy Retailers (predominantly PWC currently) to meet the RET obligations could be as high as $120M by 2020; however, the yearly cost by 2020 is expected to be between $12M-$21M[13 14].

Referring to the Australian Government modeling, if there is no increase in investment in renewable energy sources within the NT prior to 2020, the NT's projected GSP is estimated to be 0.08 per cent lower between 2010 and 2030 compared with the RET not having been imposed. In net present value (NPV) terms, the negative impact on the Territory's GSP is estimated at $126 million. This is mainly a consequence of the negative effects of higher energy prices, where there is no offsetting effect from investment in renewable energy generation[15].

Current cost estimates and forecasts suggest that it is unlikely that the requirement for provision of LGC's will be met from NT based renewable power stations without some form of market intervention by the NT government.

4.3.2 CARBON TRADING SCHEME

On the 10th of July 2011, the Australian Government announced the details of its proposed Emissions Trading Scheme that would come into effect on the 1st of July 2012[16]. The key attributes of the scheme include a fixed price period for 3 years of $23/Tonne of CO_2 (rising at 2.5% per annum in real terms) for companies and businesses that emit greater than 25,000 tonnes of CO_2 annually. The estimated number of businesses and companies that will become liable entities is 400 to 500. The determination of total business emissions is governed under the National Greenhouse and Energy Reporting Scheme (NGERS Act) and, based on current data, fewer than 10 companies within the NT, including PWC, are expected to be liable.

After the 3 year fixed scheme, the fixed price permits will transition to a market-based mechanism with a floor price of $15/Tonne and a price cap that will be determined by a future comparison of international markets. Both will be subject to escalation.

Free permits will be issued to trade exposed-emissions intensive industries, such as aluminium smelting, of up to 95% of the respective entities' obligations during the transition period.

Approximately 50% of the revenue generated from the sale of permits will be returned to individuals and households through a variety or measures to offset the cost impact of the carbon price. The balance of revenue is to be used for other industry support mechanisms, including for Emissions Intensive and Trade Exposed industries and generators, as well as support for investment in renewable energy (further detail is contained below). While it is self evident that as a result of the carbon price, the increased costs for generating electricity with fossil fuels will make renewables more attractive and more viable, it is important to note that there may be an additional impact on longer term natural gas prices, as other States transition to natural gas from more carbon intensive generating sources, such as coal.

13 Current forecasts for LGC Prices in 2020 vary between $40 and $70/certificate (CEC, SKM/MMA 2010)

14 LGCSs are tradable certificates, and as such the market price for LGCs will generally be the same for all LGCS at the time of purchase regardless of origin, thus making the purchase price of LGC independent of the cost of generation. For example, on a given day a solar farm and a wind farm may both generate 20 LGCS (20MWh of renewable energy); however, the purchase price of energy from the wind farm (excluding LGCs) may be $110/MWh, versus that of the solar farm which may be $160/MWh, as this is currently a more expensive technology.

15 Impacts of Changes to the Design of the Expanded Renewable Energy Target (CEC, SKM/MMA 2010)

16 Clean Energy Future Exposure Draft Legislation (Australian Government, 2011)

Petrol and diesel have been excluded from the scheme for use in cars and light commercial vehicles, through a reduction in fuel excise; however, large transport users will be affected as a result of not receiving an excise reduction[17].

Additional diesel used for stationary power generation by entities that had previously received diesel excise exemptions, in particular mining companies, will be included within the scheme through a reduction in the diesel excise rebates of 6c/L[18].

> **Opportunity:** *The decrease in diesel excise rebates for mining companies has the potential to increase the marginal cost of generation on remote mine sites by up to $20/MWh, with the implication that renewable projects may become more attractive and more viable for mine sites in the NT, thus potentially providing a domestic source of LGC's.*

4.3.3 INDUSTRY DEVELOPMENT/SUPPORT PROGRAMS

Announced with the introduction of the ETS was the intention to establish two specific measures to support the uptake of clean energy technologies within Australia. They are:

- The establishment of the Australian Renewable Energy Agency (ARENA) which will be responsible for management and implementation of grants-based renewable support programs; and
- The establishment of the Clean Energy Financing Corporation (CEFC) which will administer a $10Bn fund supporting the development and uptake of low emissions technologies, with at least half of this funding dedicated to renewable energy through mechanisms such as low interest loans and loan guarantees.

These measures are discussed further below.

4.3.3.1 ARENA

ARENA will have the responsibility for management of 10 existing renewable energy support programs with $3.2Bn of allocated funding and will operate as an independent statutory body.

Existing programs that will fall within ARENA's mandate include:

- Australian Centre for Renewable Energy;
- Solar Flagships;
- Australian Solar Institute;
- Renewable Energy Venture Capital Fund; and
- Connecting Renewables Fund

The stated intention is to ensure administrative independence from government policy influences whilst ensuring the maximum leveraging of funds within the various programs through reduction in duplication of effort, investment co-ordination and more flexible grant provision frameworks to support changes to the renewable energy technology landscape.

It is not yet clear how the existing independent boards of groups such as ACRE and ASI will be integrated into ARENA.

In addition to the creation of ARENA, with the announcement in late June 2011 of the successful consortia for Round 1 of the Solar Flagships program, a program review and consultation has commenced for Round 2 of the Solar Flagships program.

17 There are some additional opportunities for Carbon Farming Initiatives within the NT that are likely to develop in the coming years; however, it is unlikely that these will have any direct impact on meeting the RET liabilities

18 Ibid

Initial industry consultations have indicated a strong preference that the requirements within the 1st round of Solar Flagships for minimum installation sizes of 150MW with connection into the NEM will be relaxed in favour of a greater number of smaller installations, perhaps in the order of 20-50MW. This has been considered as a result of specific requests from industry to ensure broader scale industry development and to optimise the effectiveness of the program by allowing support for projects in areas with higher marginal costs of generation that were previously excluded, for example Western Australia and the DKIS in the Northern Territory.

> **Opportunity:** *With the review and industry consultation for Round 2 of Solar Flagships specifically considering smaller projects, the NT may be in a prime position to support consortia wishing to develop projects in the NT.*

Further to Solar Flagships, the existing board of ACRE is moving closer to opening the first round of applications for emerging renewable energy and supporting technologies. The capital grants provided by ACRE, and subsequently by ARENA, are likely to be targeted toward new technologies, such as wave and tidal, as well as enabling technologies such as storage systems, and alternative business models.

> **Opportunity:** *The NT may be able to offer an attractive location for projects funded under the emerging technologies banner through ACRE, and in particular projects involving storage or grid stability.*

Finally, applications for Round 3 of Australian Solar Institute funding were opened on 1 July 2011, and include specific reference to research and development activities that support the uptake of solar energy within the NT and WA.

> **Opportunity:** *The NT may able to enhance collaboration between the CDU Centre for Renewable Energy, PWC and other private bodies engaged in R&D for solar in the NT, by supporting joint research applications to the Australian Solar Institute (ASI).*

4.4 FUTURE STATE OF THE ENERGY MARKET IN NT

As noted previously, the general trend within the NT is for a compounding of the following:

- Per unit energy generation costs (at least 2.5% real increases year on year);
- Per capita consumption; and
- Overall population.

The graph below provides a forecast of load growth, excluding mines and pastoral properties for the period through to 2020.

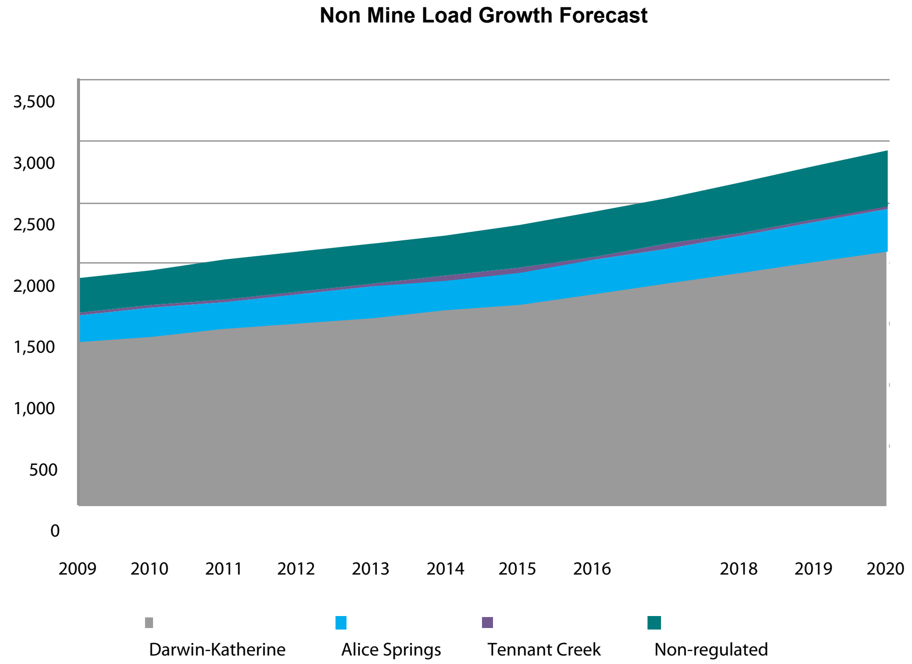


Figure 4-4 ***NT Non-mine load growth (CDU, 2010)***

NT energy growth is forecast to be higher than the national average through to 2020[19] with lower estimates of growth in consumption and peak demand of 2.23% and 2.5%[20] respectively on the DKIS and Alice Springs power systems. This is of concern, as increases in growth beyond the national average will increase the NT's percentage of total electricity sales from liable entities and thus proportionally increase the NT's RET liability by 2020. Consequently, in some cases, it may be found that the lowest cost mechanism for reducing costs associated with meeting the RET liability is actually through the reduction in consumption. For example, with an LGC price of $40, up to $8/MWh (over and above the supply cost of energy) could be spent on reducing energy demand and this option would still be cost neutral.

Further to the forecasts above, there has been some more recent modeling, undertaken by SKM-MMA, that suggests that, for the NT, the impact of a carbon price will materially alter the consumption patterns for electricity in non-industrial markets, and consequently the predicted load growth above may be too conservative. This has significant impacts in the assessment of existing generation capacity and plant life cycle assessments.

Due to the investment time-frames required for upgrades to energy generation assets, both renewable and non-renewable, it is necessary for existing generation capacity, in most sectors, and particularly the regulated market, to include sufficient capacity to accommodate both average and peak demand during normal operations, including the ability for certain units to be isolated for maintenance and servicing to meet both current and future demand. For example, in 2010, the Utilities Commission released its Network Assessment for 2010. The study found that there was generally enough capacity within the network to meet expected demand through to 2020; however, there were some constraints in certain areas of the transmission and distribution network.

19 National Institute of Economic and Industry Research, 2010
20 Statement of Corporate Intent (PWC, 2011)

As a consequence of this, alternative generation technologies are, in the medium term, generally unlikely to be able to be assessed on the basis that their construction would result in the deferment of investment in fossil fuel-based generation resulting in economic assessments that are able to be made only on the basis of savings associated with the avoided cost of generation.

Barrier: *Existing medium term investment plans may result in renewable energy investments being able to be economically assessed only on the basis of avoided cost of generation, making the economic threshold for approval more challenging.*

In addition to the forecasts above for the regulated market, potentially an additional 7 mines might commence operation between 2012 and 2020, bringing with them a requirement for a potential doubling of required energy. As all new mines require approval from the NTG, there is significant opportunity for the regulatory regime covering mining licenses to assist in the implementation of the NT's broader energy policy, by influencing the type of energy generation technologies to be used at new mine sites.

Opportunity: *With the establishment of new mines it may be possible for hybrid diesel-renewable energy systems to be justified on both avoided cost of generation and deferred capital expenditure and/or for the regulatory regime to encourage the increased uptake of renewable energy within mine sites.*

5. RENEWABLE ENERGY RESOURCE AND TECHNICAL POTENTIAL

5.1 GENERAL OVERVIEW

In 2010, only 0.46% of the NT's electricity consumption was from renewable sources; however, it is as high as 5% in within the Alice Springs grid. The existing contribution from renewable energy to the NT's electricity supply mix is predominately from solar and landfill gas methane from the Shoal Bay landfill site.

Renewable Energy is generally defined as those energy sources and exploitation technology that make use of energy that is naturally replenished from the environment around us. More specifically, however, the Renewable Energy (Electricity) Act (the Act) defines the following renewable energy sources as being eligible for the creation of LGC's[21]:

- Wind:
    - » Small Scale turbines <500kW
    - » Large Turbines >500kW
- Geothermal
- Freshwater Hydro (river- or water waterway-based turbines)
- Salt Water Hydro:
    - » Tidal
    - » Wave
    - » Ocean
- Biofuel
- Bio Gasification
- Solar:
    - » Solar PhotoVoltaics (Direct conversion of sunlight to electricity)
    - » Solar Thermal (Conversion of solar radiation to electricity via a thermal absorption medium such as water or molten salts)

There are other renewable energy sources that have been declared as eligible by the Act including black liquor, food waste, sewage waste and "any other energy source prescribed by the regulations."Specifically however, the Act defines the following energy sources are not eligible renewable energy sources:

1. Fossil Fuels; or
2. Materials or waste products derived from fossil fuels.

While only a small proportion of current energy needs are met from renewable sources, there is significant potential for further development, as the Territory has access to substantial renewable energy resources, including solar, geothermal, wave, tidal and biomass.

21 Renewable Energy (Electricity) Act 2000 as amended May 2010, Part 2, Division 3, Section 17

The NT Energy Policy and Climate Change Unit, in the Department of the Chief Minister, hasundertaken a range of renewable energy resource assessments, including wind, wave and tidal, solar, geothermal, hydro and bio-energy, drawing on NT Government, Power and Water Corporation and Australian Government sources. These data have been included in the Green Energy Taskforce's assessment of renewable potential.

It should be noted, however, that measures of resource potential do not necessarily translate into utilisation potential, as final utilisation is dependent on three further factors:

- Technical capacity
- Economic viability
- Market potential

These are issues are discussed further (below) within the context of specific barriers and opportunities for each technology; however, the image below is a useful illustration of the relationship between resource availability of actual (realised) utilisation of a resource.

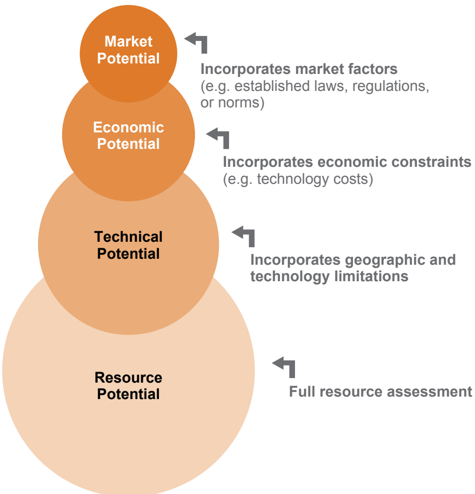


FIGURE 5-1: ***Influences on RE Potential (A Framework for State-Level Renewable Energy Market Potential Studies, NREL, 2010)***

The following sections assess each of the renewable technologies within the context of the NT, including both their state of development and the extent to which resource data indicate their suitability for the NT.

5.2 WIND

Wind turbine technology and its use for mainstream power production are now well established across the world. There are many manufacturers, and in the southern States of Australia it is a fully commercial solution.

Unfortunately, the NT generally has very low annual average wind speeds, relative to other areas in Australia where there has been significant development of wind farms. In the North, the low average wind speed masks short periods of extreme wind associated with tropical storm activity. Elsewhere, the norm is for low wind with short periods of gusty conditions driven by the hot desert climate. At a few locations, the wind does reach levels that offer some possibility of electrical energy generation. One such site is Tennant Creek, where annual average wind speeds have been recorded of 5.5m/s.

Annual average wind speed is 3 m/s for Alice Springs,3 m/s for Darwin, and 5.5 m/s for Lake Nash.

5.2.1 LARGE SCALE WIND TURBINES (>500KW)

The energy in the wind increases as the cube of the velocity. In other words, there is a lot more energy in a little more wind. Unfortunately, this means that the difference between the viability of wind turbines in low wind regions and those in moderate to high winds is very significant. Additionally, the power in the wind is proportional to the swept area of the rotor. Larger rotors mean more energy production.

There are several manufacturers now producing what are termed Class III machines. These are machines designed for low wind regions by using large rotors. The machines cannot be used where there is any risk of high winds due to the likelihood of mechanical failure. Typical rotor diameters are in the order of 50m for rated outputs of 750kW.

Due to an effect called "shear," the wind speed generally increases with height above the ground. This "shear factor" effect is caused by drag at the earth's surface due to trees and other obstacles. At extreme altitude, climatic effects such as the jet stream come into play. Unfortunately, the shear effect in the NT does not appear to be very strong. This is generally considered to be due to the lower drag factors caused be the relative flatness of the terrain within the NT and sparseness of vegetation. Although the highest wind turbine tower yet produced is the 160m Fuhrländer FL2500 (installed on a lattice tower), it is unclear whether the additional cost of high towers such as this are justified, even given the increased output at higher levels.

> **Barrier:** *The status of technology development for low speed turbines has not progressed to a point whereby they are economically viable for the majority of the Territory, which is characterised by lower wind speeds.*

5.2.2 SMALL-SCALE WIND TURBINES

Although there is a long history within the NT of windmills being used to pump water, as well as smaller household low voltage wind turbines used on pastoral stations, the few that are still operational are generally not analogous to modern wind turbines. There are, however, a number of other demonstration and prototype windmills that have been installed or are underway, including the following:

- Several enthusiasts around the Territory have at times experimented with both horizontal and vertical axis wind turbines. Typical examples have been at Tennant Creek Telegraph station and at Hillier Road in Howard Springs.
- In 1985, a 10kW demonstration turbine was mounted on a 30m tower at Battery Hill at Tennant Creek. The project comprised a 10 kW Electro wind turbine and diesel generator with a huge battery bank. It operated successfully for a number of years.
- Power and Water Corporation installed an 80 kW Lagerway wind turbine at Epenarra (about 120km southeast of Tennant Creek) in the 1990's. It is presently being recommissioned. As with many remote communities, a reduction in population and hence load poses integration problems. Average wind speeds at Epenarra are 5.5 m/sec.
- On Elcho Island (off the Arnhem Land coast), the Gawa Christian school has installed a 75 kW Lagerway turbine on a 15m guyed tower. Operational data are not yet available.
- Power and Water Corporation is about to construct three 15 kW turbines at Lake Nash on the Barkly Tableland. This trial will attempt to integrate solar/wind/diesel.

Power and Water Corporation is also collecting wind data from a dozen sites across Central Australia in order to facilitate the deployment of wind as viable opportunities arise.

As with large scale wind turbines, special features are required to deal with the modest wind regime experienced across the Territory. That is, the turbines generally are operating at a very low point on the operating curve (e.g. 10%) and hence large capital expenditure is rewarded with modest output.

> **Opportunity:** *Whilst the deployment of small wind technology is at a very low ebb, there will be specific sites and situations where it might come into its own (e.g. Elcho Island). Advances in blade design, to facilitate low start up speeds, will assist the case. A particular niche will occur where nighttime winds may produce a complementary renewable energy source to solar during the daytime.*

Conclusion: ***Although relatively mature, wind power is likely to be of marginal value due to the relatively low quality of the resource in the NT***

5.3 GEOTHERMAL

The geothermal resource within the NT is significantly different, in ability to access it, its form, and its quality, to places such as Indonesia, Iceland and New Zealand, where the resource is boosted by fluid circulation through magma conduits (volcanoes). Within the NT, the geothermal resource is at a far deeper level and is driven by the radioactive decay of minerals within the earth's mantle.

While there has been some mapping of the geothermal resources within the NT, the actual data are relatively sparse. They generally indicate that the geothermal resource is focused around Katherine and is relatively deep, >250m.

Geothermal resource mapping based on satellite imaging and ground-based penetrations indicate a high level of geothermal activity within the Katherine/Daly/Mataranka Basin as per the image below:

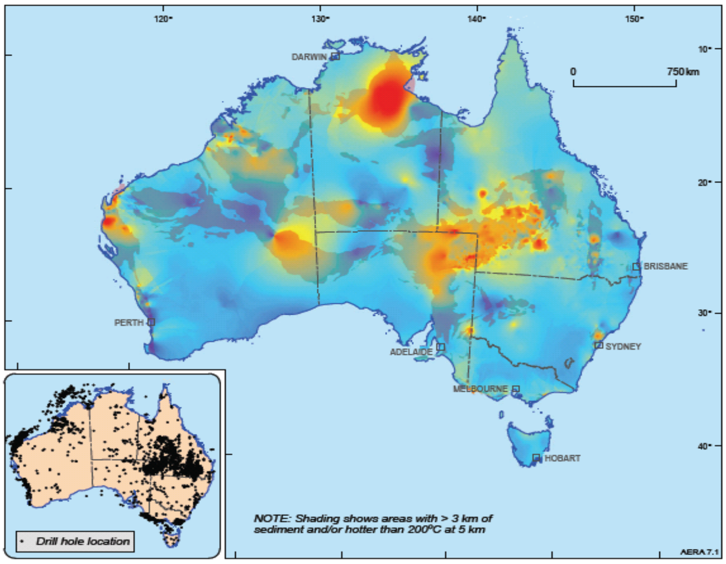


Figure 7.1 Predicted temperature at 5 km depth based mostly on bottom-hole temperature measurements in more than 5000 petroleum and water boreholes

Source: Data from Earth Energy Pty Ltd; AUSTHERM database; Geoscience Australia

FIGURE 52: *Geothermal resource intensity (GeoSciences Australia, 2009)*

What is noticeable when reviewing the inset image is the relative paucity of drill holes within the northern areas of the Territory, thus indicating that the indicated level or resource has mainly been determined through satellite imagery, and consequently has a potentially higher degree of uncertainty. Initial indications of the strength of the resource indicate that geothermal energy has the potential to become one of the primary energy sources within the NT.

> **Barrier:** *Existing assessment and forecasts of geothermal energy within the Territory have not been based on a large number of drill holes. Consequently investment may be constrained through lack of certainty in the predictions.*

The recent issues facing projects within the Cooper and Innamincka Basins suggest that while the technology is extremely promising, it is unlikely that the technical challenges posed by large-scale implementation will be resolved within the next 3-5 years. Consequently, it is unlikely that further development of geothermal resources outside the Cooper and Innamincka Basins can be undertaken within a timeframe that would allow for projects in the NT to contribute to the 2020 RET Target without further government support.

Additionally, current geothermal technologies require large amounts of water to support their operation; consequently, any planned geothermal power station would need to take into account the water requirements as well the impact the use of the water would have on the surrounding environment.

That said, geothermal power remains one the most attractive alternatives to existing fossil fuel plants, not least of which is its ability to operate not only as a fossil fuel substitute but also to be able to defer or offset capital investment in other generation. Indeed, if the technology progresses as forecast by its proponents, and the resource is proven to be as extensive as predicted, the potential remains for the NT to develop a significant comparative advantage in energy production compared with other Australian localities

The Australian Government has indicated a desire to significantly support the development of geothermal technologies, and $42 million has been allocated to aid geothermal drilling programs. More funding is likely to be available under the CEFC.

Conclusion: ***Geothermal has significant long-term potential for the NT, but is relatively immature, and it is considered unlikely that this status will change sufficiently in the medium term to allow geothermal power to make a material contribution toward the 2020 RET target.***

5.4 FRESHWATER HYDRO

Freshwater hydro power plants are generally utilisedonly in areas where significant and consistent levels of water flow are present, and the surrounding environment is able to support the construction and operation of a dam.

The Top End of the Territory has very high levels of seasonal rainfall with extended dry periods between; however, the topography of the land surrounding existing dams and waterways does not generally support the construction of dams that would be able to provide sufficient pressure, or head, to generate energy efficiently.

> **Barrier:** *In circumstances where the technology develops to such an extent that freshwater hydro could become viable, significant work would need to be undertaken to ensure that appropriate environmental controls were in place and that the use of water was consistent with existing natural resource management guidelines.*

Further, the delicate environment surrounding many of the waterways within the Top End would be potentially severely compromised were large hydro dams to be built.:

Conclusion: ***Even if the environmental implications could be managed, hydropower would, due to both terrain and the seasonal variability in rain fall, be a marginal technology for NT at best.***

5.5 SALTWATER HYDRO (TIDAL, OCEAN, OCEAN THERMAL AND WAVE)

Although there is significant development work being done around the world, exploring the potential of tidal, ocean, ocean thermal and wave technologies, and the technologies are looking increasingly promising, there remain significant impediments to the short to medium-term uptake of these technologies in the NT.

Some of these impediments are common across all the technologies, namely:

- Warm water organic growth (fouling by marine organisms, like barnacles and algae);
- High densities of marine life (dugongs, turtles, fish, etc., that could impact or be impacted by infrastructure);
- Management of environmental impacts in estuarine regions; and
- Management of connection of undersea power supplies to the mainland grid

The majority of research and development being undertaken within the various water/sea-based generation technologies is occurring in cool/cold water environments around Canada, the North Sea and Northern Europe and more recently off the coast of Fremantle in WA. While the NT has renewable resources equivalent to some of these locations, the significant difference is in the average water temperature.

With the higher water temperatures typical of the tropics, the sea-based technologies are susceptible to far higher levels of organic growth, with the potential for more rapid degradation of the technology through fouling.

Additionally, the warmer seawater produces higher average concentrations of marine life, with the potential to negatively impact the effectiveness of sea-based generation equipment.

> **Barrier:** *Lack of research on the performance of sea-based technologies in warm waters potentially reduces the capacity for these emerging technologies to be applied within the Territory.*

Finally, as with all sea-based renewable technologies, distributing power from the technology to land remains potentially problematic as a result of the potential for organic build up noted above and the very small amount of the primary grid that is adjacent to the coast line.

Notwithstanding the above, sea-based technologies remain a promising area of renewable generation, and the Commonwealth Government is investing in R&D for such technologies. Investment flows for project development will increasingly look to regions or locations where there exist both the sea-based resource as well as the industrial and professional skills and capacity to implement the projects. Additionally , warm water sea-based technologies will increasingly become of interest to nations within South East Asia and the Pacific; however, exploiting this potential will be dependent on there being an effective innovation hub for the technology.

> **Opportunity:** *The proximity of mature industry, marine support services and research facilities (through Charles Darwin University) to areas of significant energy potential in areas north of Darwin, could position Darwin as a research hub for warm water energy technologies.*

5.5.1 TIDAL

While the NT has very well mapped and documented tidal systems that are amongst the largest in Australia, tidal power systems within the NT context remain potentially problematic. The twice daily tidal flows and movement of the peak time over the course of a month, mean that the potential for higher penetrations of tidal power is decreased.

Further, alternative measures to ensure more consistent power output, such as through the construction of barrages, etc., are likely to lead to significant environmental impacts as a result of changes to estuarine flows.

There are, however, some interesting technical developments that are occurring that are worthy of further investigation. Additionally, a demonstration facility has been proposed for the Clarence Straight by Tenex and a site has now been identified.

> **Opportunity:** *Due to the proximity of Darwin to areas with large tidal energy resources, should the technical challenges associated with tidal power be resolved by their various proponents, the NT could stand to significantly benefit from this renewable resource.*

As the majority of the NT coastline has a very large tidal variation and is bounded by mangrove swamps, which are particularly vulnerable to impacts from altered currents and associated changes to freshwater/saltwater mixing and sedimentation or erosion patterns,, there is significant potential for substantial unintended damage from by poorly designed or constructed infrastructure (e.g. sea-walls) associated with capturing tidal energy. Although environmental protection legislation does exist, it has not been designed specifically for tidal power and as such the testing and verification regimes required will require adaptation to ensure that they are effective.

> **Barrier:** *Current environment and marine management legislation has not been tested against the requirements and implications of water based generation technologies.*

Conclusion: ***Despite the efforts being undertaken to develop tidal power, including demonstration sites within the NT, it is considered unlikely that it will become viable within the medium term.***

5.5.2 OCEAN/ OCEAN THERMAL AND WAVE

As noted previously, there are significant technical barriers that remain to be resolved for the aforementioned technologies, even in environments that are less challenging than those within the NT. That said, ocean currents past Cape Melville and Cape Don have substantial potential.

Additional impediments to further developing these particular uses, however, is the predominance of commercial and defence shipping lanes within the region. These issues are not irresolvable, and the size of the potential energy yield from wave power systems justifies detailed examination of regulatory or legislative measures that might otherwise impede development of these technologies.

Barrier: *Commercial and defence shipping may compete with technology proponents for preferred ocean based renewable technologies, with high probability that shipping requirements would take precedence over technological requirements identified by proponents.*

Opportunity: *Should the technical challenges associated with ocean and wave power be resolved by their various proponents, the NT could stand to significantly benefit from development of this renewable resource.*

Conclusion: ***Despite the efforts being undertaken to develop wave power it is considered unlikely that it will become viable within the medium term.***

5.6 BIOFUELS (EXTRACTION OF OILS FROM PLANT MATTER)

Biofuel has had a relatively long history within the NT, with PWC having operated its generators on biofuel and biofuel blends at various times within the recent past. The primary reason for the low ongoing uptake of biofuels is the lack of sustainable supplies, either as a result of a lack of adequate environmentally sound methods for growth and harvest or lack of source material. The VOPAC facility in Darwin is currently mothballed due to inadequate supplies at a viable price level.

Barrier: *Over-logging of rainforest for the purpose of planting palm oil plantations has led to higher levels of scrutiny of biofuel production and enhanced certification measures. This has lead to reductions in supply at economically viable levels.*

Options for the development of an Australian biofuels industry have been explored by a range of entities in recent times, and some of the business models appear attractive in the medium term. The implementation of these models, and in particular the development of cropping or plantation techniques to supply the source material, may prove problematic, however.

Pongamia is a native Australian plant (in the NT and QLD) that has been the subject of several proposals for biofuel production, the key limitation being the lack of knowledge regarding potential loss or reduction to biodiversity in areas where Pongamia plantations are planned and the inflexibility of existing land tenure arrangements, particularly pastoral leases, to accommodate alternative land use models.

Pongamia presents a significant opportunity for biofuel production should the barriers noted above be resolved. The key advantage is that it allows for the cost of capital plant upgrades to be avoided by being able to run in existing diesel gensets (to some degree, modifications may be required in some circumstances) thus yielding to significant benefits:

1. Reduction in diesel consumption, and thus exposure to global oil prices
2. No decrease in capacity utilisation of existing plant and equipment

Opportunity: *The NT Government is already supporting research for the development of Pongamia plantations. Enhanced support of this research may lead to more rapid development of alternative sources of biofuels.*

Conclusion: ***Although power generation with biofuel is relatively mature, the key challenge for the NT will be the development of sufficient feedstock and it is considered unlikely that this will be achievable within the medium term***

5.7 BIOMASS (GASIFICATION OF PLANT MATTER)

While there have been a large number of bio-gasification trials undertaken both within Australia and internationally, few, if any, of the trial plants have been able to demonstrate a viable and stable long-term model. The principal causes for failure of the model are normally associated with inadequate feedstock supplies or gasification plant failure. Alternative designs for the gasification plants have been developed to counter early plant failure; however, the alternative designs have substantially eroded the cost competitiveness of the process.

Where the source material is a waste product, such as wood chips, plant reliability has become a further issue where the source material becomes too heterogeneous. There are however some plantation-based sources of wood chips within the NT that may be a small but viable source of biomass, specifically the former Great Southern plantations on the Tiwi Islands. These plantations could be harvested to support bio gasification on the Tiwi islands and surrounding areas in lieu of diesel generation.

Opportunity: *an effective partnership between the Tiwi Land Council, PWC and the NTG could see the development of the former Great Southern plantations into an effective and sustainable renewable energy source for the Tiwi Islands.*

Alternative models utilising broad acre cropping have been developed specifically to support the gasification plant; however, complications have arisen with this model, as competition increases for fertile farmland capable of food production.

The figure below shows the uses of land around Australia and highlights the lack of available area for broad acre cropping:

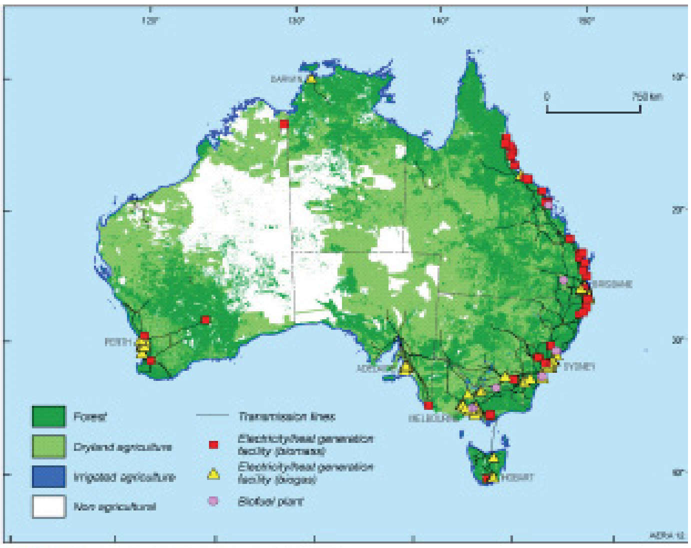


Figure 12.1 Land use and bioenergy facilities in Australia
Note: Areas depicted as under irrigation are exaggerated for presentation
Source: Geoscience Australia

FIGURE 53: *Land use and bio energy facilities within Australia (Geosciences Australia, 2009)*

The NT does not have enough arable land to support substantial broad acre cropping and as a result a viable bio-gasification industry would rely on native bio-mass collection. As yet there are little or no data to suggest that native bio-mass exists in sufficient quantities to support bio-gasification in the NT without causing significant environmental degradation.

> **Barrier:** *lack of detailed data on biomass is restricting the ability to predict viability for even the most efficient bio mass energy plant designs.*

Conclusion: The key challenge facing bio-gasification is the lack of available data to support assessment of the biomass resource**.**

5.8 SOLAR

Of all renewable energy sources, solar is the resource for which the NT has the greatest comparative advantage relative to other technologies. The map below indicates the relative level of solar resource availability across Australia:

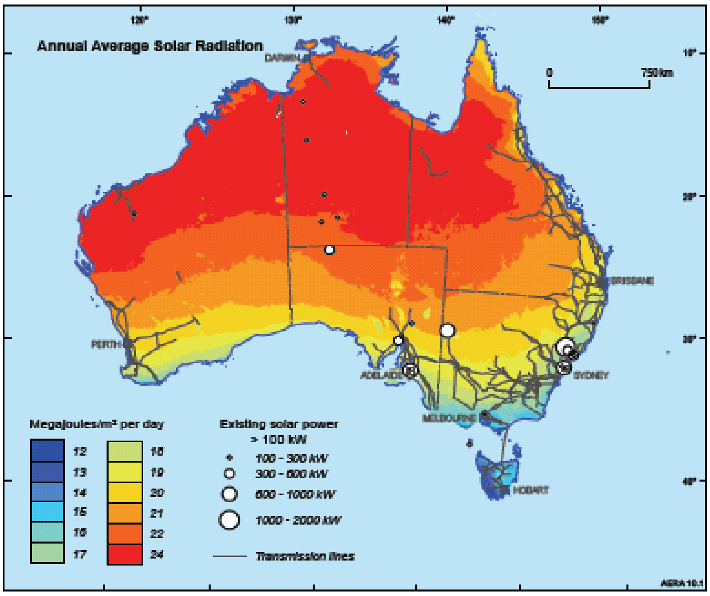


Figure 10.1 Annual average solar radiation (in MJ/m^2) and currently installed solar power stations with a capacity of more than 10 kW

Source: Bureau of Meteorology 2009; Geoscience Australia

By way of comparison, Germany, which has the highest uptake or solar Photovoltaics per capita of any market in the world, has less solar radiation per annum than the State of Tasmania.

A key constraint however is the intermittent nature of solar radiation, including both diurnal (day/night) and seasonal variations. The implications of this and other barriers are discussed further in the following section.

5.8.1 SOLAR THERMAL

Solar thermal technology has been presented previously as one of the most likely technologies to be able to support a low carbon economy. There has been considerable investment and research into solar thermal over the past 30 years; however, it has only been over the last 2-3 years where significant steps forward have been made, most notably with the cost reductions achieved from the development of Andasol 3 and more recently with the achievement of 24 hour operation (via molten salt storage) of a solar thermal plant, both located in Spain.

The potential pricing attractiveness of solarthermal has been eroded in recent times by significant reductions in the cost of photovoltaics and the lack of modularity of the plants, although this too is being resolved in some plant designs. More recent solar thermal projects in Spain and the US have been proposed at significant reductions.

Due to the rate of development in this area, lessons can be learnt from the experience with technology development associated with solar PV, namely that the price of PV dropped faster than governments and agencies predicted: in some cases this rapid price decrease distorted expected policy outcomes with faster than expected uptake of rebate and feed in tariff programs.

Consequently, the NT should seek to ensure that it works with PWC to maintain an effective oversight of technology developments within the solar thermal sector.

The principal barriers to the uptake of solar thermal within the NT are:

- The scale/modularity of solar thermal plants relative to the appropriate locations on the grid, i.e., the smallest solar thermal power plants have typically been between 20MW and 50MW. Installations at the upper end of that scale, if installed at the end of the DKIS, could cause significant issues given the relatively low capacity of the grid at that point (this could be resolved where extensive storage or gas backup was in place);
- Until recently solar thermal power plants have been typically open cycle with significant water use that is not consistent with the available water supplies within the non-cyclonic regions of the NT;
- When competing for finance against more established technologies such as wind, solar thermal has traditionally struggled to attract financing at a low enough cost to make Power Purchase Agreements (PPA's) viable within the shorter term; and
- The NT has not been eligible for funding from Commonwealth programs that have supported solar thermal such as Solar Flagships

> **Opportunity:** *Future rounds of Solar Flagships may be targeted toward smaller grids, or fringe of grid applications such as the DKIS.*

There are plant designs emerging internationally that operate at a far smaller scale, e.g. 5-10MW, and are closed cycle, thus using much less water; these may present a sound way forward for the development of solar thermal within the NT.

Conclusion: ***While the costs for solar thermal are still high and the commercial scale is currently too big for the Territory to accommodate, it is approaching a stage where it could be deployed in the NT. It is considered that the best prospects would be in combination with gas generation (to overcome the intermittency).***

5.8.2 SOLAR PV

Solar PV has rapidly reduced in cost over the last 3 years. Large scale (>5MW) solar farms are being developed in a number of areas around rural and remote NSW and QLD in areas of high availability of the solar resource and ready access to grid connection. This is also consistent with the maturity of solar PV as a technology with large numbers of systems existing in remote areas of the NT that are over 10 years old and many that are over 20 years old.

Solar PV, however, has still not been able to resolve the technical challenges associated with lack of storage and variability of supply. This has been somewhat countered at a system level by increasing the geographic spread of solar farm installations to ensure a more stable stochastic model of variability. The technology also has a large established support base both around Australia and specifically in the NT, although that support base has been largely built on State and Commonwealth incentive programs, such as Feed in Tariffs, for household PV.

Barrier: *Intermittency of supply increases challenges associated with achieving high levels of renewable energy penetration within grids.*

As the technology is reasonably mature, the attractiveness of the technology to investment partners is fairly high, compared with other renewable technologies, and has thus generally been able to attract a lower cost for financing of PPA's. The challenge however has been in identifying a price point for the negotiation of a PPA that would be commercially acceptable to both PWC and investors. The significance of this issue is decreasing as costs decrease; however, lack of understanding by the market of PWC cost structures may remain an impediment to effective engagement by renewable energy developers.

Lack of knowledge regarding the potential impact of higher line voltages within the transmission system may inhibit the rate at which additional PV capacity could be added to the existing network; however present work, particularly in Alice Springs has generated a significant data set on the impacts of PV within a smaller grid.

Opportunity: *to position the NT as a "Centre of Best Practice" for the development of high penetration PV systems.*

The current cost advantage of solar PV relative to other renewable technologies with major potential for the NT could imply advocating a policy of rapid rollout of PV to achieve the 2020 target; however, doing so may decrease the opportunity for alternative technologies to enter into the market when they reach maturity at possibly lower cost points.

Conclusion: ***Solar PV is relatively well developed and the NT has an abundance of the solar resource: intermittency and cost remain the major barriers to widespread uptake in the short term. This can be solved with further research and development of integration methods***

6. RENEWABLE ENERGY ECONOMIC AND MARKET POTENTIAL

To assess the economic and market potential for various renewable technologies discussed in the previous section , it is important to understand not only the current state of development of any given technology and its associated economic viability, but also the potential for further development of the respective technologies and accompanying reductions in cost. Consequently, it is important to understand the impact on technology economics of the 5 stages of development that are characteristic of any technology development cycle. It is during this development cycle that assessments and predictions of the technologies' relative performance will be made by technology developers and researchers. Often the relative cost forecast for a technology is quite low during the early stage research, with predictions of cost increasing through the development cycle until economies of scale are reached such that cost is able to be subsequently driven down.

An indicator of the relative state of maturity of the various renewable technologies available for use within Australia can be seen in the figure below:

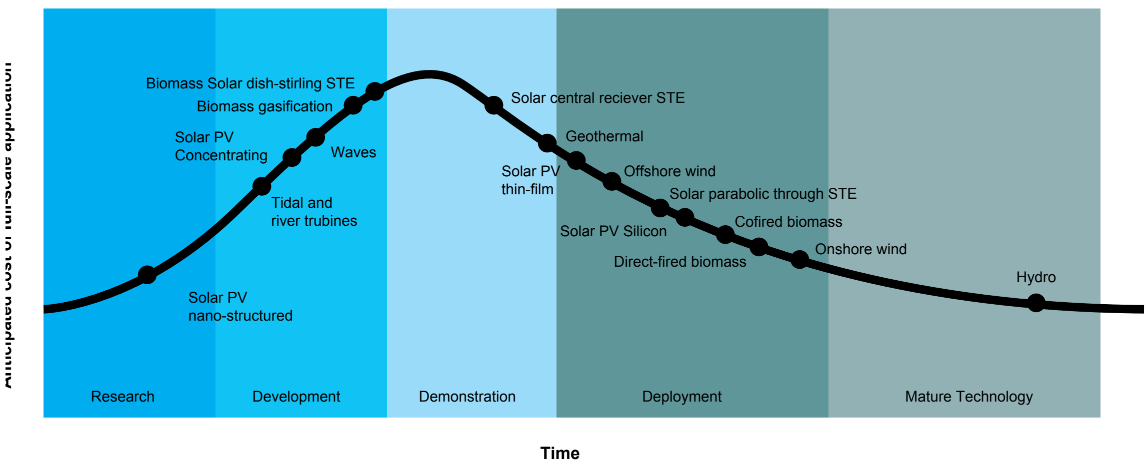


FIGURE 6-1: ***Grubb Curve (Australian Solar Institute, 2010***

The five categories of technology development noted above can be broadly defined as follows:

- **Research:** Foundational principal research, primarily university based and/or government supported
- **Development:** The first stage of prototyping and commercialisation – not at full scale; research often supported by commercialisation grants or "Angel Investors"
- **Demonstration:** Initial installations are generally at scale but are heavily subsidised and/or supported by Venture Capital funds
- **Deployment:** Installations proceed within a growing market, further research and development generally focused on refining construction and balance of system costs and overall reliability and maintainability
- **Mature Technology:** Technology is well understood with an effective supply chain and skills base present to support the technology; while subsidies may still be required, they tend to be through indirect means such as tax concessions rather than direct grants

The preceding figure is indicative only and does not allow for certain technologies to rapidly change the market place due to transformational technology development.

Similarly, generalised statements can be made about the boundary conditions for the implementation cost of various technologies. The assessments of cost are made utilising a metric known as the Levelised Cost of Energy (LCOE) which takes into account both the full cost of capital (CAPEX) and operational costs (OPEX) throughout the life of the technology, including the Weighted Average Cost of Capital (WACC), discount rates, and capacity utilisation of the technology.

The following graph shows the range of costs for different technologies relative to their respective emissions intensity:

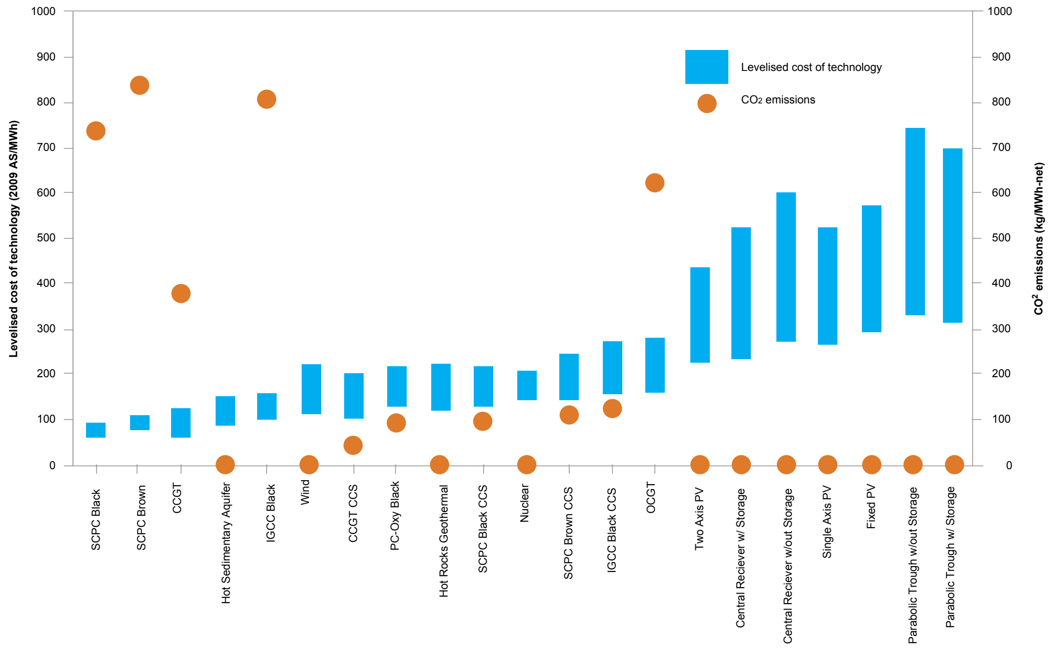


FIGURE 6-2:– ***Estimated LCOE for various generating technologies relative to CO2 emissions (Australian Government Department of Resources Energy and Tourism, 2009)***

The estimates of costs noted above are from one source only and are based on a given set of assumptions at a given point in time, and are for a general data set across Australia. Other more recent data sets[22] suggest that the lower range of the cost estimates for renewable energy may be significantly lower, and the higher range for non-renewable alternatives may be greater. Despite any potential disagreement in the exact cost estimates, there are some principles generally agreed by all studies:

1. Renewable Energy sources are generally more capital intensive while having lower operational costs. At this point in time, the cost of renewable energy generation is higher than for fossil fuel alternatives; however, increases in cost of fuels and continuing technical development of renewable energy technologies could see this gap close.

2. The uncertainty around costs is greater for most renewable energy technologies, reflected in the diagram by the greater breadth of the cost bands for renewable energy than for conventional technologies. The greater level of uncertainty reflects the fact that most renewable energy technologies are earlier in the development cycle (further to the left on the Grubb curve, Fig 6-2). This suggests, however, the potential for future cost reductions to close the gap in costs.

3. When renewable energy sources are assessed against zero emission fossil fuel technologies, e.g. gas turbines with carbon capture and storage (CCS), the renewable energy sources are generally competitive. That is, the costs are in the same range across these low emission technologies.

6.1 MARKET POTENTIAL AND VARIABILITY VS INTERMITTANCY

While a thorough understanding of the potential for future cost reductions and economies of scale for various technologies allows some predictions about future costs to be made, the characteristics of the market itself may become a limiting factor in the potential for future technology development and cost reduction. For example the size and stability of some grids may make them more or less susceptible to variability in the output of renewable energy systems. It is important to understand the difference between variability and intermittency and their relative impact on a power system.

All forms of generating plant have some inherent ability to respond to variability in demand; however, the critical barrier is one of time scale. A coal fired power station may only be able to increase or decrease its output efficiently over the course of 4-8 hours whereas a gas turbine may be able respond within the order of 15 minutes.

Renewable technologies such as geothermal, wave, hydro and biofuel/biomass are able to provide relatively stable system outputs that can be increased or decreased (within their maximum capacity and subject to availability of resource) reasonably regularly. These types of systems are described as dispatchable.

Technologies such as tidal, wind and solar PV are dispatchable, only to the extent that the sun is shining, the wind is blowing or the tide is going in or out. These variations are due to diurnal, lunar and seasonal variation in the environment and cannot be mitigated without the insertion of large storage systems. More significantly perhaps, wind and solar are prone to sudden increases or decreases in output due to non-regular intermittency in the resource, e.g. it is simple to forecast when the sun will come up and go down and thus what the maximum solar resource is; however, minute to minute resource availability can change dramatically as a result of short-term weather cycles, e.g. clouds coming over can rapidly reduce solar resource for short periods of time. The extent to which these sudden changes in output can be managed is restricted by the ability to predict the imminent change, and the speed with which the change occurs.

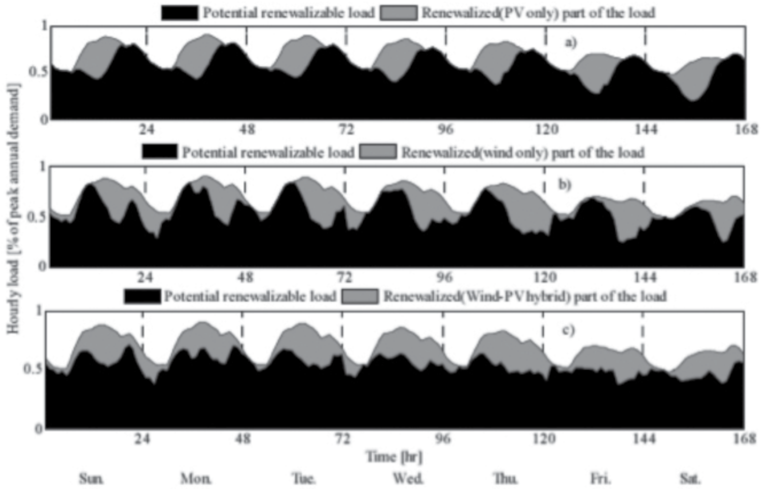
Where the solar PV system or wind turbines interact with the grid at a single point of connection and that connection represents a significant portion of the generation requirement for the grid, ie >10%, the changing output can cause destabilisation of the grid.

Recent work by the Australian Energy Market Operator (AEMO) has demonstrated that in the case of wind, new forecasting mechanisms and grid management systems have allowed far greater utilisation of wind within the National Electricity Market than was originally envisaged. This is, however, based on the construction of wind turbines geographically dispersed over a large area.[23]

Further, recent analysis undertaken for islanded grids similar in scale to DKIS has demonstrated that through geographic dispersal of a combination of wind and solar PV, the relative impacts of intermittency on a grid can be mitigated as the aggregate output of the systems becomes less dependent on the weather at any single geographic location, and, as a result, becomes more predictable[24].

23 AEMO Submission to Senate Enquiry (Craig Oakeshott, 2011)
24 An energy-based evaluation of the matching possibilities of very large photovoltaic plants to the electricity grid: Israel as a case study (AA Solomon, D Faiman, 2010)

This can be seen in the figure below:



6-3 Simulated Hourly Gird Penetration with diversified Wind/PV (Solomon, Faiman et al, 2010)

The Figure above demonstrates that the combination of the varied wind and PV sources can provide stable generating capacity within certain boundary conditions.

Barrier: *Single large scale renewable plants present significant opportunity for achieving economies of scale versus a larger number of smaller (<5MW) plants; however, technologies such as solar PV have greater potential for network instability when connected at single points, unless installed with some form of storage.*

6.2 TECHNOLOGY ECONOMICS

The preceding graph is based on generic data sets collated by the Australian Solar Institute for use across Australia and is subject to potential redundancy due to the rapid pace of technology development. Accordingly, the Green Energy Taskforce commissioned further data analysis to be undertaking by SKM-MMA with a view to providing models that could be updated on a regular basis as either the underlying economic or technology assumptions specific to the Northern Territory change.

6.2.1 RENEWABLE ENERGY VS GAS FIRED GENERATION

In comparing the Levelised Cost of Energy (LCOE's) for renewable energy and fossil fuel generating plant, the underlying assumption is that the investment in a renewable energy generation could offset the investment in fossil fuel plant.

In practice, however, some utilities, including PWC, are reluctant to defer capital investment in fossil fuel plants due to commitments under existing medium-term investment plans as well as concerns around intermittency of some renewable energy, particularly solar PV and wind.

In the graphs below, it has been assumed that:

- All plants are connected to DKIS (except for off grid diesel generation and off-grid solar PV);
- All plants are in the order of 50MW (except for off grid diesel generation and off-grid solar PV);

- Solar PV and wind include a cost component for backup gas turbines to ensure stability of supply;
- Geothermal and solar thermal technologies are based on forecast cost reductions;
- A Carbon Price starting at $23/Tonne CO2e in July 2012, increasing by 2.5% per annum in real terms and increasing by 4.5% per annum once emission trading starts in mid 2015. This cost trajectory reflects the expected carbon price from the modeling undertaken by the Australian Government under its Clean Energy Futures Scheme; and
- Capacity utilisation of 57% reflecting the need for power to operate in intermediate mode.

A detailed set of assumptions is contained within Appendix 8.2. As noted in the previous section, the uncertainty associated with the cost of various renewable technologies is higher earlier on in the development cycle; consequently, for the purposes of the following analysis, not all technologies were assessed. This is not a reflection on the potential of any particular technology to be utilised within the NT; rather, it acknowledges the challenges of predicting costs where there is greater variability in the underlying assumptions.

The following chart demonstrates the varying cost of implementing existing technologies within the NT relative to current non-renewable energy technologies. As can be seen, based on the assumptions within the model, in circumstances where capital costs of fossil fuel generation are included, flat plate PV is the closest of the renewable energy technologies to be able to compete with either open or closed combined cycle gas turbines, similar to those used within existing generating plant by PWC.

The cost for PV generation is around 5% higher than for a comparable level of generation from an open cycle gas turbine and around 20% higher than combined cycle gas turbines. The differences could be smaller as the estimates assume only 3% per annum decrease in capital costs for PV systems over the next decade, which is conservative, relative to other published estimates of cost reductions. High temperature solar thermal is the next least expensive alternative to fossil fuel generation, with cost differences of around 30%. However, there is a potential for substantial cost reduction for this technology, so the gap in cost could diminish rapidly.

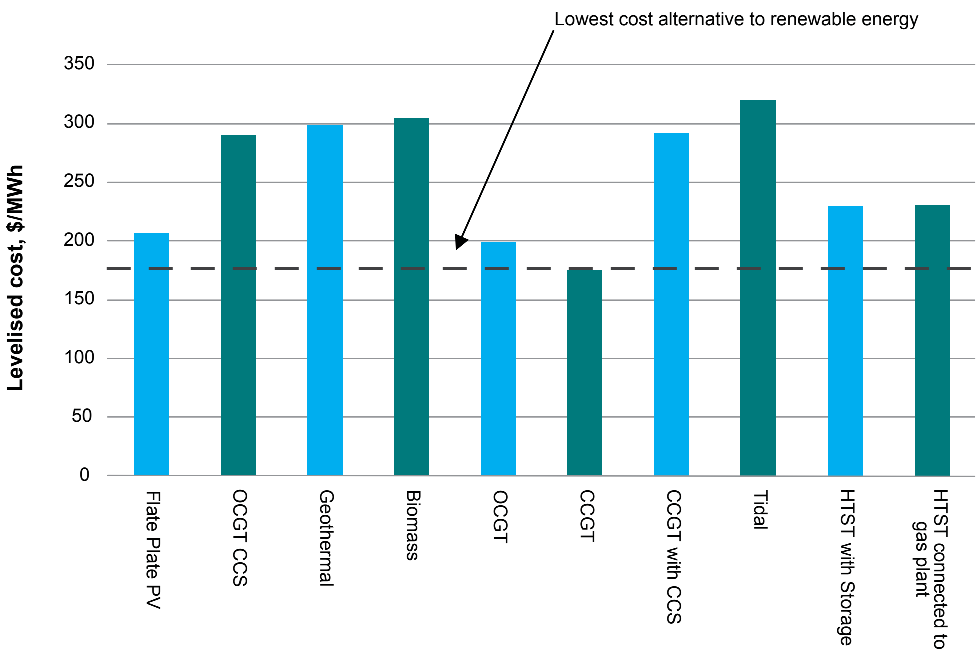


FIGURE 6-1: ***Levelised cost of Energy for various energy sources within the NT (SKM-MMA, 2011).***

The figure on the previous page, demonstrates an LCOE at a single point of time, utilising an assumed starting price for the fuels sources with which the renewable technologies will be competing. To better understand the relationship between fuel cost and LCOE for various technologies, the following chart demonstrates the sensitivity of LCOE to changes in starting cost of fuel based around a nominal base price.

The analysis suggests that fuel price increases of the order of 10% higher than those assumed would see PV generation being competitive to open cycle gas turbines, but that a fuel price increase of the order of 30% would be required before PV could compete with combined cycle generation. Clearly, either significantly higher carbon prices (than the \$23/t CO2e to \$25/t CO2e assumed for the period to 2015) or significant further reductions in capital costs would be required before renewable energy technologies would be preferred.

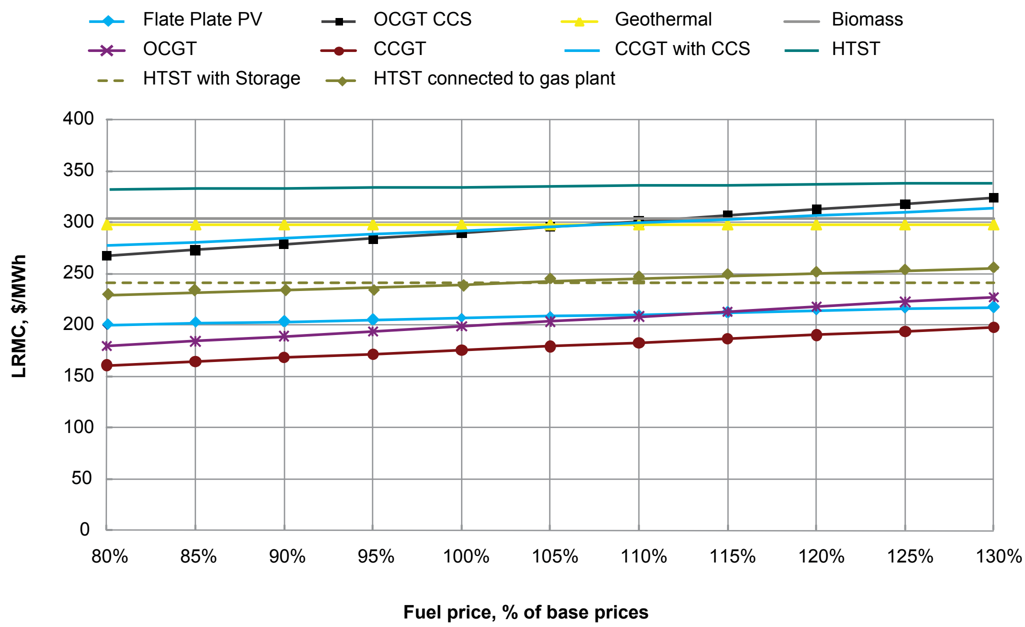


FIGURE 6-2: ***LCOE sensitivity to fuel price variation in 2015 (SKM-MMA, 2011)***

It can be clearly seen from this chart that variation in fuel prices will make renewable energy, particularly PV more attractive than other alternatives. Once again, however, the chart is still limited as it is based on a series of assumptions that may only apply if the respective power stations were built today, rather than waiting for technologies such as solar thermal or flat plate PV to be deployed in the NT after economies of scale had been achieved elsewhere.

The following chart provides an indication of the likely path for further reduction in LCOE for different technologies relative to the variations in operating cost for different non-renewable generating technologies over the coming years ;however, this chart has been included only to indicate the potential variance in LCOE based on the date on which a given power station was constructed. It is not a definitive prediction of likely technology costs.

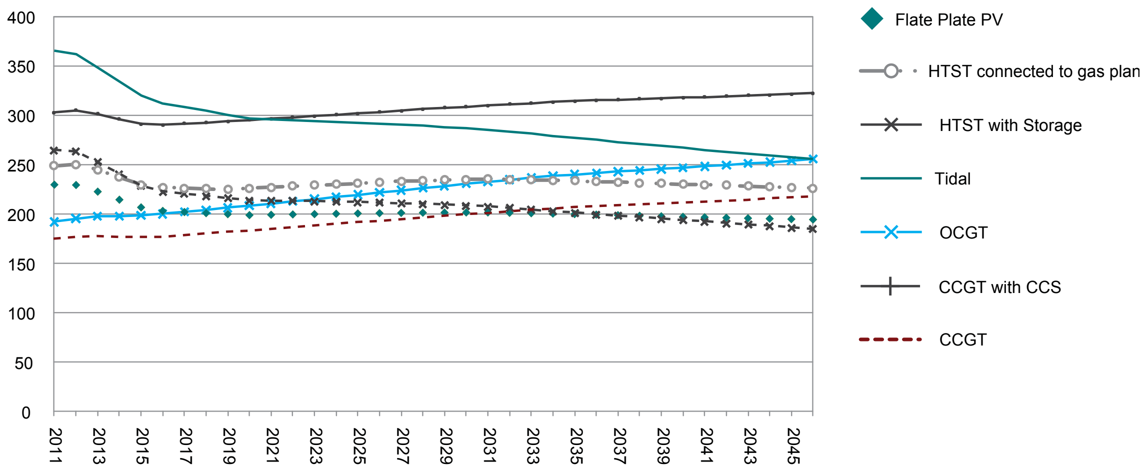


FIGURE 6-3: ***Variation in LCOE for different renewable technologies over time (SKM-MMA, 2011)***

The chart demonstrates the impact of expected rising carbon prices and the expected decline in renewable energy generation costs. This analysis indicates that:

- With rising carbon prices, flat plate PV technologies could become competitive with new fossil fuel generation as long as modest reductions in capital costs for PV technologies are achieved. With modest capital cost reductions PV generation could become economic with open cycle gas turbines by the end of this decade and with combined cycle technologies around 2030.
- Over time, other maturing renewable energy technologies such as solar thermal with storage could become competitive with conventional technologies as long as development of these technologies continues in line with recent trends.
- Novel renewable energy technologies (such as tidal) may take longer to become competitive. But, it is here that the Northern Territory Government could have a vital role to facilitate the rapid reduction of costs for these technologies by assisting in the proving of the resource and overcoming other barriers to the demonstration and early deployment of these technologies.

The LCOE predictions take into account the impact of policy measures such as RET, and consequently a rise in the LCOE for flat plate PV can be seen for power stations constructed after 2030 due to the removal of the RET as a support mechanism.

As noted, the preceding charts were included by the Green Energy Taskforce only to provide a broad understanding of the influences that varying assumptions can have on the economic viability of different renewable technologies. The graphs above cannot be specifically used to justify an immediate investment in large-scale solar PV on the DKIS, as the previous discussion on capacity utilisation shows that DKIS already has sufficient capacity to accommodate forward projections of load growth and consequently large scale solar PV will be competing purely against the marginal cost of generation by gas fired generation plants which is considered to be between $100-$130MWh.

End consumers pay substantially more than $100-$130/MWh, particularly large commercial users that are not eligible for support through the CSO system, such as supermarkets, hotels, warehouses and offices. Tariffs for these customers are individually negotiated and are confidential; however, estimates of the current tariffs can be made by adding the value of the CSO subsidy and the uniform tariff. This suggests that commercial tariffs are in the range of $201-$230 for DKIS users, and $210-$240 for users in Alice Springs. The difference in cost between the marginal cost of generation and the end price paid by a consumer reflects the fixed costs of generation and embedded costs associated with transmission and distribution, as well as other operational costs incurred by PWC, or any other retailer.

Recognising that the previous assessment of solar PV presumed a 50MW plant size, and thus the opportunity for increased economies of scale, existing data on smaller scale PV plants (500kW-3MW) indicates an LCOE of around $230-260/MWh[25] are feasible. Given that it is a reasonable presumption that energy prices are likely to rise, the question can then be asked as to why businesses and particularly those with large roof surface areas such as supermarkets and factories with high energy costs are not actively pursuing large scale PV systems, effectively using the PV system as a negative load or energy efficiency measure[26].

Extensive work undertaken as part of the Alice Solar City projects commercial scale engagement highlighted two primary reasons for lack of uptake of renewable energy, and particularly PV, by larger commercial users:

1. Availability of finance, or lack of capital – businesses interviewed generally had their existing capital or finance streams allocated to specific business growth activities and these could not be diverted to measures that were regarded as a low priority; and
2. In many cases, the energy consumer did not own the property in which they operated and were merely leasing the building. In circumstances where the energy consumer was willing to contribute to the cost of a PV system, the building owner was often reluctant, because, for the installation to be viable, the owner needed to be confident that they would be able to sell the energy for 15-20 years, and their leases were often only for 3-5 years. (This has been resolved in places such as California, and more recently Melbourne, by changing the legal rights of landlords with respect to the value of energy produced by PV systems.

Barrier: (Renewable energy vs Gas): *Ownership structures and lack of financing, or structured revenue streams serve as a disincentive even in markets where the economics of renewable energy, in particular PV, are competitive.*

Opportunity: *The higher energy costs for commercial consumers mean that they have significant motivation to invest in renewable energy subject to the provision of a supportive regulatory regime that assists in removing the barriers noted above.*

6.2.2 RENEWABLE ENERGY VS DIESEL

Where the renewable technology is being compared to non-renewable generation in remote areas where diesel is the primary fuel source, the underlying assumptions, and outcomes, of the model change again.

The chart below, provides an indication of the varying levels of investment return that could be expected for a 2MW PV system on a diesel powered grid, such as Groote Eylandt, relative to variations in assumed capital cost for the PV system and the year on year pricing increases forecast for diesel. In particular, it highlights that the economic justification for installation of a PV system in off-grid areas is critically dependent on the assumptions surrounding diesel price escalation, and the minimum financial returns required from the investment.

25 PV Cost Trends, PV in Australia Report (APVA, 2010)

26 An example of this is the Crowne Plaza Hotel Alice Springs where a 305kWp pv system on the roof of the hotel has reduced the hotels net energy purchases from PWC by 20% per annum

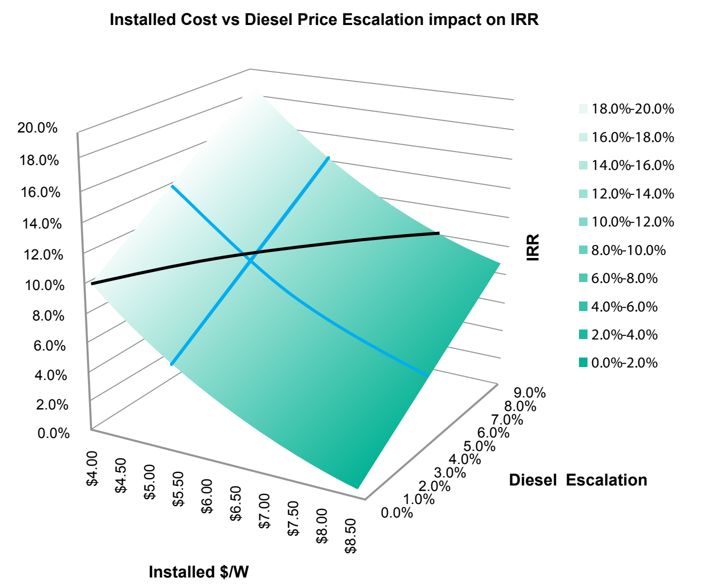


FIGURE 6-4: ***IRR for 2MW PV system vs Capital cost and diesel escalation (CAT Projects, 2011)***

Despite technical issues associated with intermittency of some forms of renewable energy, on diesel grids renewable energy technologies such as solar PV are already viable: the question remains why further uptake is not already occurring independently of government investment.

> **Barrier:** *(Renewable energy vs Diesel): Financing costs and ownership constraints as well as challenges associated with achieving economies of scale are the most often-cited restrictions to further uptake of renewable energy within diesel grids*

6.3 POLICY OPTIONS

There are a range of barriers that should be addressed in order to increase the viability of renewable energy within the NT and a range of opportunities for increasing the benefit of renewable energy to the NT. The policy challenge, however, is whether the NTG should engage in a passive or active intervention in the development of renewable energy in the NT.

Passive interventions would involve addressing many of the barriers noted previously, particularly those related to research priorities or regulatory challenges. An active intervention includes the passive measures, but is primarily about a financial stimulus or subsidy: should the NTG allocate financial resources to the development of renewable energy in the NT to ensure that the revenue from various RET liabilities stays within the NT?

The possible interventions range from block grants to fund 100% of the capital cost of the renewable energy installations, through to feed in tariffs (FIT) that cover the difference in generation cost for the renewable technology versus the standard cost of generation. Additionally measures such as loan guarantees could assist in decreasing project risk for investors.

While the ultimate assessment of the merits of active financial intervention will be based on a range of factors that are not necessarily quantifiable within the body of this report, the Taskforce felt that it was appropriate to consider two policy options that assisted in quantifying the magnitude of the challenge:

1. Do Nothing: Allow the RE industry to develop in response to national climate change policies, with liable entities purchasing LGC’s from NT sources where possible and purchasing the balance from interstate; or

2. Invest Now: Spend whatever is required on the most viable technology today to ensure that the NT's RET liability is met from NT sources

The implications of these options are discussed further below.

6.3.1 DO NOTHING

As noted in Section 4, the RET liability for the NT will be approximately $12-$21M per year by 2020. This is based on an assumed liability of 300GWh of LGC's (300,000 certificates) to be surrendered in 2020 at an LGC price of between $40 and $70 each.

As there are a number of renewable energy installations throughout the NT that are able to generate LGC's, the output of these installations can be deducted from the required liability (i.e. the NT already is generating a proportion of its liability). As a result of existing policy measures and market status, some further renewable energy systems may be developed between now and 2020 to further reduce the shortfall in LGC's required to be surrendered by 2020.

The table below provides an indication of the number of certificates likely to be generated yearly by the existing and planned renewable installations throughout the NT.This presupposes no significant external investment or subsidy from the Commonwealth via programs such as Alice Solar City, RRPGP, etc. between now and 2020.

TABLE 6-1: ***Existing and Planned LGC Generation Capacity***

Facility Name	System Size (kWp)	Technology Type	Yearly LGC Generation (MWh)	Year Commissioned
Kings Canyon	200	Fixed PV	320	2002
Hermannsburg	235	Concentrating dishes	500	2005
Shoal Bay Landfill	1,100	Landfill Gas	8,000	2005
Lajamanu	235	Concentrating dishes	500	2006
Yuendumu	235	Concentrating dishes	500	2006
DKASC				2008
Crowne Plaza	305	Fixed PV	510	2009
Alice Springs Airport	250	Concentrating Flat Plate PV	600	2010
Uterne Solar Farm	1,000	Tracking PV	2,200	2011
Ti Tree	324	Fixed PV	660	2011
Kalkarindji	402	Fixed PV	550	2011
Lake Nash	266	Fixed PV	440	2011
Araluen Arts Centre	150	Fixed PV	270	2012
Projected IES Systems	3,000	Fixed PV	6,000	2014
		TOTAL	**21,050**	

NOTE 1: The projected IES System is based on an assumed uptake of solar PV in to offset diesel generation at low penetration levels

NOTE 2: The PWC 30MW EOI has not been included at this stage as it is not yet apparent what the conclusions from this process will be

Based on the data above it is possible to estimate the Nett LGC shortfall and the potential shortfall cost of purchasing LGC's from interstate. The table below provides estimates of the total LGC liability for the NT in each year between 2012 and 2020 (the liability from 2020 to 2030 is not presently legislated to change) along with the estimated shortfall and an upper and lower shortfall cost estimation. It should be noted that these are estimates only and will change from year to year based on the level of load growth from other liable entities relative to those in the NT and has been included only as a high level indication of the potential costs.

TABLE 6-2: ***Estimated RET Liabilities and LGC Shortfalls***

Year	Estimated RET Obligations	Existing/Planned LGC supply	Shortfall	Lower Shortfall Cost ($40/LGC)	Upper Shortfall Cost ($70/LGC)
2012	119546	14,780	104,766	$4,190,654	$7,333,644
2013	133449	14,780	118,669	$4,746,751	$8,306,815
2014	117805	21,050	96,755	$3,870,195	$6,772,841
2015	131707	21,050	110,657	$4,426,293	$7,746,012
2016	150593	21,050	129,543	$5,181,707	$9,067,988
2017	184251	21,050	163,201	$6,528,049	$11,424,085
2018	217910	21,050	196,860	$7,874,390	$13,780,183
2019	251568	21,050	230,518	$9,220,732	$16,136,280
2020-2030	300000	21,050	278,950	$11,158,000	$19,526,500
			Total (at 2020)	**$57,196,771**	**$100,094,349**

NOTE: The liabilities above do not include the liabilities associated with small technology certificates. Small Scale Certificate Liabilities are currently being met though domestic solar hot water and PV installations.

From the table above it is clear that the "Do Nothing" option may result in the purchase of between $50M and $100M of LGC's from interstate between 2012 and 2020, representing a nett cost to the NT. This becomes the effective lower threshold for assessment of the relative benefits of actively intervening in the renewable energy industry.

6.3.2 INVEST NOW

The "Invest Now" option is effectively an immediate response to the challenge identified in the "Do Nothing" option, i.e. invest in whatever is currently the most affordable renewable technology today to ensure that there is no LGC shortfall between now and 2020.

Based on the analysis contained within the previous sections of this report, it is apparent that the most economically and technically viable technology currently available for use within the NT is solar PV; consequently it is necessary to determine exactly how much solar PV would be required to be installed to offset the estimated LGC Shortfall.

Table 6.2 indicates that by 2020, the annual LGC shortfall is estimated to be 278,950, i.e. 278,950 MWh of Renewable Energy. To generate the required LGC's from fixed PV systems, a total of 160MWp[27] of PV will need to be installed across the NT.

$$\frac{278{,}950MWh}{1.75\ {}^{MWh}/_{kWp}} \approx 160{,}000kWp$$

While it may be tempting to simply consider installing the entire 160MW of PV at the end of the Darwin-Katherine Interconnected System in order to achieve the greatest economies of scale, practical considerations such as line capacity, voltage regulation, and grid stability associated with intermittency (as discussed in Section 5.2) prohibit this. Consequently, given the design of the various grids within the NT, for the purposes of this analysis it is assumed that the average size of installation will be between 1MWp and 5MWp.

At current market rates, it is reasonable to estimate that, with effective bulk procurement frameworks, 5MWp installations could be constructed for an average of approximately $4.00/Wp, or $4.0M/MWp (this presumes no storage). This implies that an investment of approximately $640M would be required to construct 160MWp of PV, thus offsetting the LGC shortfall. Given that the

27 Typical fixed PV systems are able to generate approximately 1.75MWh/kWp installed whereas tracking PV systems are able to generate 2.1MWh/kWp installed. While tracking PV systems are able to generate more energy per unit installed (MWh/KWp), they also cost more per unit ($/KWp). At current market prices there is a relatively small difference in actual generation cost $/MWh, so, for the purposes of this scenario we will only consider fixed PV systems.

construction of the renewable energy power systems generates savings, or revenue, as the result of the displacement of fossil fuel generation, real “additional” cost of the investing in the 160MWof PV systems is determined by using the following formula:

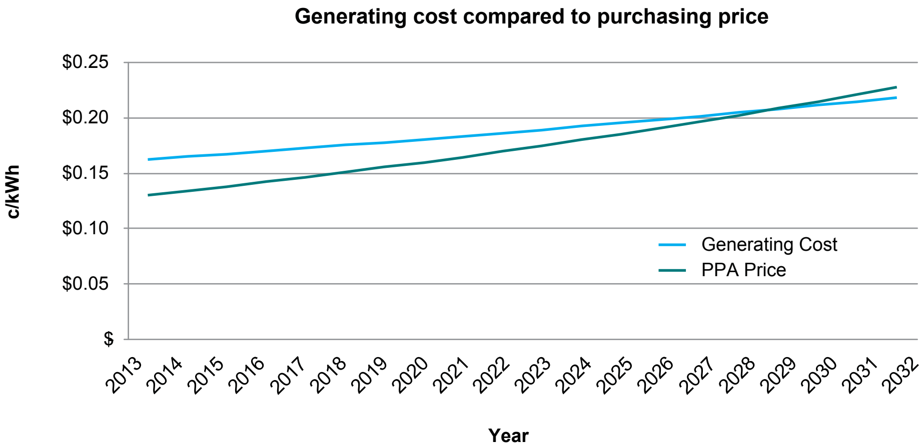
$$Cumulative\ Revenue\ Shortfall = \sum_{2013}^{2020}(Capex\ Finance\ Repayment + OPEX) - \ XMWh * \$130$$

where $130 is the avoided cost of generation with natural gas per MWh

In the vast majority of renewable power systems within the NT, the construction and operation of the power station is managed under contract between PWC and the power station owner through a Power Purchase Agreement (PPA). The PPA is a simple agreement detailing the agreed amount the Principal (PWC) will pay the Supplier (power station owner) for each and every MWh over a defined time period – generally 15-20 years.

While PPA’s are not the only, or always the most appropriate, frameworks for provision of energy services, for the purposes of this analyses we will assume that all the solar PV systems are built, owned and operated under PPA’s with PWC, or indeed any other energy retailer/consumer, within the NT. As noted previously, the renewable energy systems do not need to be connected to the same grid or region in which the RET liability is generated; however, as each grid or power system is unique, the marginal cost of generation, and therefore the potential PPA price at each location, will be different. As a result, an assumed PPA price of $130/MWh (excluding LGC’s) has been used.[28] The financial principles detailed above apply for both the circumstance where PPA’s were entered into for the construction and operation of the renewable energy systems, and where the grid operator(s) borrowed money at commercial rates to finance the construction of the power station and offset re-payments with money saved from other generation sources.

Taking all of the above into account, as well as underlying assumptions regarding the cost of operation, land lease costs, depreciation, tax, indexation etc, it is possible to then develop a model that highlights the required revenue in order for the solar PV power stations to be commercially viable and then compare that to the actual revenue that could be generated from a PPA at costs reflecting the marginal cost of generation on gas grids as shown in the following graph. Details of the model assumptions are included in Appendix 8.2.



65 Solar PV generating cost relative to PPA price

28 While there are many power systems within the NT where the marginal cost of generation is higher than $130/MWh, the installed capital cost also tends to be higher: consequently, for the purposes of developing a revenue gap assessment, rather than an assessment of absolute capital cost, $130/MWh is still an appropriate baseline.

As can be seen from the graph above, if the plants commenced operation in 2013, there is a difference between the avoided cost of generation (i.e. the PPA Price PWC would be willing to enter into) and the minimum revenue required for the solar power stations to be viable. The cumulative value of this shortfall in revenue for renewable energy power station operators between 2013 and 2020 is between **$145M** and **$200M**. Assuming that the LGC's generated from the plant are sold at the lower end of estimated market prices, i.e. $40/LGC, there will be a remaining cumulative revenue shortfall for the renewable energy technology proponents between 2013 and 2020 of between **$60M** and **$110M**.

More specifically, it is estimated that for the NTG to implement an "Act Now" strategy, utilising existing technologies would require between $60M and $110M cumulative subsidy between 2013 and 2020.This subsidy could be provided in a variety of ways, including Feed In Tariffs, Concessional Loans, or capital grants. Regardless of which mechanism is selected for provision of the subsidy, it is this final shortfall against which the merits of investing in renewable energy in the NT should be assessed[29].

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

In preparing the Second Report, the Taskforce considered a variety of data sets and information sources, as documented within the balance of this report and associated appendices, and has developed a series of conclusions underpinned by the following assessment of the existing energy market:

- Within the regulated energy market (DKIS, Alice Springs, Tennant Creek) there is enough existing and planned generating capacity to meet anticipated demand for peak load and energy beyond 2020;
- Liable entities within the NT, predominantly PWC, have a renewable energy target obligation (RET) that rises to approximately 20% of demand by 2020 (approximately 300 GWh), and the cost will be passed through to all consumers, subject to regulatory approval.
- The obligation exists only for retailers within the DKIS;
- PWC, or other liable entities, could meet that obligation by generating renewable energy itself, buying renewable energy from other parties, located in the NT or elsewhere, or Large Generating Certificates on the market: regardless of the source of the LGC's it is estimated that by 2020, the direct cost of meeting this obligation will be between $12M and $21M annually; and
- Generation Utilities, utilising fossil fuels, including natural gas, will have an obligation to purchase emissions permits under the proposed Clean Energy Act 2011 (initially at the rate of $23/t of CO_2e). This will increase electricity generation costs this cost increase will also be passed through to all consumers.

The NT Government has expressed a desire for the RET obligation to be met from sources within the NT, in order to maximise the benefit to the NT of expenditure required to meet these obligations, and has sought advice from the Taskforce to facilitate the uptake of renewable energy.

29 This modeling is very general in nature and is included only to provide an indication of the scale of the potential costs rather than a definitive forecast of future costs

The analysis conducted by the Taskforce of the current and near-term status of the technologies suggests that:

- Wind, although relatively mature, is likely to be of marginal value due to the relatively low quality of the resource in the NT;
- Geothermal has significant long term potential for the NT, but is relatively immature and it is unlikely that this status will sufficiently change in the medium term that geothermal will be able to make a material contribution toward the 2020 objective;
- Hydro is undeveloped and even if the environmental implications could be managed would, due to both terrain and the seasonal variability in rainfall, be a marginal technology at best for NT;
- There are reasonable efforts being undertaken to pursue tidal energy within the NT; however, it is unlikely to be sufficiently prospective in the medium term to meet the target;
- Biofuels and biomass have a number of technical and economic hurdles to overcome, rendering them unlikely to contribute at a commercial scale in the medium term;
- Solar thermal is approaching a stage where it could be deployed in the NT: the best prospects would be in combination with gas generation (to overcome the intermittency). The costs are still high but they are decreasing; and
- Solar PV is relatively developed and the NT has an abundance of the solar resource: intermittency and cost remain the major barriers to widespread uptake in the short term.

Further to the technical and resource barriers noted above, additional conclusions reached by the Taskforce are as follows:

- The overall regulatory and resource environment is not specifically restrictive to the uptake of renewable energy, nor is it specifically attractive for renewable energy proponents;
- There are, however, a number of policy areas that may need to be addressed in the longer term if some of the renewable energy technologies are to be further developed. These include:
  - “Right of Access” sources of renewable energy as part of the planning scheme;
  - Land Tenure and Land Use limitations;
  - Environmental assessments for renewable energy projects;
- To date, it appears that PWC has shown a willingness to undertake renewable energy projects, within the framework of a power purchase agreement (PP), when a fair and competitive price is offered. A general barrier to determining a fair and competitive price by renewable energy technology proponents and developers is the limited understanding of the real marginal costs of generation within the NT energy markets;
- The NT has high energy generation costs already and a substantial Community Service Obligation (CSO) budget commitment thus providing significant incentive to explore opportunities for reduction in energy consumption and pursuit of alternative generation sources;
- In areas, such as mine sites or large commercial buildings, where the marginal costs of supply would otherwise be considered to be high enough to support the uptake of renewable energy, other constraints exist, including access to capital and overall project risk, that have limited the uptake of renewable energy;
- Significant contributions of energy from intermittent renewable sources such as solar photovoltaic (PV), where storage is not included at single locations could present significant network stability issues for the network operator, implying that distributed, smaller sources would be more effective;

- In 2011, the cost of the most developed renewable technologies, relative to the marginal cost of generation within the regulated market, means that the NT Government would have to provide a substantial subsidy, by way of capital injection or ongoing price support, to meet the objective of meeting the RET obligation from NT sources by 2020; and
- It is estimated that the cumulative value of this subsidy between 2013 and 2020 would be between $60M and $110M.[30] This may change in the medium-longer term as the renewable technologies develop further and the cost of fossil fuels rise with global forces and emissions constraints.
- Given the time frames for infrastructure planning, investment and construction, action to develop and implement a policy intervention, should it be required, would need to commence by 2015 in order for it to be fully implemented and the benefits realised by 2020.

Extended commentary and caveats to the conclusions noted previously are detailed below. Specifically, given the medium-term objective of meeting the 300GWh 2020 RET target with NT sources and the longer-term objective of facilitating the uptake of renewable energy across the NT, some renewable implementation models, including household PV, have not been specifically considered due to their inability to contribute to the 2020 target.

More generally it was noted by the Taskforce that, to date, there has not been significant interest from third parties to enter into the NT market . This is generally assumed to be a result of the relatively small market in relationship to the costs of establishing a market presence; however, Q Energy has now established itself as an alternative retailer within the Darwin region. Further to this, the majority of renewable energy systems connected to the grid are either privately owned, nett metered, installations reducing an individual consumer's (person or company) demand, or installations built under the framework of a PPA.

Given that this has been the case for some time, there remains a questions as to whether it is likely within the foreseeable future that genuine competition will emerge within the NT market, and if so whether it is likely to facilitate the uptake of renewable energy.

As noted elsewhere, there are also significant technical barriers associated with installing large amounts of renewable energy at a single point within a grid, i.e. greater than 30MW, and consequently, for intermittent technologies such as wind and solar PV, a larger number of geographically dispersed installations would be more stable.

Further, if it is assumed that within the foreseeable future substantive competition will not be present within the NT electricity market, then it is implied the PWC will need to become the principal purchaser of on-grid renewable energy, or at very least will have to be actively involved in facilitating its uptake. The recent call for Expressions of Interest for provision of up to 30MW of renewable generation on the DKIS by PWC is an important first step.

Consequently, there are two policy options:

1. "Do Nothing": Assuming no further development of renewable energy within the NT, purchase sufficient LGC's to meet the 2020 liabilities from a combination of existing or planned renewable power systems with the balance procured interstate at an estimated cumulative cost to 2020 of $58-$100M; or
2. "Invest now": build up to 160MW of solar PV systems in modules of approximately 5MW distributed throughout the various NT networks and grids in order to meet the entirety of the 2020 RET liabilities from NT Sources. This will require provision of financial support or subsidies to cover the shortfalls in revenue between the cost of construction and generation versus the likely income streams. The estimated cumulative value of the subsidy, over and above the value of the LGC's, is between $60M and $110M.

30 Note: these figures are currently only indicative and should be confirmed or amended on the basis of additional review and modelling. Were this further review to suggest that the subsidy is more likely to be at or below the lower figure, then the Taskforce would recommend that the Government intervene to specifically subsidise solar thermal or solar PV, to address its twin objectives of meeting the RET liability from NT sources and developing the Territory's renewable energy industry.

In this light, it is the view of the Green Energy Taskforce that given the rate of change in cost for various technologies, in particular solar PV and balance of system costs including storage, and the rapidly changing external policy environment, there is a strong likelihood that the attractiveness of various renewable technologies will materially increase over the coming years and that, subject to removal of identified non-economic barriers, there is a reasonable probability that either:

a) There will be a natural increase in the uptake of renewable energy as a result of increasing economic viability; or

b) If the level of investment is still not sufficient to meet the entirety of the 2020 RET liability from NT sources, the cost of intervening will be substantially lower than at present;

and therefore it would be inappropriate to recommend an investment in any one technology at this point in time.

This does not, however, preclude investment providing support for appropriate demonstration projects and will require a formal review of the state of renewable investments no later than 2015.

Of potentially greater significance, however, are the challenges associated with implementing renewable energy in environments or sectors where it can be shown that the LCOE of a renewable energy is below the marginal cost of generation. Yet there has been little or no historical uptake of renewable energy, e.g. at mine sites.

The Green Energy Taskforce has also concluded that there is a unique opportunity to work with renewable energy developers, mining companies, and Power Water Corporation to develop effective mechanisms to support the uptake of renewable energy in the mining sector.

Finally, it was noted that, beyond the specific challenges of meeting the RET obligation by 2020, the NT has unique access to renewable resources such as solar and, as such, the NT Government can play an important role in facilitating and enabling the development of renewable energy technology through research and demonstration.

7.2 RECOMMENDATIONS

The Green Energy Taskforce has identified a number of key recommendations that would assist the NT in meeting the objective of meeting the 2020 Renewable Energy Target from Territory-based sources. The recommendations are relatively concise as the Green Energy Taskforce found that, in general, there are few specific barriers to the uptake of renewable energy beyond those associated with cost. Consequently the recommendations are skewed to ensuring the NT is able to prepare early, and respond quickly as new technology opportunities arise.

Additionally, throughout the preceding analyses, there are a number of opportunities highlighted. Not all opportunities that have been identified have been specifically listed as recommendations. In some cases, this is because the opportunity is not specifically an action within the remit ofthe NT Government but rather an opportunity for an individual or investor. Some opportunities have been bundled together into more general recommendations to ensure conciseness.

Given the conclusions noted, above the Green Energy Taskforce recommends that the Northern Territory Government:

1. Not intervene directly to subsidise renewable energy at this point in time. Rather it should continue allow market participants to make commercial decisions in the context of the RET and emissions trading legislation. This would mean not actively pursuing, through direct financial support, the objective of meeting the 2020 RET target from NT sources at this time;

2. Support the development of a detailed strategy for engaging and developing an active partnership with the Commonwealth Government in order to ensure that the NT is able maximise the leveraging of Commonwealth funds from programs, including the Australian

Solar Institute (ASI), the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC), for investors in renewable energy within the NT. Outcomes of this strategy should specifically include the following:

a) Active facilitation and support for a large solar project that is able to meet the eligibility criteria for Round 2 of the Solar Flagships program, including, where necessary, advocacy for program criteria that accommodate the specific challenges of developing large projects within the NT; and

b) Development of innovative investment support structures that, in conjunction with the CEFC, seek to remove risk barriers in environments that would otherwise have compelling economic justifications for renewable energy , namely sites with high marginal costs of supply such as mine sites, hotels, warehouses and shopping centres;

3. The Government should maintain a formal watching brief on technology developments for solar PV, solar thermal and geothermal as well as monitoring other drivers of the NT energy market, including natural gas prices and movements in LGC and Emission Trading Scheme (ETS) permit prices. Such developments will require a detailed review of Recommendation 1. This should be facilitated through a detailed review and revision of this report in the following years:

   a) 2013 – with a view to monitoring the impact of the carbon tax and the establishment of ARENA and the CEFC, and making a detailed assessment of those technologies that have proceeded further in the development cycle, most specifically solar thermal as well as a concurrent assessment of the broader community benefits of investment in renewable energy generation; and

   b) 2015 – with a view to developing a detailed costing framework for intervention and support of renewable energy to achieve the 2020 RET target, where there remains a gap in investment or an imperative to close such a gap.

4. Support the development of a comprehensive R&D strategy for renewable energy within the NT, with a view to making the NT a Centre of Excellence for Renewable Energy deployment in tropical and arid environments, including:

   a) Support for existing research into potential bio-fuel sources such as Pongamia;

   b) Support for ongoing research into implications of higher penetrations of intermittent renewable energy such as PV on grids;

   c) Positioning the CDU as a hub for warm water tidal and wave power research;

   d) Develop a working group within the NT to monitor technology development and investment flows in order to ensure the NT is able to respond rapidly;

   e) Work with Geosciences Australia, CSIRO and AEMO to develop and maintain extensive resource datasets for the NT including biofuels and biomass, wind, and particularly geothermal;

5. Create an effective and attractive investment environment by:

   a) Continuing to work with the Utilities Commission to ensure the efficient development of the electricity energy sector within the NT, allowing for fair competition across technologies and removing any barriers to entry to new technologies and/or market participants;

   b) Actively engaging with the Commonwealth Government to ensure thatprograms such as Solar Flagships are able to be implemented within the NT;

   c) Developing an appropriate regulatory framework for encouraging new mine sites to adopt renewable energy as part of their power generation capacity; and

d) Work with native title agencies, NGO's, government departments and other land management stakeholders to develop an effective regulatory framework to support land and resource access for renewable energy, in particular

   i. Marine access rights for tidal and wave power generation; and

   ii. Reducing land use restrictions for pastoral lands where biomass or bio fuel could be generated

The above recommendations are based on the absence of an over-arching policy rationale to subsidise renewable energy in the Territory; however, should the Government determine that it does wish to actively intervene in the energy market to ensure that the 2020 RET liability is met from NT sources, the Taskforce recommends that the Government:

a) Utilise an open tender/bidding process for supply of renewable energy systems able to meet some or all of the RET liability at 2020;

b) Ensure that the tender/bidding process allows for any renewable technology, subject to technical requirements for connection and integration, but noting that it is considered likely that solar PV, possibly thermal could emerge as the most likely candidates; and

c) Leave the structure of its support (e.g. block grants, tariff support, loan guarantees) open to proponents in order to ensure that the most efficient and lowest cost outcome is achieved.

8. APPENDICIES

8.1 GAS ENERGY INFRASTRUCTURE

The backbone of the Territory's energy network is the gas pipeline from Darwin to Alice Springs and the McArthur River Mine with extensions to Wadeye and Hermannsburg currently being considered.

This gas network provides fuel to the electricity generation power plants and also supplies gas for large industrial customers.

Our gas supply comes from the Blacktip field in the Bonaparte Basin which is located within Northern Territory waters. There is sufficient supply to fuel the Territory's needs for the next 25 years.

Since the mid 1980s and prior to Blacktip gas coming on line in 2009, gas was sourced from central Australia (Palm Valley/Mereenie) and supplied via the Amadeus Basin to Darwin pipeline.

It is the second longest pipeline in Australia and delivers over 20PJ of natural gas to the Power and Water Corporation for electricity generation. The Amadeus Basin to Darwin Pipeline is a covered pipeline under the Gas Access Code, and tariffs are regulated in accordance with our Access Arrangement.

Gas also comes from the Bayu-Undan field to Darwin LNG (Conoco Phillips); however, all of the gas is committed for export. There is also a connection to the Darwin to Amadeus pipeline to provide backup gas if required.

The Northern Territory has a limited natural gas distribution network ,supplying commercial and residential customers. There is a small reticulated natural gas network in Alice Springs, supplying 983 residential customers and 97 industrial and commercial customers. Envestra's gas distribution network in Alice Springs comprises 37.56 kilometres of gas main (31.2 km's in Alice Springs North, and 6.36 km's in Alice Springs South).

There is also a small natural gas reticulated network in Darwin, originating at the Darwin City gate (a pressure reduction station, 11 km's east of Channel Island) to Berrimah Gaol, the Darwin bio-fuel plant (Vopak, at East Arm Port), the Trade Development Zone, and a galvanising plant in Berrimah. There is also a small LPG reticulated network supplying hotels along the Esplanade in the Darwin CBD.

8.2 ECONOMIC MODELLING ASSUMPTIONS

8.2.1 COMPARATIVE ANALYSIS OF LCOE FOR VARIOUS GENERATION TECHNOLOGIES ASSUMPTIONS

Levelised costs of energy (LCOEs) are a benchmark indicator for comparing the relative costs of generation from different technologies. It is a method to enable comparisons where the fixed and variable cost profiles differ amongst the technologies. In one sense, it represents the average cost of generation over the life of the technology. It also represents the price required to be achieved in order to make an investment in the technology economic.

The levelised cost of energy can be calculated by:

$$LCOE (\$/MWh) = \sum(C_t/(1+i^t))/\sum(G_t(1+i^t))$$

Where C_t = Cost in year t (capital and operating cost) in \$, G_t = generation in year *t*, and *i* = discount rate (weighted average cost of capital). The calculation is undertaken for the assumed life of the project

The key structural and economic assumptions underpinning the calculations of the LCOE include:

- Weighted average cost of capital of 11.6% (based on 60:40 debt to equity ratio, 16% (real) return on equity and 8% (real) return on debt.
- Emission intensity of natural gas of 51 t CO_2e/PJ combusted.
- Capacity factor set at 57%. For intermittent renewable energy generation that has a lower capacity factor, the difference is made up of purchases of gas-fired generation for back-up.
- Carbon prices start at \$23/t CO_2e in July 2012, rising at 2.5% per annum in real terms to July 2015, after which prices increase by around 4.5% per annum in real terms. Based on these assumptions, carbon prices reach \$33/t CO_2e in 2020, \$52/t CO_2e in 2030 and \$125/t CO_2e in 2050.
- Gas prices set at world benchmark levels, which is currently at \$7.50/GJ well head plus \$0.50/GJ for transmission. The price is assumed to increase 1% per annum in real terms.
- Biomass fuel costs set at \$4.00/GJ for waste products and \$10.00/GJ for energy crops.

Technology assumptions are outlined in the following table.

	Life, years	Sent-out Capacity, MW	Capital Cost, 2011, $/kW sent out	Capital Cost Deescalater, 2010 to 2020, % pa	Capital Cost Deescalater, 2021 to 2030, % pa	Thermal Efficiency, %	Efficiency improvement, % pa	Variable Non-Fuel Operating Cost, $/MWh	Fixed Operating Cost, $/kW
Natural gas									
CCGT	30	54	1,691	0.3	0.3	49	0.60	6	44
OCGT	30	34	1,220	0.3	0.3	33	0.60	3	20
CCGT with CC	30	44	3,552	1.0	0.3	28	0.70	10	70
Renewables									
Wind	25	30	3,075	1.0	0.5		0.20	2	35
Biomass	25	27	5,433	2.0	1.0	28	0.10	8	70
Solar thermal plant	20	50	6,663	3.0	1.0			8	70
Solar thermal plus storage	20	50	8,200	3.0	1.0			8	70
Geothermal	25	50	7,175	2.0	0.5	30	0.10	8	90
Flat Plate Tracking PV	30	50	5,638	2.0	1.0	25	0.10	3	50
Rooftop PV	30	2	6,329	2.0	1.0	25	0.10	3	50
Tidal	30	49	10,250	3.0	1.0	25	0.10	3	70

CCGT = closed cycle gas turbine; OCGT = open cycle gas turbine; CC = carbon capture

8.2.2 "INVEST NOW" LIFE CYCLE COSTS ASSUMPTION

General Inputs	
Indexation	3.00%
Inflation	3.10%
REC Inflation	0.00%
Tax	30.00%
Weighted Average Cost of Capital	11.20%
Cost of Equity	16.00%
Franking	70.00%
System size (kWp)	160000
System output (kWh/pa/kWp)	1750
installed cost ($/Wp)	3.50
Capital Cost	
Power Station	560,000,000
Other Costs 1 (insert description)	0
Other Costs 2 (insert description)	0
Total Capital	560,000,000
Grant	
Total Proponent Contribution	560,000,000
Annual Ongoing Costs (initial year)	
Operating & maintenance	3,200,000
Additional operating costs	0
Insurance	320,000
Warranty	0
Lease of land	320,000
Financing	
Debt	100%
Interest Rate	7%
Loan (years)	20
Power Value	
SPS Output per annum (kwh)	280,000,000
Output degradation per annum	1%
PPA Purchase price ($/kWh)	0.13
REC Starting Price ($/MWH)	0
Useful Life	
Contract Term	20
Tax Life	20
Depreciation per annum	28,000,000
Start Date	1-Jul-10
Terminal Value (% of cost)	0%