Port Augusta Solar Thermal Generation Feasibility Study

Project Definition Report

February 2013

A project jointly funded by:

- Alinta Energy
- Australian Renewable Energy Agency, Emerging Renewables Program
- Government of South Australia, Enterprise Zone Fund

For more information:

www.alintaenergy.com.au/Port-Augusta-Solar-Thermal-Generation-Feasibility-Study

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Acronyms

AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
CAPEX	Capital expenditure
DNI	Direct Normal Insolation
EIS	Environmental Impact Statement
GIS	Geographic Information System
LRMC	Long run marginal cost
MLF	Marginal Loss Factor
MW	Megawatt
NPS	Northern Power Station
OEM	Original Equipment Manufacturer
OPEX	Operational expenditure

1 Company Overview

Alinta Energy holds a portfolio of diverse assets serving retail customers, operating generation, managing fuel sources and transportation, building new infrastructure, and ensuring competitive prices through wholesale market operations.

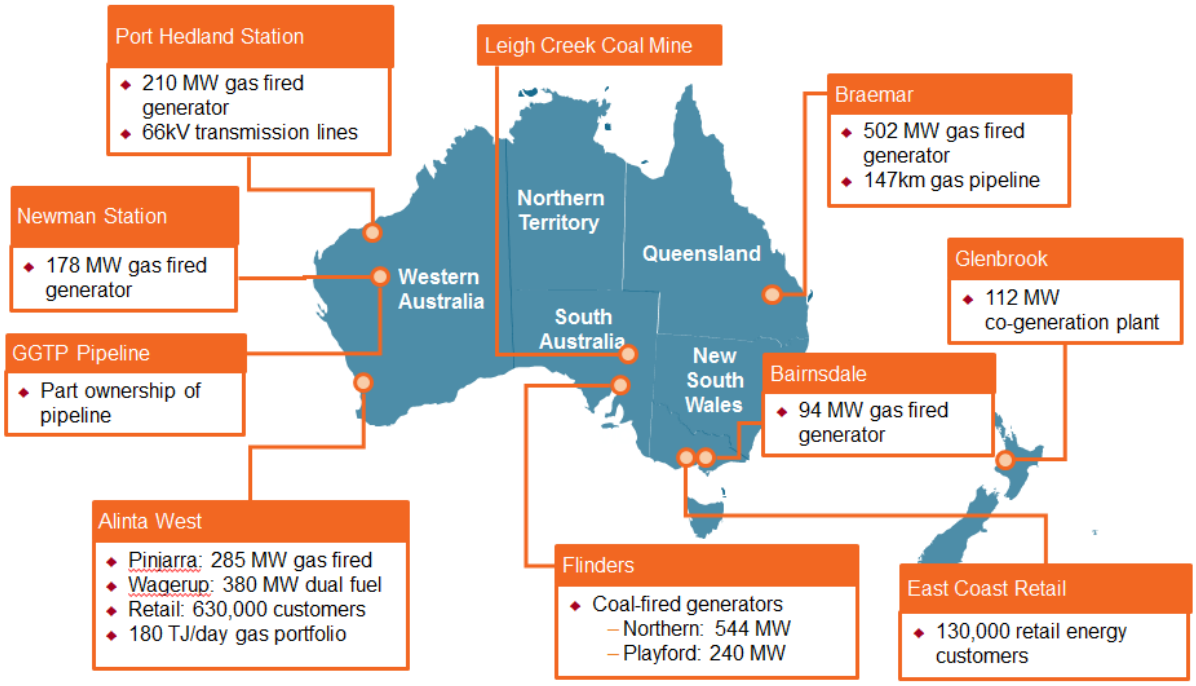
Alinta Energy operates across 14 geographic locations in Australia and New Zealand with a long history, including assets dating back to 1941, and a legacy shaped by a series of mergers, acquisitions and divestments since 1995.

Alinta Energy is an emerging electricity retailer on Australia's East Coast, with a growing number of South Australian and Victorian customers, and a progressive strategy to move into other markets on the Eastern Seaboard.

Alinta Energy also has a significant business position in Western Australia as a natural gas retailer to more than 630,000 customers, one of the main independent power generators in the Pilbara region and a significant wholesale gas portfolio including pipeline interest.

While Alinta Energy has nine power stations with more than 2,500MW of installed generation across Australia and New Zealand, the most sizeable asset, and where the largest numbers of employees are based, is its power station assets located at South Australia.

The Augusta Power Stations, as they are commonly known, is an integral part of Alinta Energy's operation and exerts a significant influence on the culture of the organisation. The long term development of the August Power Station assets is critical to Alinta Energy's future.



2 Project Overview

2.1 Project Background

Alinta Energy owns and operates Northern Power Station 1 and 2, and Playford B Power Station located at Port Augusta and collectively referred to as the Augusta Power Stations.

- The Northern Power Station 1 and 2 are 272MW unitised coal fired boilers, commissioned in 1986 with an emissions intensity of approximately 1.1tCO_2/MWh.
- The Playford B Power Station is comprised of 6 x 40MW range boilers and 4 x 60MW range steam turbines with a maximum capacity of 240MW and an emission intensity of approximately 1.5tCO_2/MWh.

The Augusta Power Stations are base load thermal coal generation supplied from the Leigh Creek coal mine. The coal is shipped via rail line on a daily basis.

In light of climate change policies and the growth in renewable energy investment opportunities, Alinta Energy undertook a Solar Concept Study to assess the viability of solar generation in Port Augusta and Leigh Creek. The Solar Concept Study made a number of clear conclusions.

- South Australia is a high quality location for solar thermal.
- Leigh Creek and Port Augusta sites have been identified with sufficient solar resource.
- Stand-alone concentrated solar power based on parabolic trough, linear Fresnel and power tower are all feasible.
- Potential for hybrid configurations at Northern Power Station and possible use of Playford facility/components.
- Thermal storage should be considered and incorporated into final designs so the plants are “dispatchable”.
- Solar thermal matches South Australian generation profile and provides a balance to significant wind resources in the region.

Following assessment of the Solar Concept Study Alinta Energy concluded further analysis of potential solar investment in the region was justified and approached the Commonwealth and State Governments to seek co-funding of a full feasibility study.

2.2 Project Objective

The *Port Augusta Solar Thermal Generation Feasibility Study*, will

a) Undertake a full feasibility and technological analysis of solar thermal power generation, including hybridised and standalone options, over the Port Augusta Power Stations (Northern Power Stations 1 and 2, and Playford B Power Station); and

b) Improve the coordination and collaboration between governments, fossil fuel based power generators, the solar thermal industry and broader renewable energy industry through data collection, analysis, public engagement and knowledge sharing activities.

2.3 Project Description

Alinta Energy is seeking to progress the project by undertaking a full feasibility and technological analysis of solar thermal, including hybrid options.

- The value and intensity of the solar resource on site.
- The viability of integration with existing thermal coal infrastructure of solar thermal technologies.
- Tailored technological developments consistent with integration of ongoing brown coal generation for the purposes of progresing a hybrid model.
- Back-up steam to support gas generation units at minimum generation to improve efficiency or lower fuel consumption at times of high generation.
- Grid connection feasibility.
- Scale options at the Port Augusta site.
- Progressing commercialisation and quantifying the financial gap that cannot be funded commercially through debt and equity.

2.3.1 Project outputs

There are a range of outputs with the key outputs listed below.

- Project Definition Report, 31 December 2013.
- Options Study, 30 April 2014.
- Siting Study, 30 April 2014.
- Balance of Study Report, 31 December 2014.
- Full Feasibility Scoping Paper, 30 March 2015.
- Full Feasibility Study Report, 31 December 2015.

2.3.2 Dependencies and related activities

The project has a number of key dependencies.

- Australian Renewable Energy Agency funding application – $1,000,000.
- Enterprise Zone Fund – Upper Spencer Gulf and Outback funding – 132,141
- Engagement and support of Port Augusta City Council.
- Engagement and support of the State of South Australia.
- Interest of potential commercial and technology partners.

2.4 High Level Project Assumptions

There are a number of high-level assumptions underpinning the study.

- The location of the Augusta Power Station, and in the vicinity of the facility, is suitable for the siting and development of a solar thermal facility.
- Alinta Energy understands the current arrangements for land tenure permit the siting and development of a potential solar thermal facility on land within the control of Alinta Energy or adjacent to subject to the Sale / Lease arrangements between Flinders Power Partnership and the Government of South Australia.
- The life of the Leigh Creek Mine, which supplies coal to the Augusta Power Stations, will be extended through further investment by Alinta Energy.
- The Augusta Power Stations will remain in operation, in their current form supplied by the Leigh Creek Coal Mine, until at least 2028 to 2032.
- The useable life of the Augusta Power Stations, including re-use of facility components, extends beyond the current expected life of the Leigh Creek Mine.
- The pre-measure activities and studies relied upon in the development of this study which detail the potential value and strength of the solar resource, the potential for hybrid solutions, and the potential utilisation of components from the Playford B Power Station is the best estimate and advice of the respective experts.
- The range of project benefits, fuel diversity opportunities for South Australia, dispatchable energy potential, compatibility with South Australian energy system, network connection options, technology costs and acceptable technology types do not materially deviate from those understood at the commencement of this study.
- Progress beyond the study will depend on a number of factors outside the scope of this piece of work which have not been estimated or modelled at this point in time.

3 Business Case

In South Australia, Alinta Energy owns and operates Augusta Power Stations comprising Northern Power Stations 1 and 2, and Playford B Power Station and runs the Leigh Creek Coal mine.

There is a strong case that solar thermal capability can be intergrated with existing site and either: (a) connected to the grid drawing upon surrounding supporting infrastructure; or (b) supplement the existing generation unit operations to form a hybrid brown coal / gas and solar system.

Alinta Energy's initial analysis indicates that the development of a hybrid system, while presenting a number of engineering challenges, is an achieveable objective at Port Augusta and further feasiblility work will deliver a range of innovative developments in the area of solar thermal integration.

Alinta Energy's initial analysis suggests potential for use of components of the existing Playford B Power Station in the construction of a solar thermal facility.

3.1 Expected benefits

Impacts on Augusta Power Stations

The specific benefits for Alinta Energy are immediately apparent and underpin much of the company's ongoing interest in investment in a solar thermal facility in South Australia.

- Solar thermal matches high production periods at Augusta Power Stations where there will be additional upside in increasing the amount of energy delivered from Augusta Power Stations into the market.
- Extends economic life of Augusta Power Stations and Leigh Creek Mine as solar generations reduces the dependence on brown coal from 100 per cent of production to a lesser amount. Allows for optimisation between fuel sources that is currently not permissible or seen in the Australian market.

Increasing Australia's knowledge of technical developments and expertise in renewable energy

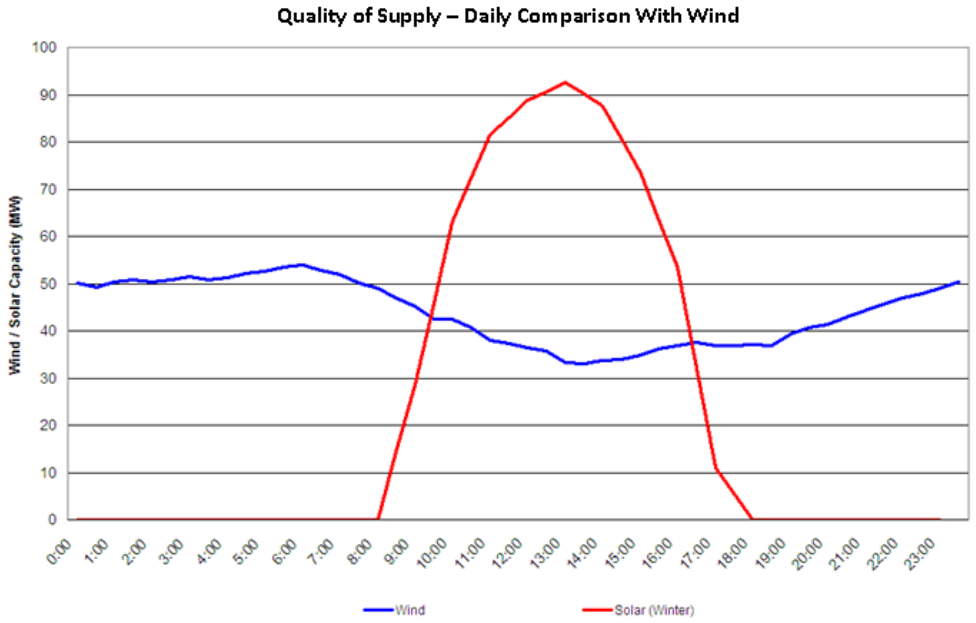
The knowledge and expertise that would be derived from the feasibility process, including the hybrid options, and any further demonstration developments will allow for absorption of the findings of the study into the solar thermal industry. This is particularly significant given the potential flow-on to coal plants throughout Australia.

It is Alinta Energy's view that a hybrid option that uses a singular unit, including turbines and boilers, to draw on steam generated by both coal-fired and solar thermal sources, as will be scoped during the feasibility study, is not presently in existence in Australia.

This knowledge gap will be bridged by the feasibility study and is an important step in identifying existing opportuntities for thermal coal generation to extend plant life, reduce emissions and facilitate the integration of solar thermal plant at least cost.

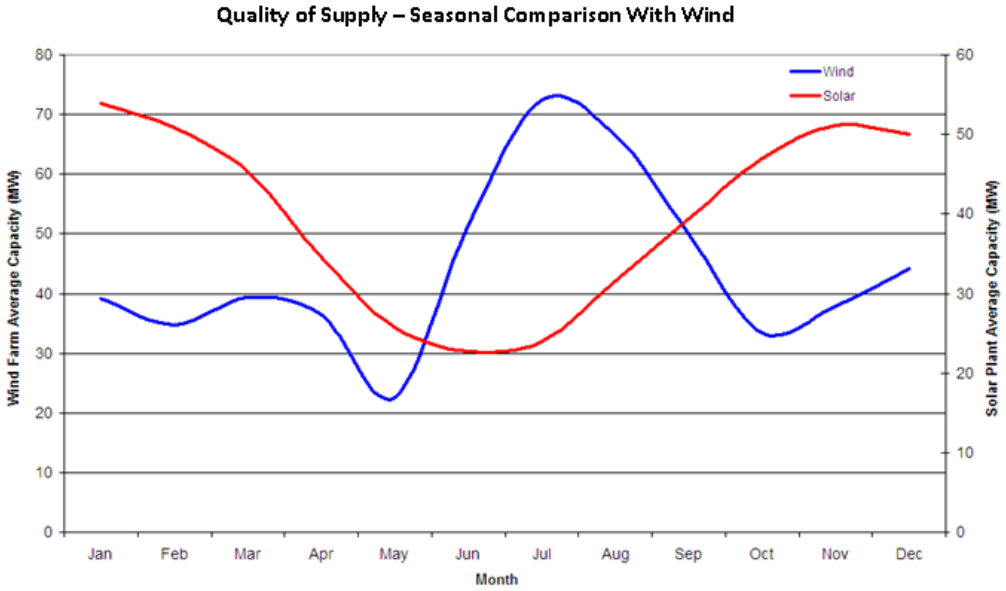
Electricity Market Dynamics

Renewable energy investment has higher long-run costs to consumers but is associated with lower short-run costs. In this regard, a solar thermal plant is similar to a wind farm; however, unlike wind, solar in South Australia provides a better complement to the current asset base and generation profile and better aligns with periods of peak production.



- A solar invesment will increase generation diversity and reduce the impacts of excessive wind in South Australia.
- A solar facility will increase efficiency of Augusta Power Stations and improve energy security by diversitying the renewable generation portfolio in South Australia It is currently not feasible for Alinta Energy to run its baseload assets throughout the autumn and spring periods which raises energy security concerns.
- A South Australian solar facility better matches peak demand which may reduce network investment costs for reliability and can be accommodated without additional augmentation
- A solar facility provides additional low cost supply across the inter-connector; however, will be more reliable than wind.
- Will have a marginal increase on hedge contract liquidity.
- Reduces emissions profile of South Austrtalian region at times of peak demand.

- Additional provision of ancillary services not natural to wind but required to stabilise the power system. This has a wider benefit but may have some small revenue upside for Alinta Energy.
- Delays need for additional investment that would most likely be wind in South Australia funded by the Renewable Energy Target or additional thermal generation.



Regional investment

Alinta Energy has a long corporate history with the surrounding community and industry and is looking at opportunities to invest in power generation in Port Augusta.

In Alinta Energy's view there are a number of methods to invest in the power generation sector in the area beyond the current projected life of the existing thermal coal generation facility. Incorporating renewable energy assets into the existing generation base is one of these. Given existing policy settings the benefits of a solar thermal plant have been investigated by Alinta Energy and form the most immediate opportunity to increase Alinta Energy's investment profile in the region.

The project can be broadly summarised in three overarching steps: pre-construction, construction and operation.

The plant once operational will require staff and service providers to operate and service the facility. This will complement the skill base of the local workforce, create additional employment opportunities and support the community.

The construction stage will involve the creation of a number of temporary construction jobs as the solar thermal unit is constructed on-site. This will also involve an additional demand for support services for visiting companies and temporary employees.

Pre-construction involves assessment of the solar resource, available land, financial viability, technology selection and in this case options for integration with existing power generation assets.

This pre-construction stage is the subject of this application and is required to progress this opportunity. The local industry will be required to assist in the provision of services to the pre-construction stage.

Non-market benefits

There is a range of non-market economic benefits associated with the project.

- Utilisation of existing social and physical infrastructure
- Spill-over benefits associated with hybrid proposal would be significant and applicable to range of thermal plant and absorption of finding from feasibility or development.
- Builds upon existing nascent solar industry in the region creates potential for Australian first hybrid arrangements and contribution to the development of an alternative energy industry in the region.

Environmental benefits

The environmental benefits of solar thermal are also well demonstrated and include a reduction in carbon, particulate and dust emissions from the combustion and fuel handling processes.

Social benefits

While it is not possible to definitively quantify the potential social benefits of the establishment of a solar thermal power station in Port Augusta, the expected, intangible benefits include:

- Diversification of local economy.
- An increase in the profile of Port Augusta both nationally and internationally.
- Potential increase in tourism.

Potential opportunities for people involved in the construction and operation of future plant to participate in related research and/or development of similar projects.

4 Project Definition

4.1 Pre-Measure Activities

Alinta Energy has been undertaking high-level work associated with this measure for some time to demonstrate to prepare for a full feasibility study. The main pieces of work are listed below.

- Solar Concept Study, 2012

- Options Study for Future Generation at Playford Power Station Site, 2012
- Cost estimate for Feasibility Study for a Solar Thermal Plant, 2013

4.1.1 Solar Concept Study

Alinta Energy has undertaken a Solar Concept Study to assess the viability of solar generation in Port Augusta and Leigh Creek which drew a number of clear conclusions.

- South Australia is a high quality location for solar thermal.
- Leigh Creek and Port Augusta sites have been identified with sufficient solar resource.
- Stand-alone concentrated solar power based on Parabolic Trough, Linear Fresnel and Power Tower are all feasible.
- Potential for hybrid configurations at Northern Power Station and possible use of Playford facility/components.
- Thermal storage should be considered and incorporated into final designs so the plants are "dispatchable".
- Solar thermal matches South Australian generation profile and provide a balance to significant wind resources in region.

4.1.2 Options for Future Generation at Playford Power Station Site

Alinta Energy has a number of obligations in relation to the Playford B Power Station site regarding remediation and environmental matters that would be triggered at time of full closure. Alinta Energy has nonetheless determined that there is still significant scope to utilise a number of features of the Playford B Power Stations assets.

Alinta Energy has also held a number of conversations with the State of South Australia about its intentions for reuse and while no formal position has been reached between Alinta Energy as the leasee and the State of South Australia as the leasor these discussions were beneficial.

4.1.3 Feasibility Study for a Solar Thermal Plant, cost estimate

To assist in the cost estimation process Alinta Energy developed a proposal and cost estimates for the work that would form a significant part of this project.

4.2 Pre-feasibility Study

The scope of work for the Pre-feasibility Study will include:

4.2.1 Project definition

Meeting to confirm the scope of work, its staging, start date, assumptions and budgets to understand the detail required for the study.

4.2.2 Options study

This is a relatively high level study as detailed below.

- Identify and compare technologies (parabolic tough, power tower, Fresnel) with a focus on power tower and Linear Fresnel.
- Estimate energy production from each option based on currently available solar irradiation (building on the concept study).
- Evaluate energy storage options and capacity.
- Estimate capital and operating costs of the options.
- Calculate Long Run Marginal Cost (LRMC).
- Identify any non-measurable factors, in addition to costs and output that should be considered in making a decision.
- Develop a decision matrix.
- Identify a preferred option with respect to the technology to be employed, storage capacity and hybridization.
- Refine the preferred stand-alone solar plant option to the degree required for the study.
- Update costs and performance of NPS integration option.
- Decide whether stand-alone plant or NPS hybridisation will be taken forward for this study.
- At the completion of this section of the study, a recommendation on preferred technology will be made to Alinta and it is expected that one technology will be taken forward.

4.2.3 Siting study

A further step is a formal site selection study and recommendation on siting.

- The initial survey and site selection will be based on GIS and satellite data (with appropriate constraints) identifying a short listing of potential sites.
- Consideration of environmental, infrastructure, community constraints issues with respect to plant layout and future development approval process will follow.
- Site specific conditions will be analysed including meteorological factors, proximity to local communities and land acquisition costs.

- Site topography, geology and geotechnical conditions.
- Development of a siting matrix to identify the preferred site.
- After this initial scan and in collaboration with Alinta a preferred site will be identified and a site visit will be conducted.

4.2.4 Solar resource for the study

Two packages of solar resource data would be used for the study. Initially, Direct Normal Insolation (DNI) sourced from satellite data would be used in the preliminary part of the work such as the Options Study and Pre-feasibility Study. This would be either daily or monthly DNI average data.

A more comprehensive set of data, with site measured data calibrated against short and longer term satellite data would be used for the full feasibility study.

Early in the project, it is recommended that a monitoring station, capable of recording DNI, other solar data and meteorological data be installed at the site. It is anticipated that this would continue right through the development period and in the operational period it would become part of the operational monitoring and forecasting system. After approximately 12 months data collection, data from this station would be calibrated against more comprehensive satellite data and compared with the initial satellite data used.

The monitoring station would include instruments for measuring DNI (pyreheliometer), GHI (pyranometer), weather station, data logging and transmission. All would be set up for remote, unattended operation.

Data collected would be verified utilizing currently available satellite data, for the site. Current “real time” satellite data coinciding with the time of measurement at the site would be used to compare with site readings. This would then be compared with long term data to gain a picture of both accuracy of measured data and its variation over time.

The full feasibility study would use hourly data to be sourced while using long term satellite data along with data collected at site to establish site conditions to calibrate the monitoring results.

4.2.5 Balance of pre-feasibility study

This would take the preferred option from the options study and describe the project with the preferred solar thermal technology.

The objective of this study would be to describe the project, its technology, costs, and performance as detailed below.

- Details of the plant and its operation.
- Capital and operating and maintenance costing at +/-30 per cent.

- Energy yield and generation profile.
- Infrastructure requirements.
- Environmental studies including land use. Profile and identification of and environmental issues.
- Planning and development and requirements for a Development Approval.
- Network connection.
- Power purchase agreement arrangements.
- Implementation plan.
- Community issues and consultation.
- Preliminary financial evaluation.

4.3 Full feasibility study

This would refine the pre-feasibility into a full feasibility study with a level of accuracy of around +/-15% or an alternative level required. It would cover the same areas as the pre-feasibility but in significantly more detail.

- The plant design developed in detail, with best estimates of all physical characteristics and performance of all parts such as solar field, receiver, energy storage and power block.
- Site survey to define the site, topography, geology, hydrogeology and land use.
- OEM/s for the preferred technology would be approached and specific plant details would be included.
- Solar resource data used would be based on hourly increments with at least 12 months site data and calibrated against long and short term satellite derived data. Solar data would be analysed statistically and presented based on statistical probability, typically, between P90 and P50.
- A model of the plant performance would be developed and used to produce an hourly profile of generation. This would be extended to a seasonal and an annual profile.
- Civil and mechanical works for the solar field, receiver/s, energy storage and power block would be designed and estimated.
- Control and instrumentation strategies developed.
- Electrical works.
- Network connection would be addressed, including MLF.
- Environmental studies leading to an EIS would be scoped and commenced.
- Operations and maintenance.

- Project implementation plan including contracting strategy.
- Power purchase agreement arrangements.
- Costing and commercial analysis

Other components of the Feasibility Study are detailed in the following sections.

4.3.1 Financial review and evaluation

- Model assumptions and sensitivities
- Estimated cost through the project lifetime
    - Estimate the CAPEX, initial assessment +/- 30% refined to +/- 15%
    - Calculate the OPEX; identify an operating strategy including operation and maintenance provisions. Review the requirements to integrate with Alinta operation.
    - Note any Tariffs (if applicable)
- Estimated financial output through the project lifetime
    - Electricity sales
    - Identify and quantify state and federal government support
- Nominate the required power purchase agreement and merchant generation arrangements.

4.3.2 Environment and community

- Consider the natural environment including land, air, aquatic, flora and fauna
- Carryout necessary investigations and nominate approval requirements
- Identify community stakeholder interests
- Consult with community and stakeholders.

4.3.3 Planning, approval and licensing

- Articulate the approval hierarchy process noting state and local government requirements
- Prepare and submit the development application
- Ensure licensing requirements are met with AEMO and the Clean Energy Regulator
- Identify necessary approvals, including the Development

4.4 Project timelines and milestones

The project will be undertaken in two Stages, with Stage 1 occurring between the Commencement Date and 31 December 2014 (Milestone 3). Stage 2 will comprise Milestones 4 and 5 and finish on 31 December 2015.

The major project milestones are set out below.

- Project Definition Report, 31 December 2013.
- Options Study, 30 April 2014.
- Siting Study, 30 April 2014.
- Balance of Study Report, 31 December 2014.
- Full Feasibility Scoping Paper, 30 March 2015.
- Full Feasibility Study Report, 31 December 2015.

Each of these reports and papers will be available at:

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