Final Technical Feasibility Report

PUBLIC RELEASE VERSION

RATCH-Australia

Collinsville Solar Thermal Power Station

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Introduction

RATCH-Australia Corporation Limited (RAC), in partnership Transfield Infrastructure Pty Limited, and The University of Queensland (UQ), is undertaking all the preparatory development work to assess the viability of converting an existing 180MW coal fired power station to a 30MW hybrid solar thermal / gas power station at the Collinsville Power Station (CPS) in Queensland (the Project).

As part of the Project, RAC will also examine the feasibility of using Novatec's Supernova Linear Fresnel Solar Thermal technology to generate superheated steam to be supplied directly to a steam turbine to provide grid connected electricity. The dual-fuel boiler will also be designed to use natural gas to enhance grid reliability from the Project.

The Australian Government, through an Australian Renewable Energy Agency's (ARENA) Emerging Renewables Program Funding Agreement, is partly funding the feasibility study.

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Plant description

The CSTPS is a hybrid power station comprising a 30 MW solar steam generator and a gas-fired boiler capable of operating independently or with the solar field to maintain full steam supply to a conventional turbo-generator. This allows for full load solar generation during sunny periods, shared solar/gas generation during periods of low or variable solar insolation or full gas operation during the night or during periods of unbroken clouds.

The plant includes the following main features:

- A Novatec linear Fresnel SuperNova solar boiler, with 175,000 m^2 of reflectors and a total solar field area of 352,000m^2. This comprises both evaporating and superheating sections and is to deliver steam of the quantity and quality required by the power block.
- A 30 MW net conventional power block. This includes a single-reheat steam turbine and a 4 pole air/water cooled generator. Rated steam conditions are 500/430 ˚C and 120/30 bar. Other power block equipment includes a surface condenser and a circulating water condenser cooling system, feedwater heaters, deaerator and boiler feed pumps.
- Mechanical draft cooling tower with variable speed fans to allow both power and noise reduction during critical periods.
- A 30 MW duel fuel, quick response boiler. This has the capability to supply the full generation capacity and to operate at low and variable loads to supplement the solar boiler. The primary fuel is coal seam gas with light fuel oil available as the auxiliary fuel.
- A packaged water treatment plant capable of supplying demineralised water for the solar and gas boilers, to meet the required steam conditions of the steam turbine.
- Distributed control system that provides all control, protection, monitoring and alarming to allow the plant to be safely operated and maintained.
- Electrics including medium voltage switchgear, generator transformer and other systems.
- Control room, office, administration and amenities and maintenance facilities.

The solar technology for this project represents the first commercial deployment of the Novatec SuperNova direct steam generating technology. It is based on development work at the 1.4 MW test facility at Puerto Errado in Spain and the commercial saturated steam (30 MW) project at the same site.

The CSTPS adjoins the Collinsville Coal Mine and is sited on land owned by RAC. The plant itself covers approximately 40 ha and uses existing power transmission facilities, auxiliary fuel, water supply and waste water disposal facilities that were part of the old Collinsville Power Station infrastructure. The land is not flood-affected and preliminary geotechnical work has identified no adverse issues that would not make this an appropriate site. The project will connect to the Ergon 33 kV transmission network at an existing switchyard.

RAC is currently undertaking a program to monitor solar energy at the project site. This has been operating for 16 months and when completed, it will be calibrated against long term solar data sourced from satellites, and compared with real time satellite data coinciding with the monitoring period. In the interim, until this monitoring program is finished, satellite data for the period 1999 through 2006 was obtained from 3Tier and was used to define the solar resource for this study. Design annual Direct Normal Insolation (DNI) for this study was 2,124 kWh/m^2/day.

Key plant characteristics are summarised in Table 1.

Specification	Details
Nominal output gross/net	32.5 MW_e / 30 MW_e
Maximum turbine capacity	35.71 MW_e
Solar / collector technology	Linear Fresnel solar collectors, with direct steam generation
Net solar energy export	55,761 MWh per annum
Net gas energy export	78,713 MWh per annum
Net plant energy export	134,474 MWh per annum
Gas production %	58.5 % of net annual production
Gas consumption	23,778,353 Nm^3 per annum
Steam cycle	Dual pressure, single reheat
Rated steam conditions	Main steam: 500 ˚C, 120 bar Reheat steam: 430 ˚C, 30 bar
Steam turbine	Condensing reheat extraction steam turbine
Generator	4 pole, water / air cooled
Terminal voltage	11 kV

Export voltage	33 kV
Auxiliary fuel	Coal seam methane / light fuel oil fired boiler.
Cooling type	Mechanical draft cooling tower with wet cooled conventional surface condenser.

Table 1 : Plant characteristics

Generation forecast

The CSTPS is planned to operate at full load between 0700 and 2200 hours, Monday to Friday. On weekends and public holidays, it will be scheduled to run only if sufficient solar resource is available. The gas boiler will operate to support the full-load 30 MW solar generation during the week, and to keep the plant hot and ready for solar operation daily and over the weekends.

Estimated annual generation and capacity factors are shown in Table 2. Monthly solar and gas generation forecast is shown in Figure 1.

Table 2: Forecast production and capacity factors

Parameter	Value
Net annual production (solar)	55,761 MWh
Net annual production (gas)	75,331 MWh
Net annual production (total)	131,092 MWh
Annual capacity factor (solar)	21.2 %
Annual capacity factor (gas)	28.7 %
Annual capacity factor (total)	49.9 %

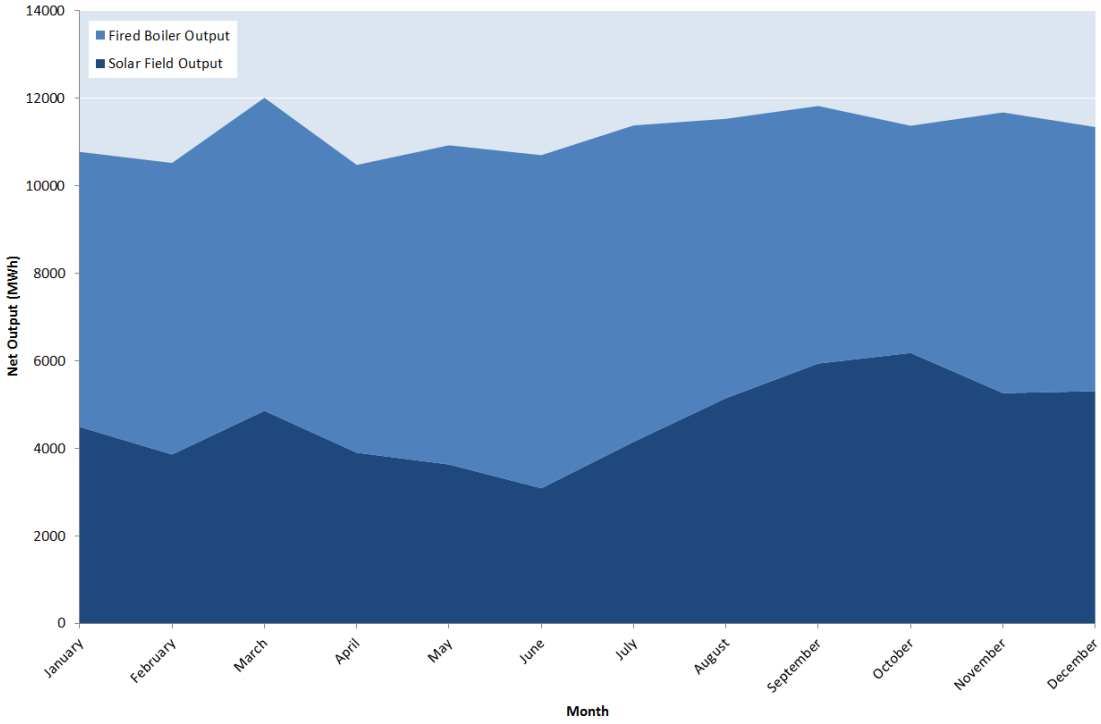

Figure 1: Solar field and fired boiler annual production

Gas and water supply

Fuel gas is to be supplied by a 37 km pipeline from the Mount Saint Martin CSG field. The gas will be dewatered, compressed and delivered to the CSTPS site. Gas demand will be variable, as required to meet the forecast variable operation in this operating role. To mitigate this, it has been determined that approximately 6.5 TJ of buffer gas storage will be provided by packing the supply pipeline at an elevated pressure. Annual gas consumption is estimated to be approximately 750 TJ (LHV) per year.

Water requirements of the CSTPS are estimated to be approximately 290 ML/annum. Power station cooling uses 95% of this amount for cooling tower evaporation and blowdown, and the balance is for boiler water, cleaning and general services. Supply will come predominantly from the Bowen River Weir, supplemented by a small amount (between 2.5-5%) of treated CSG water. The total requirement is approximately one sixth of the amount currently allocated for the old Collinsville Power Station, and less than the threshold of 10,000 m^3 that would trigger the requirement of an ERA64 approval.

Waste water from CSTPS is estimated to be 44 ML/annum. This will be of a quality suitable for discharge to the existing waste water ponds for ultimate disposal into the local watercourse, as is currently approved for the existing Collinsville Power Station waste water discharge.

Cost modelling

Project capital and O&M costs for CSTPS were estimated and are summarised in Table 3 and Table 4 below.

Item	Cost ($A'000)
Solar thermal steam generator	98,846
Dual-fired boiler	12,173
Mechanical plant	29,792
Electrical, instrumentation and control equipment	10,902
Civil works	14,971
Gas supply infrastructure	42,301
New powerhouse and buildings	3,850
Balance of plant	7,800
Land acquisition	1,500
Construction insurance	1,926
RAC construction management	1,500
EPC contingency	25,991
Indirect costs (EPC contractor scope)	30,965
Price adjustment estimate	3,380
Total cost	285,897

Table 3: Capital cost estimate

Item	Cost ($A'000)
Year 1	5,710
Year 2	5,724
Year 3	5,836
Year 4	5,934
Year 5	5,999
Total (5 years)	29,203

Table 4: O&M cost estimate

Risk assessment

A high level risk assessment process identified around 27 project risks. After mitigation measures were identified and applied, 19 were classified as low to moderate risk, and four were high to very high risk. Some of the high/very high risks are discussed in Table 5.

Risk criterion	Risk description	Possible cause	Existing / planned controls	Risk rating
Technical risk	Technology does not operate as specified.	Superheat process is commercially unproven for Novatec.	Design for a robust superheat system. Peer review / audit. Use experience from other operating plants.	High
Technical risk	Technology does not operate as specified.	Integration challenges of fired boiler with solar field.	Modelling to analyse dynamic response of steam generation. Control system design to accommodate rapid transients. Boiler design for fast ramp rate. Engage experienced vendor. Detailed fatigue analysis.	High
Delivery risk	Reduced government funding.	Change in government policy.	Monitor government policy. Communication and representation with government.	Very high
Delivery risk	Satisfactory performance guarantees not provided by EPC contractor.	Contractor uncertainty with technology and performance.	Negotiate outcome (guarantees) suitable to both parties or do not proceed with contract.	High

Table 5 : Key project risks

Project impacts

Surveys have identified only one sensitive receptor within 2 km of the CSTPS. This is an unoccupied house owned by the Collinsville Coal Mine. Construction noise is assessed to be acceptable with noise increase of less than 1 dB (A) above background at the nearest occupied receptor, on the Bowen Development Road. Noise from the operating plant was below the adopted background noise creep and project specific noise goals during the day, evening, and night-time periods, for neutral and noise-enhancing meteorological conditions, at the nearest receptor.

The air emissions of most concern from construction were identified as dust and motor vehicle exhaust emissions. Based on the adoption of the normal construction management techniques such as minimisation of vehicle movement on unpaved roads, regular watering of access and operational areas and the expected duration of construction works, it was determined that construction air quality impacts will be controlled to within acceptable limits.

During operations, the main emissions are expected to the stack emissions from the gas boiler and particulates. Emission modelling has demonstrated that these emissions will be within acceptable limits as defined by the DEHP air quality objectives.

A socio-economic assessment has shown that the project will provide a significant boost to social and economic development, predominantly at the local and regional levels. The project supports the existing social and economic goals of various key government agencies and their respective development frameworks including Infrastructure Australia and regional and local planning schemes.

Socio-economic impacts

The primary objective of the CSTPS project is to implement a large-scale, commercial, grid-connected and dispatchable solar thermal hybrid power station and to operate this within a competitive electricity market. Other objectives of the project are to assist with the development of a solar industry in Australia, encourage regional development, to develop Australian intellectual property in solar power generation and to develop and share technical and economic knowledge.

This project would be the first large-scale, purpose-built solar-gas hybrid power station in Australia, and one of the largest of its type in the world. As such it is likely to be the focus of considerable social and economic interest. The overriding social and economic goals of the project are to:

- provide a clear public benefit
- make a positive long-term social and economic contribution at the local, regional, state and national level.

The purpose of this section is to describe the existing regional social and economic environment, provide a preliminary assessment of the potential benefits and impacts arising from the project construction and operation, and corresponding enhancement and mitigation measures for the broader benefit of the region.

The CSTPS site is located within the Whitsunday Regional Council Local Government Area. The region has a diversified economy, based largely on horticulture, coal mining, beef cattle, fishing and tourism.

The project is located 10 km north-west of the twin townships of Collinsville and Scottsville. The nearest sensitive receptor to the project is an unoccupied homestead located approximately 1 km to the south-east. The nearest occupied sites are between 2 km and 2.5 km to the east/north-east. While the economic base of the Whitsunday region shows some diversity, the economic base of many of the smaller regional centres such as Collinsville are based predominantly around mining. The Collinsville and Somona mines are major contributors to the existing local socio-economic setting.

As at 30 June 2009, the estimated resident population of the Whitsunday region was 34,195 persons, the urban centre of Bowen was 8,587 persons and Collinsville was 2,068 persons. The region also comprises a relatively high number of non-resident workers, consisting largely of fly-in/fly-out and drive-in/drive-out persons.

The demographic profile of the Whitsunday region reflects the younger, mostly male, transient populations associated with high participation rates in the tourism, agricultural and mining sectors. In Collinsville, almost 30 percent of persons ages 15 years and over were employed in the mining sector.

The project site offers a direct feed into the national electricity system, which provides electricity for the growth in coal mining in the Bowen Basin and secures the electricity supply to regional economic centres and surrounding townships. The site avoids sensitive receptors and areas of intensive land use; avoids impacts on mapped extractive resources, key resource areas, mining lease or mining lease application areas; and avoids sites of known cultural significance.

Development of the project is in close proximity to the recently shut-down Collinsville Power Station, which is owned by RAC. This situation enables the project to capitalise on long and recent power industry experience and existing community partnership programs and engagement initiatives in the local and regional areas.

The total investment for the construction and commissioning of the project and associated infrastructure (including water and power transmission) is estimated to be $286 million. The construction period is estimated to be just over two years. The operational costs for the project are estimated at $5.8 million per annum. The design life of the project is 30 years.

The project will provide a significant boost to social and economic development at the local, regional and state levels. The project supports the existing social and economic goals of various key government agencies and their respective development frameworks including Infrastructure Australia and regional and local planning schemes. For example, there is potential for the CSTPS project to act as a major catalyst for the regional Green Industry Diversification Project.

While a number of social and economic costs have been identified, these are considered to be materially outweighed by the project benefits to the local area, region and state. These benefits include:

- a major capital investment of economic significance to the State of Queensland, resulting in greater economic activity through the sourcing of goods and services from within the region
- increased diversity and robustness of the regional economy through development of the renewable energy sector
- further regional employment opportunities for 50 to 60 skilled and unskilled workers during construction of the power station, solar field and associated infrastructure; particularly in engineering and technical trade areas
- a small operations and maintenance workforce over the 30 year life of the project and additional requirements for skilled maintenance and engineering services, as required
- skill development and diversification through the establishment of a new industry and the subsequent export of these skills to other parts of Queensland, Australia, and overseas
- continuing support to the development of social infrastructure and services through the extension of existing initiatives implemented by RAC in the project area
- provision of a major source of investment in renewable energy and enhanced industry knowledge and capacity in the development and operation of a commercial solar thermal power station.

Project construction has potential to decrease the availability and affordability of accommodation within the local township of Collinsville. Investigations will be undertaken during the project approvals process to identify construction workforce housing options and determine the most appropriate housing and infrastructure strategy for the construction phase.

Construction of the solar thermal power station is expected to contribute between $0.36 and $0.46 million per annum in gross region product (GRP) and between $10.4 and $13.4 million per annum in gross state product (GSP). This is expected to support between 14 and 15 full-time equivalent jobs regionally and between 146 and 195 full-time equivalent jobs throughout the state.

Operation of the solar thermal power station is expected to contribute between $1.6 and $2.0 million per annum in GRP, and $1.3 and $1.6 million per annum in GSP. This is expected to support between 20 and 26 full-time equivalent jobs regionally and between 37 and 49 full-time equivalent jobs throughout the state.

The potential social and economic benefits associated with the CSTPS project development are significant and long-term at the local, regional and state levels. These benefits include a major source of renewable energy, regional employment, industry diversification and research and development. Should the project proceed to the detailed design stage, the results of this assessment will be supplemented by further social and economic investigations and more stakeholder consultation to support the development approval process.