

KEY IMPACTS AND THEIR MANAGEABILITY

Following a scoping and risk assessment process, the following key issues were identified for the project:

- Biodiversity
- Indigenous heritage
- Visual amenity
- Noise

These issues were given priority in the Environmental Assessment. Specialist reports were prepared for biodiversity, visual and indigenous heritage issues. Background noise monitoring is also underway to inform noise mitigation measures.

Biodiversity

Broad vegetation communities recorded at the site include:

- Black Box Woodland
- Myall Woodland
- Black Box Woodland derived grass/shrubland
- Derived Native Grassland
- Exotic dominated pasture/crops

Coolibah – Black Box Woodland derived and Myall Woodlands are listed as Endangered Ecological Communities (EEC). High conservation value areas have been identified and would be avoided by the infrastructure layout. Generally, onsite vegetation has minimal conservation value. A follow-up flora survey would be undertaken to confirm the assumptions made in this assessment.

Three threatened bird species were identified at the proposal site during surveys. Habitat for threatened species at the site includes hollow-bearing trees. Generally, fauna habitat would be avoided by siting panels in unvegetated areas.

Visual amenity

The landscape character, visual sensitivity and potential impacts of the project were assessed from nine viewpoints which would have prominent views of the site. The greatest visual impact would be apparent at East Nyngan Road and Mitchell Highway, areas which are sparsely populated. The proposed infrastructure would largely be screened by existing vegetation, topography and the flood levee that surrounds the town. The visual assessment concluded that overall the proposal would result in low impacts to the surrounding environment in terms of landscape and scenic values. Visual impact mitigation measures include selecting sympathetic colours for infrastructure, the use of underground cabling and screen planting (boundary planting, foreground planting at affected viewpoints and residential tree planting).

Indigenous heritage

Ground disturbance, such as installing tracks or footings during construction, would result in physical impacts to Aboriginal objects which may be present within the soil profile. Two Aboriginal objects were recorded in the proposal site during the field assessment and were assessed to be of low archaeological significance. The proposal site was assessed to be of low archaeological potential. No further archaeological investigation is considered warranted.

Noise

The proposal site is located in a semi-rural environment and background noise levels are generally low. Noise emissions would be produced during the construction phase of the project. Noise targets are based on background monitoring. Multiple sensitive receivers are located within one kilometre of the site. At times during the construction period, noise emission targets may be exceeded for noise sensitive receivers, requiring mitigation measures.

No adverse operational noise impacts are anticipated.

OTHER IMPACTS CONSIDERED

A range of other lesser issues were included in the EA; these issues and the main assessment findings are summarised in the table below.

Issue	Impacts
Hydrology and water quality	The proposal site is subject to flooding. Some infrastructure components would be raised to mitigate against any potential flooding. Other hydrology and water quality impact are considered readily manageable.
Traffic and access	Traffic levels in the Nyngan area are relatively low. It is not anticipated that additional vehicles during construction/decommissioning or operation would strain the capacity of the road system. Road dilapidation as a result of delivery of containers would be addressed through consultation with Bogan Shire Council and the RTA and the preparation of a road dilapidation report.
Soils and landforms	Construction would disturb soils and introduce erosion and sedimentation risks. However, impacts are expected to be temporary and localised and risks are readily manageable using safeguards specified in the EA. Dryland salinity is a risk at the site and mitigation measures such as planting deep-rooted species would be implemented to prevent salinity. There are no known contaminated sites on the property.
Historic heritage	No historic heritage items are located at the proposal site. No heritage approvals are required.
Air quality and climate	The proposal would not significantly affect local climate or air quality.
Waste management and resource use	Waste and resource management issues would not be significant during the construction or operation phases of the project. The proponent would prepare a Waste Management Plan which applies the Reduce-Reuse-Recycle hierarchy.

Socio-economic and community	Generally positive socio-economic impacts would result from the proposal including employment and demand for goods and services. The presence of a solar farm may add a further feature of interest for visitors to the area.
Mineral resources and land use	The proposal would operate within the area of an active mining exploration lease. This would temporarily restrict the ability for the area to be explored for mineral resources. Temporary loss of agricultural land would have some negative impacts to land use. These would be offset somewhat through the consideration of grazing sheep under the panels.
Health and safety	Electromagnetic and electric fields would be produced by infrastructure at the site, but emissions would comply with NHMRC guidelines. There would be no public access to the solar farm.
Fire and bushfire issues and risks	The risk of panels causing a grass fire is considered to be very low, and the risk can be mitigated by applying best practice design and installation methods. Suntech PV modules comply with UL1703 spread of flame and fire brand tests, meaning that they are not combustible and pose a very low fire risk.
Cumulative impacts	Potential cumulative impacts arise from concurrent projects such as mining operations having impacts to traffic, water quality and resource use. Cumulative impacts are readily mitigated.

ENVIRONMENTAL MANAGEMENT OF IDENTIFIED IMPACTS

The identified environmental risks and impacts would be managed in accordance with the Statement of Commitments, and implemented via a Construction Environmental Management Plan (CEMP) during the construction period and an Operation Environmental Management Plan (OEMP) for the operational phase.

The Statement of Commitments incorporates specific recommendations contained in the specialist reports and additional measures identified during the preparation of this Environmental Assessment (refer Section 0).

Key mitigation measures applying to the Nyngan Solar Farm include:

- Layout design and micrositing requirements to avoid significant biodiversity features
- The offsetting of vegetation clearing with tree planting and habitat protection measures
- The application of tree clearing guidelines (including hollow-bearing tree removal)
- Tree planting to mitigate visual impact
- A range of noise reduction and management techniques, and consultation with receivers, would be implemented during the construction period
- Raising of kiosk transformers and central inverters by 0.5 metre to mitigate potential flood impacts
- Planting deep rooted species to prevent dryland salinity
- Consult with St Barbara Limited regarding impacts to potential mineral exploration
- A Traffic Management Plan would be prepared in consultation with roads authorities to minimise impacts to roads and traffic during the construction period

CONCLUSION

The proposal would comply with State and Local Government legislative and policy requirements (subject to further biodiversity survey and assessment). The solar farm proposal is compatible with surrounding land and resource uses. Transport routes to the site are suitable for the anticipated construction traffic.

The solar performance of the site has been assessed as suitable for the construction of a viable solar farm. The site is logically positioned next to existing electricity generation infrastructure and close to large population centres, and is well-placed for the promotion of low carbon energy sources in the community.

Set against the background of anthropogenic climate change, the proposal is considered to be consistent with the principles of Ecologically Sustainable Development. In particular, the project addresses the need to minimise the risk of dangerous climate change to current and future generations by reducing carbon emissions. The proposal would not diminish future options for land and resource use and nature conservation.

On balance, the project is considered to be a valuable and sustainable contribution to the urgent challenges of climate change and energy supply.

1 INTRODUCTION

1.1 AIM OF THIS REPORT

This Environmental Assessment (EA) has been prepared by **ngh**environmental on behalf of Infigen Energy (the proponent) to assess the environmental impacts associated with the development of a solar farm at Nyngan, NSW in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposed development is considered to be Major Infrastructure under Part 3A of the EP&A Act and this assessment has been prepared to meet the requirements of this act and the *State Environmental Planning Policy (Major Development) 2005* (Major Development SEPP).

This EA aims to:

- Describe the proposal site and Nyngan locality in the context of the proposal
- Describe the proposal infrastructure and construction, operation and decommissioning requirements
- Identify relevant legislative requirements
- Identify and assess the environmental impacts of the proposal with a focus on key issues
- Provide mitigation to avoid or minimise potential environmental impacts
- Inform stakeholders and the public of the project and subsequent environmental impacts

Key issues identified for this proposal are biodiversity, indigenous heritage, visual amenity and noise impacts. Specialist studies have been undertaken for biodiversity, visual and indigenous heritage and are included as appendices. Background noise monitoring is also underway to inform noise mitigation measures.

The EA has been prepared with reference to the Director-General Requirements (DGRs) developed in response to the Preliminary Environmental Assessment (PEA) and relevant reports and documents.

1.2 ASSESSMENT PROCESS OVERVIEW

1.2.1 Declaration of Part 3A

The proposal was declared to be a project to which Part 3A of the EP&A Act applies by the Minister for Planning on 5 July 2010 (Appendix A). The proposed solar farm development at Nyngan is considered to be a Major Project (Major Infrastructure) under Part 3A because Clause 75B (1) of the EP&A Act, states that: [Part 3A] *applies to the carrying out of development that is declared under this section to be a project to which this Part applies:*

(a) *by a State environmental planning policy, or*

(b) *by order of the Minister published in the Gazette (including by an order that amends such a policy).*

Part 3A projects declared in the *State Environmental Planning Policy (Major Development) 2005* (Major Development SEPP) include development for the purposes of solar electricity with a capital investment value greater than \$30 million. The proposed Nyngan Solar Farm would have a capital investment of \$300 million and is therefore considered to be Major Infrastructure under Part 3A of the EP&A Act.

1.2.2 Environmental Assessment in the context of the Part 3A assessment process

Steps in the Part 3A assessment process that have been followed to date for this proposal include the following:

- The development is declared to be a Major Project by the Minister for Planning. This occurred on 5 July.
- Project Application is submitted along with a Preliminary Environmental Assessment to the Department of Planning (DoP) which outlines a summary of the project and the key environmental issues. This occurred on 28 July 2010.
- The DGRs are received from the DoP which outline the key issues that the proponent must address in the Environmental Assessment (EA). Relevant public authorities are consulted to provide input into the DGRs. The DGRs were received on 1 September 2010.
- Preparation of the EA (this report) in consultation with stakeholders. The EA is required to address the DGRs and include a Statement of Commitments (SoC). Sections 6 and 7 have been prepared in response to the DGRs which are provided in Appendix B. A draft Statement of Commitments is also provided in Section 0.

At any stage of the Part 3A assessment process, the Minister may request the Planning Assessment Commission (PAC) to review or advise aspects of the project.

Following submission of the EA, the following steps will be undertaken:

- The EA is exhibited for a minimum of 30 days whereupon the public are invited to provide comment.
- Public submissions are provided to the proponent whereupon the proponent may be required to provide a response to the issues raised or amend the project and SoCs. Where changes are made, these are outlined in a Preferred Project Report prepared by the proponent, made available on the DoP website.
- The Director-General provides a report to the Minister including:
 - The EA and any Preferred Project Report
 - A statement relating to compliance with EA requirements
 - Any advice provided by public authorities or the PAC
 - A copy of or reference to the provisions of any State Environmental Planning Policy (SEPP) that would substantially govern the carrying out of the project
 - Any environmental assessment the Director-General has undertaken or any other matters considered by the Director-General

- If the Director-General recommends the project is approved, draft Conditions of Approval are attached to the report.
- The Minister approves or disapproves the project and determines the conditions that apply (Ministers Condition of Approval (MCoA)). The determination considers section 75J (2) of the EP&A Act, the Director-General's report and if applicable the PAC recommendations.
- MCoA would be monitored by the DoP throughout the project life.

1.2.3 Critical Infrastructure

The proposal would also be considered as 'critical infrastructure' under the EP&A Act. The News Release from the Premier of New South Wales on 27th February 2009 'Doing Green Business in NSW Made Easier' included lowering the threshold for critical infrastructure from 250 megawatts to 30 megawatts for renewable energy generation facilities within identified renewable energy precincts. This is relevant to the proposal. Critical infrastructure provisions declared by the Department of Planning (2007a) include:

- The timely and efficient delivery of essential infrastructure projects
- Allowing the government and the planning system to rapidly and readily respond to the changing needs of the state
- Providing certainty in the delivery of critical infrastructure projects
- Providing rigorous scrutiny to ensure environmental outcomes are appropriate
- Focusing on delivering outcomes essential to the NSW community

The environmental assessment process does not differ for projects declared to be critical infrastructure.

1.3 PROPOSAL OVERVIEW

Infigen Energy proposes to construct a 100 megawatt capacity solar farm on a 450 hectare site at Nyngan. The solar panel array would be comprised of a series of photovoltaic panels mounted on fixed frames, and would occupy approximately 200 hectares of the site. Preliminary layout and structural plans for the proposal are provided in Section 2 and the area within which infrastructure may be located (the development envelope for the proposed solar farm) is shown on Figure 2-1.

The Nyngan Solar Farm would connect to the existing Nyngan 132kV substation which is located adjacent to the solar farm. This substation would require minor augmentation to facilitate the connection. The solar farm would have an expected operating life of up to 50 years. The decommissioning phase would remove all above ground infrastructure from the site.

2 PROPOSAL DESCRIPTION AND JUSTIFICATION

2.1 THE PROPONENT

The proponent for this proposal is Infigen Suntech Australia Pty Limited (Infigen Suntech). Infigen Suntech Australia Pty Limited is a consortium comprising Infigen Energy, Australia's leading specialist renewable energy business, and Suntech Power Holdings Co. Ltd, the world's leading producer of crystalline silicon solar photovoltaic modules.

Infigen Energy

Infigen Energy is a specialist renewable energy business that develops, owns and operates renewable energy generation facilities in Australia, the US and Germany. It is listed on the Australian Securities Exchange. Infigen Energy has interests in 36 wind farms (2,236MW installed capacity) across Australia, the United States and Germany. It also has a large-scale, diversified pipeline of development opportunities across six Australian states, which strongly positions the company to capitalise on the Federal Government's Renewable Energy Target (RET) legislation.

Infigen Energy's energy generation assets in Australia comprise the Capital wind farm in New South Wales (NSW), Lake Bonney wind farm, stages 1, 2 and 3, in South Australia (SA), and the Alinta wind farm in Western Australia (WA). Infigen Energy, with Suntech, is expanding its operations into solar energy generation with four solar farm proposals (including this proposal) currently undergoing planning and development assessment (refer Table 2-1).

Table 2-1: Australian renewable energy projects developed by Infigen Energy's development team

Solar Projects	Size	Development Status	Region
Nyngan Solar Farm	100 MW	Pre-approval	Western Plains, NSW
Moree Solar Farm	60 MW	Pre-approval	Western Plains, NSW
Manildra Solar Farm	50 MW	Pre-approval	Central Western, NSW
Capital Solar Farm	50 MW	Pre-approval	Southern Tablelands, NSW
Wind Projects	No. of turbines / Size	Development Status	Region
Alinta Wind Farm	54 turbines – 89.1 MW	Operating	Mid Northwest WA
Capital Wind Farm	67 turbines – 140.7 MW	Operating	Southern Tablelands, NSW
Lake Bonney Stage 1	46 turbines – 80.5 MW	Operating	South East, SA
Lake Bonney Stage 2	53 turbines – 159 MW	Operating	South-east, SA
Lake Bonney Stage 3	13 turbines – 39 MW	Operating	South-east, SA
Woodlawn	20 turbines – 42 MW	Under construction	Southern Tablelands, NSW

Suntech

Suntech develops, manufactures, and delivers the world's most reliable and cost-effective solar energy solutions (Suntech 2010). Suntech was founded in 2001 in China by leading solar scientist Dr. Zhengrong Shi and is now the world's largest producer of silicon solar modules.

Solar modules produced by Suntech are installed in over 80 countries and offer clean power for every application and market, from off-grid systems, to homes, to the world's largest solar power plants (Suntech 2010).

In 2008, Frost & Sullivan recognised Suntech for excellent products and performance, naming them solar development company of the year. Major milestones for Suntech have included achieving a record 1 gigawatt solar cell and module production capacity in January 2009, and setting efficiency records with their Pluto mono- and poly-crystalline cells in March 2009 (Suntech 2010).

2.2 PROPOSAL SITE AND SURROUNDS

2.2.1 Regional context

The proposal site is located in the Darling Riverine Plains Bioregion in Central Western NSW. Tottenham, which is the closest town to the geographical centre of the state of NSW is located 75 kilometres to the south of Nyngan. The other nearest towns are Cobar, 130 kilometres west of the site and Warren, 62 kilometres to the east. This area is dominated by large rural properties that support cropping and grazing with a generally low population density.

The proposed solar farm site is located within the Bogan Local Government Area (LGA) and is zoned 1(a) General Rural under the Local Environmental Plan (LEP). Bogan LGA covers an area of approximately 14,610 square kilometres with an estimated population of 3220 of which, 2500 reside in Nyngan (Bogan Shire Council 2010).

2.2.2 Proposal site

The proposal site covers approximately 450 hectares of flat terrain characteristic of the alluvial floodplains of the Nyngan locality. The site is located 2 kilometres south from the township of Nyngan, between the junction of Tottenham Road and the Mitchell Highway.

The proposed photovoltaic (PV) array and operation and maintenance building would be sited on rural land across two landholdings adjacent to Nyngan's southern semi-rural/residential precinct. Transmission line would pass underground through open terrain connecting the PV array to the existing Nyngan 132kV substation. The location of the proposed works is shown on Figure 2-1.

The site's current use is predominately grazing with some areas being utilised for cropping.

Some of the grazing land has been subject to pasture improvement.

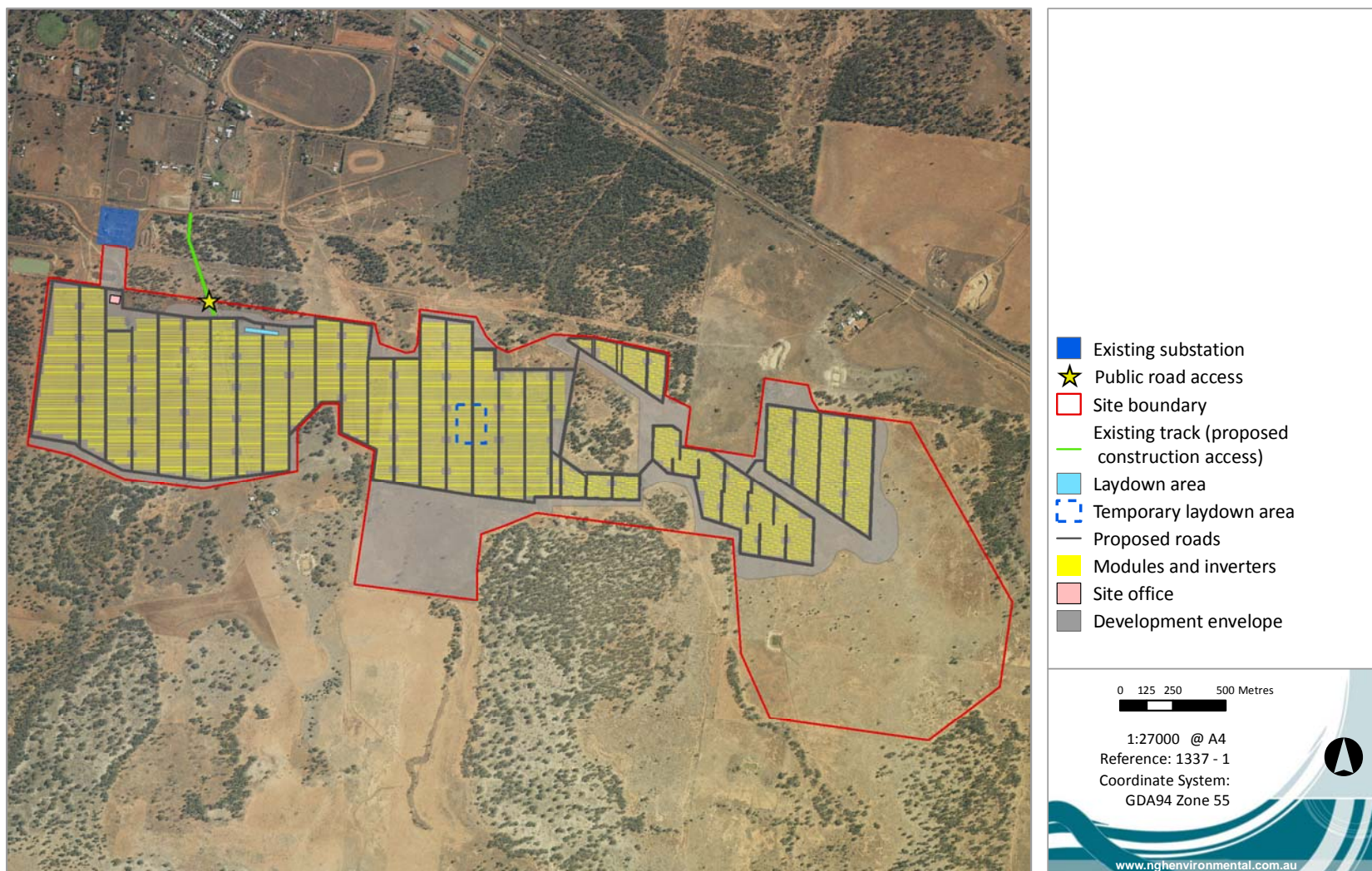


Figure 2-1: Proposed Nyngan Solar Farm site

2.2.3 Site suitability

The proposed Nyngan Solar Farm site has certain characteristics that make it suitable for a solar farm development. The Bureau of Meteorology (2010b) indicates the Nyngan area has an average daily solar exposure range of 18-21 megajoules per square metre. Solar resource modelling based on satellite imagery correlated with onsite solar resource data collection has confirmed that there is an ample solar resource. Site surveys assessing shading obstructions and other obstacles also confirm that there is consistent solar access.

The solar farm has been sited specifically to utilise existing grid connection infrastructure. The Nyngan site is located in close proximity to the NSW electricity transmission network and is located within 230 metres of the Nyngan 132kV substation.

Preliminary investigations into the grid connection capacity at the point of connection have confirmed the proposed 100 megawatt capacity is appropriate to support the grid with added local generation. The substation would require minor augmentation but this is not considered significant.

Site topography and geotechnical conditions allow for a low impact mounting structure design and layout at the proposed site.

2.2.4 Surrounding land use

Land uses on land surrounding the proposal site include:

- Agricultural production that includes cropping and grazing
- Electricity infrastructure (i.e. Nyngan 132kV substation, transmission and distribution lines)
- Rural residential

Additional land uses in the local area include transport corridors (Mitchell Highway, local roads and rail), Nyngan Racecourse, Nyngan Cemetery, urban residential and commercial areas of the Nyngan township, grain storage (silos), schools, sports ovals, churches and Nyngan railway station.

2.2.5 Sensitive receivers

Sensitive receivers near the proposal site include residences, businesses and recreational areas. The closest business, a horse ranch, is located approximately 85 metres from the northern boundary of the proposal site. A farm house/residence is located 160 metres to the south of the site. Several other residences are within 1 kilometre of the site and a race track and cemetery are located 900 metres to the north and landscaping business 380 metres to the northeast.

Table 2-2 presents an overview of sensitive receivers within 1 kilometre of the closest boundary of the proposal site. Distance to the proposed development site may be greater than those specified below depending on final layout of infrastructure.

Table 2-2: Proximity of nearby sensitive receivers to proposal site

Receiver	Approximate distance from proposal site (m)	Direction from proposal site
Horse ranch	85	North
Residence	160	South
Landscaping business	380	North-east
Residence	600	North
Residence	650	North
Residence	660	North-west
Residence	830	North
Race course	900	North
Cemetery	900	North

Other sensitive receivers such as schools, churches and sportsgrounds are located further than 1 kilometre from the site, within the Nyngan township.

2.3 SOLAR FARM DEVELOPMENTS

There are two main categories of technology available for solar power generation:

- Photovoltaic (PV) systems
- Concentrating solar power systems (photovoltaic or solar thermal)

2.3.1 Solar photovoltaic

Solar PV is a method of capturing the sun's energy to generate electricity cleanly and quietly. Solar radiation is converted directly into electricity by transferring sunlight photon energy into electrical energy, through cells of specially fabricated semiconductor crystals (Infigen Energy 2010b). PV cells can be 'monocrystalline' or 'polycrystalline'. Monocrystalline cells are made of a single continuous unbroken crystal with no grain boundaries, and are recognisable by an even colouring. Polycrystalline cells are made from a number of smaller crystals and can be recognized by a visible grain or a "metal flake effect" (refer Figure 2-2). PV cells are often grouped in the form of 'modules' to produce arrays (Department of Planning 2010).



Source: Wikipedia 2010



Source: Suntech 2010



Source: SAS 2010

Figure 2-2: (L to R) Polycrystalline solar PV cells, solar PV module and Solar array

PV systems can be either fixed at a set angle or 'track mounted'. A tracking array enables the PV module surface to follow the sun to increase the amount of solar radiation captured by moving on one or two axes. The electrical output of track mounted systems is greater than fixed systems (Department of Planning 2010).

PV systems can be ground mounted, roof mounted, or integrated into buildings by replacing conventional building materials (Department of Planning 2010). The largest utility scale PV systems in the world are ground mounted systems in the order of 50-60MW.

2.3.2 Concentrating solar power

Lenses or mirrors combined with tracking systems are used by concentrating solar power (CSP) systems to focus sunlight to more efficiently generate heat and/or electricity. The concentrated light is then used as a heat source for a conventional power plant or is concentrated onto photovoltaic surfaces (Department of Planning 2010). Concentrating solar power systems are divided into:

- Concentrating solar thermal (CST)
- Concentrating photovoltaics (CPV)

Four main concentrating solar thermal (CST) power technologies exist and are illustrated in Figure 2-3:

- Parabolic trough collectors
- Linear fresnel reflector systems
- Power towers or central receiver systems
- Dish/engine systems

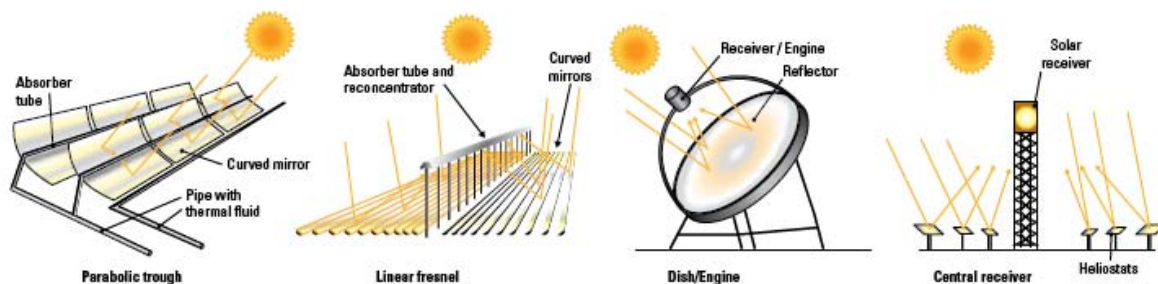


Figure 2-3: Concentrating solar thermal power systems (Source: Department of Planning 2010)

CST technologies operate by transforming solar radiation into heat by concentrating a large area of sunlight into a small beam to heat fluid. The fluid is usually contained in either receiving tubes or towers, and once heated is used to convert heat into electricity in a similar operating system to a fossil fuel power (Department of Planning 2010). Alternatively, the concentrated light could be directed to a boiler generating steam which can then be pumped to a nearby generator or energy storage system, such as for a dish/engine system.

CPV systems similarly concentrate sunlight but direct it onto PV surfaces where it is converted into electricity.

2.3.3 Comparison: photovoltaic and solar thermal technologies

The differences between solar thermal and photovoltaic technologies have been considered in Table 2-3. Analysis of the advantages and disadvantages of each technology coupled with site specific requirements and combined with Infigen Energy’s technical capacity has lead to the selection of solar PV instead of solar thermal technology for the Nyngan site.

Table 2-3: Solar thermal and solar PV comparison

Issue	Solar photovoltaic	Solar thermal
Grid Connection	Solar PV reaches its commercial optimum at approximately 10 MWp (megawatt peak). Even in weak electricity networks this is unlikely to cause any connection issues but in support as embedded peak generation. Therefore, grid connection costs are typically significantly lower for installations compared to solar thermal.	Solar thermal power generation plants reach their commercial optimum typically at project sizes of 100 megawatts or more depending on system technology. In many cases it is challenging to find sites with sufficient solar resources combined with strong grid connection points. Network upgrades are usually necessary and can be a major expense.
Generation profile, availability	In general terms there is a close match between the commercial load profile and the typical generation profile of PV. Especially on hot summer days, the solar resource is most reliable.	Solar thermal power plants have comparable output characteristics to solar PV which is generally a good match with peak demand times. Under the typical size of 50 megawatt plus, the intermittent character of solar generators may cause

Issue	Solar photovoltaic	Solar thermal
	<p>Being in the lower MW range of generation capacity, solar PV plants are less likely to cause transmission conflicts due to their intermittent nature. In most cases the need for storage does not apply to PV because the generator is following the profile of typical peak load generators.</p>	<p>significant grid stability issues.</p> <p>Solar thermal generators provide the possibility for comparably low cost thermal storage but this would still add significantly to the total cost per delivered MWh.</p>
<p>Technical reliability</p>	<p>One of the key advantages of fixed tilt flat plate PV is the ability to generate electricity without any moving parts. Therefore, operation and maintenance requirements are very basic and most can be handled through remote data access to the system via satellite communication. This makes fixed tilt PV ideal for operation in small generation units at remote locations. Cleaning of the panels is rarely needed as the tilt angle provides sufficient self-cleaning even in dry conditions.</p>	<p>One of the major advantages of solar thermal power generation is the efficiency of steam turbine technology. However, this technology at a very large scale has significant operation and maintenance costs. This is a particular disadvantage in remote locations.</p> <p>As sunlight is concentrated to generate heat, only direct radiation is usable. Diffuse radiation on days with cloud cover or caused by pollution (dust) on the reflector surfaces cannot be used for energy production. Cleaning of reflectors to prevent impacts leads to a significant increase in operation and maintenance costs, especially at remote locations.</p>
<p>Environmental issues</p>	<p>While the yield of PV plants is reduced to some degree by pollution (dust, bird droppings etc) there is generally no cleaning of the modules required to allow for commercial operation of the system.</p> <p>Solar PV cells can help the soil humidity and improve vegetation growth in dry or arid areas (Gekas et. al. 2002). They can be structured to avoid environmentally sensitive areas.</p>	<p>As solar thermal power generation uses steam turbines there is an immense demand for water for steam production and cooling.</p> <p>While there are technical possibilities for closed cycle operations available these come with significant additional costs which are commonly not included in publications of costs per MWh.</p> <p>Solar thermal manufacturing emissions are notable (Gekas et. al. 2002).</p> <p>They do, however, have very efficient energy production per unit of land (4000-5000 MWh/ha/year) (Gekas et. al. 2002).</p>

2.3.4 Current utility scale solar power

Overseas solar farms

The largest producers of electricity from solar energy in 2007 were Germany (3.1 TWh), the United States (0.7 TWh) and Spain (0.5 TWh), with all other countries each producing 0.1 TWh or less (GA and ABARE 2010). There are numerous examples of 10-60 MW plants in Spain, Germany, and the US. The largest ground mounted photovoltaic (PV) power plant, as at August 2009, is 60 MW (refer Table 2-4). The largest proposed PV plant is a 123MW plant in Italy, which would use Suntech modules.

Table 2-4: Largest PV power plants in the world as at August 2009 (Source: DoP 2010)

Plant	Country	Capacity
Olmedilla PV Park	Spain	60MW
Puertollano PV Park	Spain	50MW
Moura PV power station	Portugal	46MW
Waldpolenz Solar Park	Germany	40MW

Solar farms in Australia

Figure 2-4 illustrates the locations of operating renewable energy generator plants in Australia, including solar plants. ABARE (2010) lists the largest solar generator in Australia as Solar Heat and Power Pty Ltd's 2 megawatt solar thermal plant at Liddell. The next largest is a 1 MW plant at Broken Hill, which is followed by a number of small plants with capacities under 1 MW. This lack of large scale solar projects is the main driver behind the Australian Government's solar flagships program.

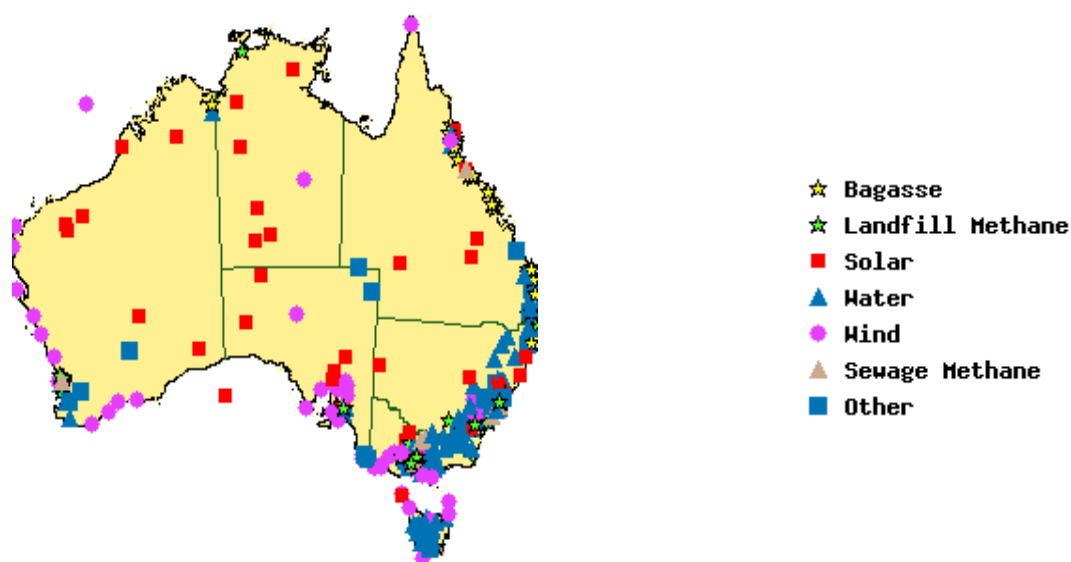


Figure 2-4: Operating renewable energy generation plants in Australia (Source: GA and ABARE 2010)

Solar farms in NSW

New South Wales has the five largest capacity solar power generation plants in Australia, according to ABARE 2010, with a combined capacity of just over 4 MW. A number of solar projects proposed for NSW include the four Infigen Energy – Suntech proposals identified above. ABARE (2010) identifies a 3 MW solar thermal proposal at Lake Cargelligo, NSW, which has received a government grant. A 10 MW solar component was included in the broader Kyoto Energy Park proposal at Scone, which received approval in January 2010.

This proposal would be located in a part of NSW well suited to solar power generation and would substantially increase the solar power generation capacity in NSW.

2.4 INFRASTRUCTURE COMPONENTS

Project infrastructure for the proposed solar farm would include:

- A fixed photovoltaic solar module array (PV array), arranged in a series of rows between 3 and 4 metres above the ground, angled for maximum efficiency and supported by steel framing on steel posts fixed in the ground.
- Electrical connections between PV array and central inverters via underground or frame secured cabling
- A series of central inverters and kiosk transformers distributed throughout the PV array
- Electrical connection into the existing 132kV Nyngan substation via an underground transmission line, including any required switchyard and substation augmentation
- Internal access tracks and upgrades to existing roads, where required
- Fencing and landscaping around the solar farm
- Site office and operations and maintenance building
- Additional temporary construction infrastructure such as a site compound and equipment laydown area

The construction of the solar farm would require:

- Pile driving equipment to install pylons, to support the solar module array
- Lay down areas for equipment and shipping containers
- Shipping container trucks, concrete trucks and heavy vehicle access
- Trenching of underground cabling
- Access to gravel pit for roads

2.4.1 Photovoltaic array

Introduction

Photovoltaic (PV) systems are energy devices that directly convert sun energy into electricity. PV systems are highly modular. The basic building block of a PV system is the PV cell, which is a semiconductor device converting solar energy into direct current (DC) electricity. More cells in series form a PV module. Typical peak power of module in commerce is 50-150 W_p ¹, although in few cases it arrives up to 300 W_p . More modules connected in series form a so-called string. More strings connected in parallel form the actual PV array (or PV “generator”). (Adapted from Frankl et al. (2006).

The photovoltaic array (PV array) being considered for this proposal consists of an array of Suntech Poly-crystalline solar panels mounted on a steel support frame. The panels would be mounted in long rows at a proposed maximum height of 3.5 metres from ground level. The PV panels would be fixed at a set angle facing approximately north, with a tilt angle of approximately 30° from horizontal.

The exact specification of the module and mounting frame may evolve with detailed design refinement however the final design would incorporate modules and a mounting structure with substantially similar dimensions and specifications to those assessed in this EA. Additionally, the final mounting structure design would not exceed a maximum height of 3.5m. The orientation and tilt angle of the array would be selected to provide maximum efficiency for solar power generation, however similarly would be substantially the same as the parameters nominated above.

The fixed PV array would result in a low risk, less intrusive facility (the infrastructure would be closer to the ground) than a tracking solar PV or solar thermal system. A fixed PV array also has lower operational and maintenance requirements.

Suntech poly-crystalline solar panels

The proposed Suntech panels are efficient modules suitable for utility scale solar power generation (refer Figure 2-5). Each panel would be approximately 2 metres long x 1 metre wide x 5 centimetres thick. The panels would consist of 72 poly-crystalline solar cells arranged in a 6 x 12 formation, and would each weigh 27 kilograms. The panels would be made out of 4 millimetres thick tempered glass on the front of an anodized aluminium alloy frame. An IP67 rated junction box would be located on the back of each panel and 4 millimetre squared output cables would be used.

The panels and mounting system (see below) would be engineered to comply with the Australian standard AS/NZ 1170 *Part 2 wind load specification* and all associated design rules and standards. The panels have been given IEC 5400Pa certification, indicating their ability to withstand strong winds. A specification sheet for an example Suntech 270 Watt Poly-Crystalline solar panel is provided in Appendix C.

¹ The term peak power (expressed in peak Watt – W_p) indicates the maximum power produced by a PV device when exposed to sun radiation under Standard Test Conditions (1000 W/m^2 , cell temperature of 25 °C)

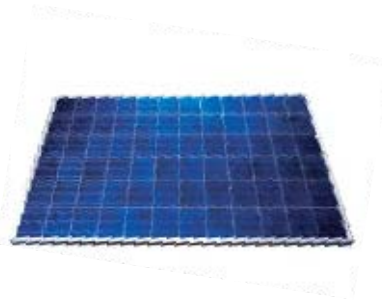
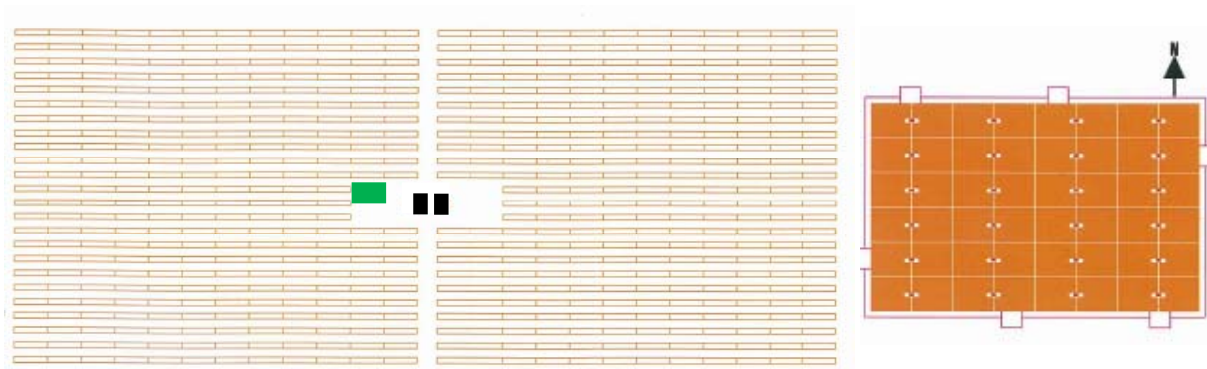


Figure 2-5: Proposed Suntech solar panel (Source: Suntech 2010)

Solar array layout

The Nyngan PV array would consist of approximately 70 array blocks each containing a series of panel rows. A small group of inverters (likely two) and one kiosk transformer would be located in the centre of each block, potentially with a small outdoor enclosure (Figure 2-6). The distance between rows would be between 2 and 5 metres to ensure each row does not shade the next and to allow vehicle access between rows for maintenance activities such as weed control or panel washing if required.



One array block

24 Array blocks

■ Kiosk transformer ■■ 2 x inverters

Figure 2-6: General Phoenix Solar PV array layout

The PV panel mounting structures would not require any excavation or modification of landforms prior to installation. Approximately 1,400 pylons per array block would be installed to a depth of 2 to 3 metres using a pile driver. A total of 100,000 pylons would be used. Concrete footings would not be required, thereby minimising the level of soil disturbance during construction. A module mounting structure would be attached to the pylons to provide a solid support for the panels to be fixed to (refer Figure 2-7). Electrical cabling from each panel would be attached beneath the panels to the end of each row.

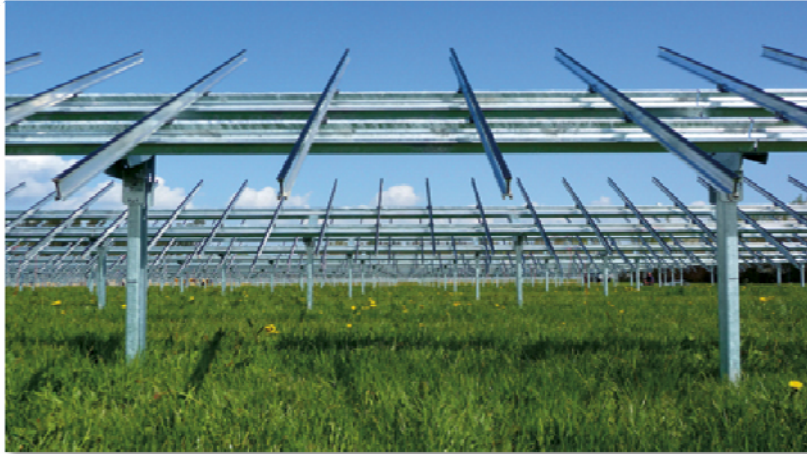


Figure 2-7: Potential supplier Habdank's PV panel mounting structure (Source: www.hpvm.com)

Approximately 20 string distribution cabinets (DCUVs) would be located in each array block to receive and house electrical cabling from the panel rows, with one DCUV installed at ground level at the end of every two to three rows on average. Each array block would also contain a number of main distribution cabinets (DCHVs), each receiving cabling from a group of DCUVs before connecting to one of the array block's inverters at the central inverter and kiosk transformer site (refer 2.4.3 for further information regarding electrical connections). Access would be provided to each inverter/kiosk transformer site via a gravel track.

The preliminary layout, structural and electrical single line diagrams are provided in Appendix C.

2.4.2 Central inverters and kiosk transformers

The PV panel system would produce power at a maximum of 1000 volts in Direct Current (DC). The power produced by the panels would need to be converted to Alternating Current (AC) before being fed into the electricity grid, which operates in AC. Inverters would be therefore be needed to convert the DC power generated to AC and transformers would be required to step up the voltage before feeding into the grid.

A total of approximately 140 inverters and 70 kiosk transformers would be installed, likely in groups of two inverters and one kiosk transformer. Internal gravel access tracks would be provided to all inverter/kiosk transformer locations.

Inverters

The inverters installed at the centre of the array blocks would convert the DC power produced by the PV panels to low voltage AC (approximately 350VAC) and feed it to an adjacent kiosk transformer.

The inverters would be approximately 2.5 metres long, 2.3 metres tall and 1 metre wide and would each weigh 1800 kg. The inverters would be installed on a concrete slab of approximately the same length and width. Each inverter would be raised to a height of 0.5 metres above the ground, subject to engineering plans, to avoid potential flooding impacts. The inverters would be located in the centre of each array block at a minimum distance of 4 metres from the panel rows.

The specification sheet for an example SMA brand 760CP inverter is provided in Appendix C.

Kiosk transformers

One 22 or 33kV kiosk transformer would be installed adjacent to the two inverters in each array block. The purpose of the kiosk transformers would be to step up the voltage from approximately 350V to 22 or 33kV.

Transformers would be approximately 4.3 metres long by 2.2 metres wide and would be installed in an enclosure on a concrete slab with an oil containment bund. Each kiosk would be raised to a height of 0.5 metres above the ground, subject to engineering plans, to avoid potential flooding impacts. The kiosk transformers would weigh approximately 8400 kilograms each.

An example sheet for the kiosk transformers is provided in Appendix C.

2.4.3 Electrical connections

To export power from the solar farm, it is necessary to electrically connect the solar farm to the NSW electricity grid. Electrical works for the proposal would include:

- A combination of frame secured and underground low voltage power cabling from PV panels to distribution boxes and inverters and kiosk transformer in each array block
- Underground power reticulation cabling from kiosk transformers at 22 or 33kV to connect each kiosk transformer at the centre of an array block to a switching station and control room at the Nyngan 132kV substation
- Onsite control and communications cabling
- An onsite control room housing control and communications equipment

Connection between PV panels and central inverters

The power produced by the PV panels would be transferred at a maximum of 1000V in DC along electrical cabling attached beneath the panels of each row. From the end of each row, DC cabling would enter one of that array block's string distribution cabinets, run underground to each of the main distribution cabinets, and then on to one of two inverters in each array block. The inverters would convert the DC power supply to AC before connecting to the kiosk transformer via further underground electrical cabling. The kiosk transformer would step up the voltage from 350V to reticulation voltage of 22 or 33kV.

Trenches approximately 0.4 metres wide and 0.8 metres deep would house the underground DC cabling between panel row ends, DCUVs, DCHVs and inverters. Once cabling had been installed, trenches would be back-filled with sand to approximately 300 millimetres, then capped with a concrete slab or other protective material, and then top-covered with soil. The trenches would be revegetated to stabilise disturbed soils.

Connection to Nyngan 132kV substation

Each kiosk transformer must be connected together in a number of collection circuits at reticulation voltage, and then connected to the Nyngan 132kV substation via switching gear and the control room. These connections would be made using underground reticulation cabling.

While overhead cabling would generally minimise ground disturbance and is lower in cost, underground cabling would reduce visual impacts, maintenance requirements and safety hazards. It would also maximise shielding to minimise electromagnetic field (EMF) emissions (refer Section 7.9).

Cable trenches would, where reasonable, be dug within or adjacent to the onsite roads to minimise any related ground disturbance. Underground 22 or 33kV cables would require a trench approximately 0.4 metres wide and 0.8 metres deep. The trenches would be filled with sand to approximately 0.3 metres deep, a concrete slab installed, the cable laid and then top covered with the previously excavated soil. The trenches would be revegetated with pasture species to stabilise disturbed soils. Electrical cabling layout is shown in Figure 2-8.

Connection to the Nyngan 132kV substation would be undertaken in accordance with a grid connection agreement to be negotiated with Country Energy.

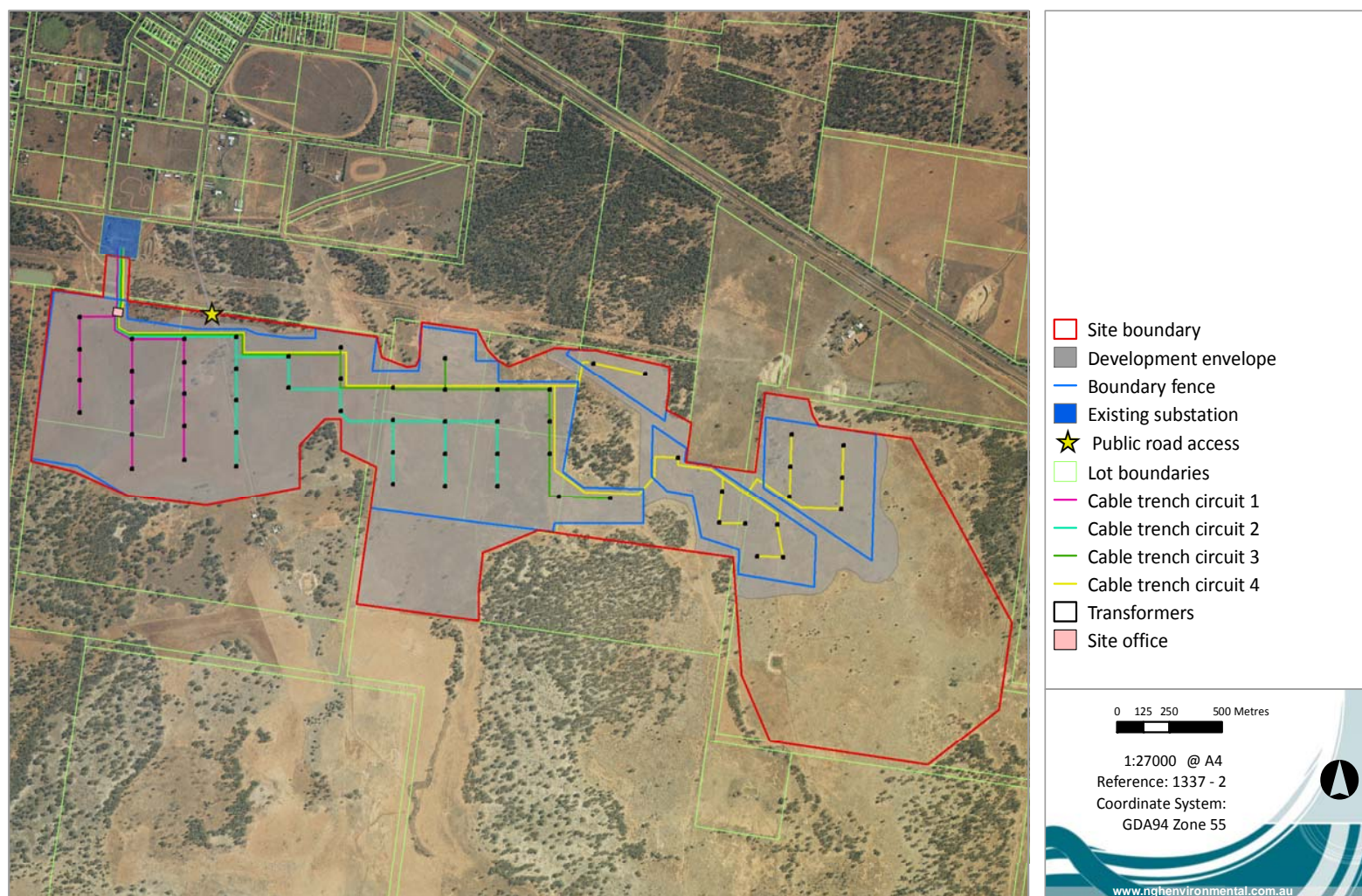


Figure 2-8: Cabling layout

2.4.4 Substation augmentation

The proposal would require the augmentation of the Nyngan 132kV substation (Figure 2-9). A new 22 or 33kV/132kV transformer would be installed on a new concrete slab. It would also include all necessary ancillary equipment for control and protection of the substation such as circuit breakers, switching and control cubicles in the substation compound. The existing substation compound is expected to have sufficient room to contain the required augmentation works, but if not, the proponent would negotiate acquisition of land from the neighbouring landholder.



Figure 2-9: Nyngan substation

The transformer is likely to be of the oil-cooled variety, and therefore may contain considerable quantities of oil. Provision would be made in the design of the substation augmentation for containment of any oil which may leak or spill from the new transformer.

The substation augmentation would be designed and built in consultation with Country Energy to ensure Country Energy's requirements are met, as well as additional external criteria such as establishing a bushfire Asset Protection Zone (APZ) that complies with the RFS *Planning for Bushfire Protection* guidelines.

While the proponent would fund and undertake the substation augmentation, it is expected that ownership and management responsibility for the new infrastructure in the substation compound would be transferred to Country Energy.

2.4.5 Internal access tracks and existing road upgrade

Access route

Access to the proposal site would be via a combination of rail and road network or entirely by road. Construction equipment and materials are proposed to be shipped either by road or rail to Dubbo and then trucked from Dubbo to Nyngan via the Mitchell Highway, a single carriageway, two-way national highway and trucking transport route with a good standard of access at all major junctions. The distance from Dubbo to Nyngan is 160 kilometres. The Mitchell Highway provides access to within 2 kilometres of the Nyngan 132kV substation and the site access point at the northern boundary. Locally maintained roads would be used to connect the Mitchell Highway to the proposal site. These include Hastings Street and East Nyngan Road.

The main access point for the proposal site is from East Nyngan Road at the northern boundary just west of the existing substation. Hoskins Street runs from East Nyngan Road to the north at the intersection of Boundary Street, 400 metres north of the site boundary. Both East Nyngan Road and Hoskins Street are under local control. Hoskins Street services residential and semi-rural properties and provides access to Nyngan Racecourse and Nyngan Cemetery.

Boundary Street provides access to the substation from Hoskins Street. Access is restricted and therefore, consultation would need to be undertaken to arrange access via this road. Alternative access is located on a private track off East Nyngan Road, under a transmission easement. This access would also need to be negotiated with the property owner.

Vehicle management

Approximately 500 shipping container deliveries would be required to deliver panels and materials to the Nyngan Solar Farm. Every effort would be made to ensure vehicles:

- Are minimised in size, length, and number
- Travel with appropriate regard to other road users
- Travel at times which minimise traffic noise impacts to surrounding residents

During construction, light vehicles and trucks delivering panels and equipment in shipping containers would generally operate within 1 hour of the normal construction hours. However, the one-off delivery of the new 50 tonne transformer to the existing substation via oversize vehicles are likely to occur at night, outside normal construction hours, in order to ensure safe passage during low traffic conditions.

Traffic management is discussed in more detail in Section 7.1. A Traffic Management Plan (TMP) would be prepared to properly manage traffic impacts in accordance with Section 7.1. It would be developed in consultation with the roads authorities to ensure that the measures are adequate to address potential safety and asset degradation impacts.

Access tracks

On site access tracks required for construction and operation would be of gravel formations up to 4 metres in width. The total length of access tracks required is 31,360 metres. Tracks are required to the following locations:

- Each site inverter and kiosk transformer site
- Construction site office
- Construction equipment laydown area
- Operations and maintenance building
- Around the perimeter of the solar farm

Once the construction phase has finished, any tracks not used for normal farming practice or PV array maintenance would be rehabilitated. Internal access tracks would be maintained to allow maintenance and repairs to the PV array.

In locating access tracks on site, every effort would be made to:

- Minimise the number and length of necessary access tracks
- Locate access tracks along the route of existing farm tracks
- Locate access tracks to minimise clearing of native vegetation
- Locate access tracks to minimise impact on sensitive biodiversity or heritage areas
- Construct access tracks with due regard to erosion, sediment control and drainage

2.4.6 Fencing and landscaping

The solar farm would be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress. Standard 2 - 2.6 metre cyclone fencing topped with three stranded barbed wire would be installed for perimeter fencing.

Tree planting would be undertaken around the operations and maintenance building and associated parking area for visual mitigation and biodiversity conservation purposes.

2.4.7 Site office and operations and maintenance building

Construction site facilities

During the construction phase, up to 50 staff would be working on site at any time. A suitable location for the construction site office would be identified. This would avoid areas that are environmentally constrained (e.g. contain intact woodland). The site office would include several demountable buildings, and an amenities block located on site for the duration of construction. The site facilities would cover an area of 500 m² and would be fenced independent of the PV array site.

Car parking would be required for between 20 - 40 light vehicles used to transport construction staff to and from the site. The total area used for construction car parking would be approximately 750 m².

A laydown area would also be required for trucks delivering panels and PV array material in shipping containers. Equipment laydown would require an area in the order of 15,000m², subject to container delivery schedule and transformer deliveries. The laydown area would likely be subject to compaction from repeated heavy vehicle use and gravel would be used to stabilise the soil surface. Additionally, in the event containers need to be unloaded from the trucks, a hardstand area would be required for a 50 tonne crane that would be used at the start and end of the project to offload construction

equipment containers. A temporary laydown area would be established in the eastern end of the proposal site at the beginning of the works period and would be relocated closer to the site office as works progress. The proposed areas are indicated in Appendix C.

Operations and maintenance building

The operations and maintenance building incorporating a control room would be located at the north western corner of the site, directly south of the substation. It would provide an office area for the site manager and house communications equipment, maintenance stores and staff amenities.

The operations and maintenance building would be constructed on a concrete slab 20 metres by 20 metres. The building would be constructed with metal or masonry walls, metal roofs, air conditioning, utilities connections and adjacent parking.

A supervisory control and data acquisition (SCADA) industrial control system would be installed and used to monitor and control the solar farm array blocks. In addition to the power reticulation cabling, control and communications cabling is required from the operations and maintenance building to each array block. This control cabling would be installed using the same method and route as the power cabling described above, that is, dug in the same cable trench as underground cables. Control and communications cables would consist of either fibre optic or metal conductors and would be used for monitoring and control of the array blocks and communications to offsite control centres where required.

2.4.8 Security arrangements

Site security during the operational phase would include fencing, security lighting and surveillance equipment. Security personnel would attend the site at a minimum on a drive-by basis during the night, possibly on a permanent basis. Access restriction and safety signage would also be used.

2.4.9 Access to gravel pit for road materials

Gravel would be sourced from a licensed quarry. Ideally, the supplier would be located locally to reduce travel time and costs. Gravel would be required for perimeter and internal access tracks and for a laydown area. Gravel thickness would be 0.1 metres for the access tracks and 0.2 metres for the laydown area. The volume of gravel required is 25,088 cubic metres for the access tracks and 3,000 cubic metres for the laydown area, totalling 28,088 cubic metres.

2.4.10 Estimated impact area

The proposed areas of impact are presented in Table 2-5. These include permanently impacted areas and areas to be impacted and rehabilitated. These areas are calculated in Table 2-6.

Table 2-5: Estimated impact areas of each proposal component

Component	Quantity	Length (m)	Width (m)	Area (m ²)
Site office and facilities	1	20	20	400
Underground electricity transmission (control room to substation)	1	500	0.5	250
Solar panels	360,000	2	1	720,000 (panel surface) 612,000 (ground coverage assuming 30 degree tilt of panels)
Pile driven posts	100,000	0.1	0.1	1,000
Underground cabling (4 circuits)	4	2,500	0.5	5,000
Inverters	140	4.3	2.2	1,324
Pad-mount transformers	70	3	2	420
Internal access tracks	1	18,560	8	148,480
Perimeter tracks	1	12,800	8	102,400
Perimeter fencing	1	12,800	1	12,800
Temporary laydown area	1			15,000
Parking	1			750
Operations and maintenance building (operational phase)	1	12	9	108
Area of infrastructure occupation				200 ha
Total site area				450 ha

Table 2-6: Area of impact summary

Total area permanently cleared for the life of the project ¹	Components	% of site area
267,682m ² (26.8 ha)	Site office and car park	6%
	PV array posts	
	Inverter and transformer pads	
	Perimeter and internal tracks	
	Fencing	
	Operations and maintenance building	
Total area cleared then rehabilitated after construction of the solar farm	Components	% of site area
20,000m ² (2 ha)	Underground cabling	0.4%
	Temporary laydown area	

¹ for the operating life of the solar farm

2.5 PROPOSAL PHASES

2.5.1 Construction and commissioning

Before project approval has been received, it is not possible to define the timeline for the construction of the project. It would be expected that from the time project approval is received, it would take a further number of months to finalise the additional agreements required before construction could commence. This includes finalising the grid connection agreement and ordering long lead-time items such as transformers. An indicative proposed timeline is outlined in Table 2-7.

Table 2-7: Indicative project timeline

Phase	Approximate timeframe	Duration
Construction	September 2012	10 months approx
Commissioning	July 2013	-
Operation	July 2013	30 to 50 years
Decommissioning	2043	To be determined

The construction phase of the solar farm would then occur over a 10 month period and would include such activities as:

- Transportation of people, materials and equipment to each precinct
- Civil works for access track construction and trenching for cables
- Installation of PV array including mounting structure and PV panels
- Construction of onsite power reticulation lines and cables
- Augmentation of substation
- Construction of temporary offices and facilities
- Temporary storage
- Restoration and revegetation of disturbed onsite areas on completion of construction works

This proposal may be constructed in phased or staged approach, with separate groups of infrastructure considered discrete work packages and commenced at different times. In general, construction would commence with the upgrading of roads and all other site civil works, including fencing of the site, preparation of hardstand areas and laying of cables. This would be followed by construction of the site facilities compound, installation of the PV array mounting structures and panels, inverters and kiosk transformers.

The PV array would be constructed using vibrated piling to drive the pylons into the ground. The module mounting structure would be attached to the upright pylons, and the panels fixed to the mounting structure using the pre-drilled mounting holes in the panel frame.

Concrete trucks would be used to supply concrete required for inverter, kiosk transformer and substation augmentation installations and to construct the slab for any proposed buildings. Concrete batching plants would not be required during the project.

The necessary substation augmentation and grid connection works would be carried out in parallel.

The commissioning phase would include pre-commissioning checks on all high-voltage equipment prior to connection to the Country Energy transmission system. Once the solar farm electrical connections have been commissioned and energised, each discrete array block is then connected and put into service.

On completion of construction, disturbed areas would be revegetated and all waste materials removed and disposed of appropriately.

Construction hours

Construction activities associated with the project that would generate audible noise at any residence would be undertaken during the hours of:

Monday – Friday	7am – 6pm
Saturday	8am – 1pm
Sunday and public holidays	Not proposed

These working hours have been proposed to allow reasonable efficiencies of effort to achieve maximum productivity to minimise the overall construction duration. However, some work (e.g. delivery of substation transformer) may occur outside of these hours due to logistic reasons.

2.5.2 Operation

The solar farm would operate for a period of 30 to 50 years. A site manager would be employed and security staff would likely be present at night, and possibly 24 hours a day. Other security provisions would include security lighting and potentially cameras and motion sensors as well as fencing and warning signs to prevent unauthorised access.

While the solar farm operates with minimum personnel, the PV array and other equipment would require regular maintenance. It is possible that some equipment may require unscheduled repair or replacement.

After the expected 25 to 30 year lifetime of the PV panels, the solar panels and other components of the solar farm may be refurbished or replaced to improve the performance or decommissioned and removed from the site.

Routine maintenance

To ensure the solar farm operates in a safe and reliable manner, it would require regular inspection and maintenance on an 'as needs' basis. This would generally be carried out using standard light vehicles and maintenance crews would attend the site as required.

A SCADA system would monitor the solar farm and identify any electrical faults, which could then be addressed by isolating and shutting down the relevant array block pending diagnosis and repair by onsite technicians.