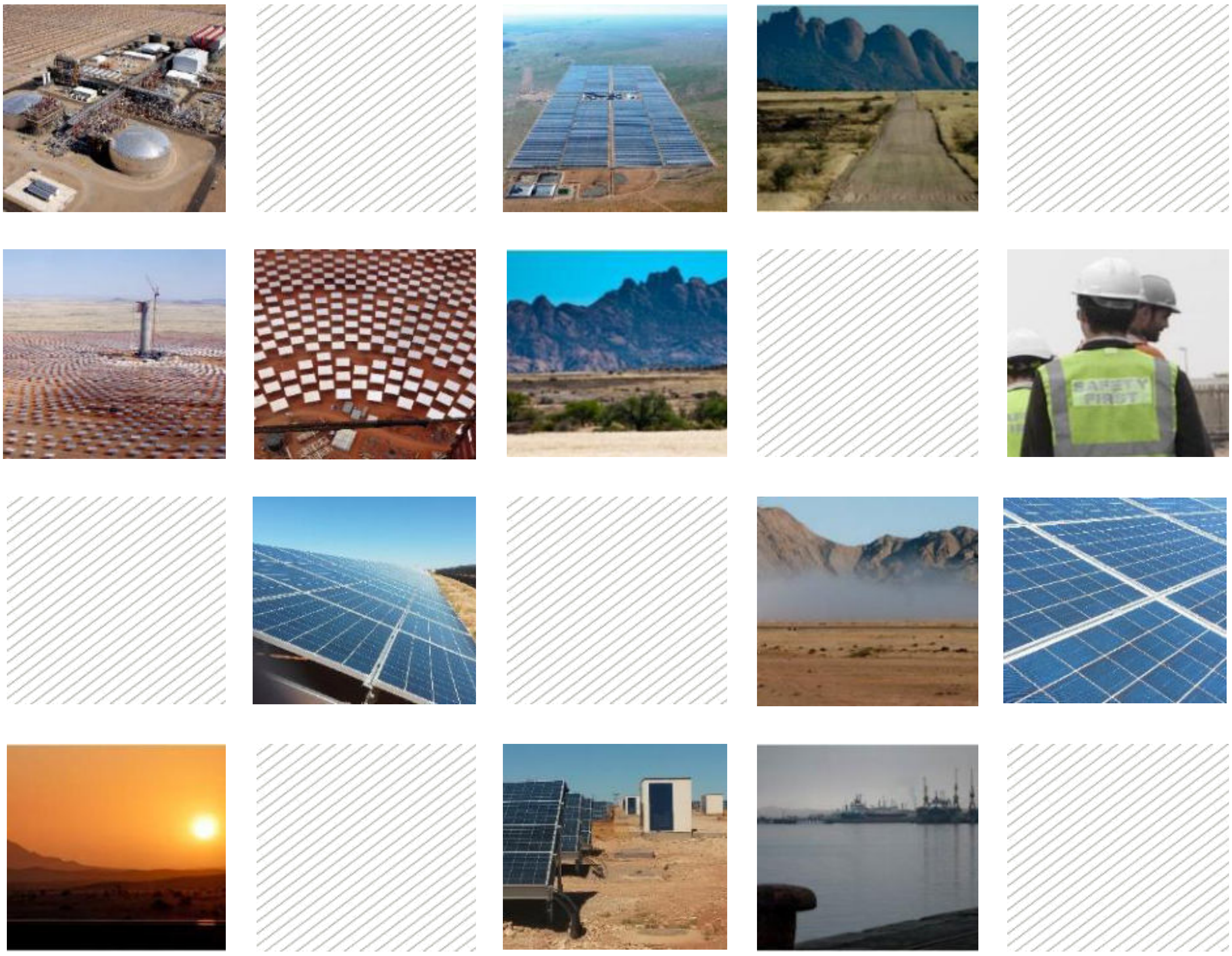
# AMENDED ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACT ASSESSMENT FOR A CONCENTRATED SOLAR POWER FACILITY NEAR ARANDIS IN THE ERONGO REGION

## Final Amendment Report



***Report Number:*** *112503/10816a*

**August 2016**


**Submitted by Aurecon Namibia (Pty) Ltd**

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## REPORT CONTROL SHEET

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| REPORT NUMBER | : *10816a* |
| REPORT TITLE | : Amended *Environmental and Socio-Economic Impact Assessment for a concentrated solar plant facility near Arandis in the Erongo Region – Final Amendment Report* |
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| REVISION | : *Final Amendment Report* |
| PROJECT NUMBER | : *112503* |
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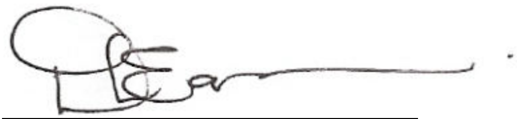

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## Status of this report

**This report is the Final Amendment Report, to be submitted to the Ministry of Environment and Tourism for decision-making. It is also made available to stakeholders for their information in the libraries at Walvis Bay, Swakopmund, and Arandis and the final documentation will be uploaded to the NamPower and Aurecon websites.**

**Minor changes have been made to the Draft Amendment Report to update the document to the Final Amendment Report, as well as address comments raised by I&APs. Information that has been added is underlined.**

# CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# ANNEXURES

**ANNEXURE A - MET: DEA CORRESPONDENCE**

- A1 - Meeting minutes from MET: DEA
- A2 - Erongo Coal-fired Power Station Environmental Clearance Certificate
- A3 - Amendment Application Form

**ANNEXURE B - ENVIRONMENTAL TEAM EXPERTISE**

- B1 - *Curriculum Vitae* of EAPs
- B2 - *Curriculum Vitae* of Specialists

**ANNEXURE C - PUBLIC PARTICIPATION PROCESS**

- C0 - Non-technical summary of the Final Amendment Report
- C1 - Updated list of potential Interested and Affected Parties
- C2 - Photographs of site notices
- C3 - Advertisements for release of Draft Amendment Report and Revised EMP
- C4 - Notification letter to Interested and Affected Parties
- C5 - Key notes from meetings with Councils and the Directorate Civil Aviation
- C6 - Comments and Response Report (CRR)
- C7 - Received comments
- C8 - Record of meetings held to present the Draft Amendment Report
- C9 - Attendance register and photo record for the Draft Amendment Report meetings

**ANNEXURE D - ENVIRONMENTAL MANAGEMENT PLAN**

- D1 - Amended Construction Environmental Management Plan
- D2 - Amended Operational Environmental Management Plan

**ANNEXURE E - UPDATED SPECIALIST STUDIES**

- E0 - Assumptions and limitation
- E1 - Updated Biodiversity Impact Assessment
- E2 - Updated Visual Impact Assessment
- E3 - Updated Air Quality Impact Assessment
- E4 - Updated Socio-Economic Assessment
- E5 - Avifauna Impact Assessment (new)
- E6 - Climate Change Impact Assessment (new)

**ANNEXURE F - ERONGO COAL-FIRED POWER STATION ESEIA**

- F1 - Summary of initial findings related to the Erongo Coal-fired Power facility
- F2 - Approved mitigation measures for the Erongo Coal-fired Power Station

**ANNEXURE G - OTHER**

- G1 - Legal requirements
- G2 - Risks identified for the Erongo Coal-fired Power Station that are applicable to the proposed CSP project
- G3 - Sustainability of proposed CSP project
- G4 - Aviation related policy, legislation and guidelines

# ACRONYMS

| | |
|---|---|
| °C | Degrees Celsius |
| AC | Alternating Current |
| AURECON | Aurecon Namibia (Pty) Ltd |
| BSI | British Standards Institute |
| CLO | Community Liaison Officers |
| CFB | Circulating Fluidised Bed |
| CRR | Comments and Response Report |
| CSI | Corporate Social Investment |
| CSP | Concentrated Solar Power |
| dBA | Descriptor that is used for noise levels which have 10 times logarithmic ratio of quantities with the same units that has been A-weighted. |
| DC | Direct Current |
| DCA | Directorate of Civil Aviation |
| DEM | Digital Elevation Model |
| ECC | Environmental Clearance Certificate |
| ECO | Environmental Control Officer |
| EEPS&EA | Energy and Environmental Program with Southern and East Africa |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EMS | Environmental Management System |
| ESEIA | Environmental and Socio-Economic Impact Assessment |
| FGD | Flue Gas Desulphurisation |
| GHG | Green House Gas |
| Ha | Hectare |
| HIV/AIDS | Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome |
| HCE | Heat Collecting Element |
| HTF | Heat Transfer Fluid |
| HV | High Voltage |
| HV/MV | High Voltage/ Medium Voltage |
| I&AP | Interested and Affected Party |
| ICT | Information and Communications Technology |
| IFC | International Finance Corporation |
| ISO | International Organisation for Standardisation |
| Km | Kilometre |
| $km^2$ | Square kilometre |
| $KNO_3$ | potassium nitrate |
| KOP | Key Observation Points |
| kV | Kilovolt |
| M | Metre |
| $m^2$ | Square metre |
| $m^3$ | Cubic metre |
| MSDS | Material Safety Data Sheets |
| $Mm^3/a$ | Mega cubic metre per annum |
| MET: DEA | Ministry of Environment and Tourism’s Directorate of Environmental Affairs |
| $mg/Nm^3$ | Milligram per normal cubic meter |
| MME | Ministry of Mines and Energy |

| | |
|---|---|
| Mt | Metric tonne |
| MW | Megawatt |
| MWe | Megawatt electric |
| NAMCAR | safety (Namibia Civil Aviation Regulations |
| NamPower | Namibian Power Corporation (Pty) Ltd |
| $NaNO_3$ | Sodium nitrate |
| NEI | Namibia Energy Institute |
| NIDS | Namibian Inter - Censal Demographic Survey |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Nitrogen oxides |
| NUST | Namibia University of Science and Technology |
| OHSAS | Occupational Health and Safety Assessment Series |
| $PM_{2.5}$ | Particulate matter with diameter smaller than 2.5 micrometre |
| $PM_{10}$ | Particulate matter with diameter smaller than 10 micrometre |
| PV | Photovoltaic |
| REEEI | Renewable Energy and Energy Efficiency Institute |
| REIPPPP | South African Renewable Energy Independent Power Producer Procurement Programme |
| SANS | South African National Standard |
| SHE | Safety, Health and Environment |
| SMME | Small-Medium and Micro-Sized Enterprises |
| $SO_2$ | Sulphur dioxide |
| STD | Sexual Transmitted Diseases |
| TES | Thermal Energy Storage |
| VAC | Visual Absorption Capacity |
| VRM Africa | Visual Resource Management Africa |
| $W/m^2$ | Watts Per Square Meter |
| ZVI | Zone Of Visual Influence |

# PURPOSE AND STRUCTURE OF THIS AMENDMENT REPORT

This Amendment Report has been developed to be read in conjunction with the original Environmental and Socio-Economic Impact Assessment Report[1] (ESEIA) for the approved Thermal Coal-fired Power Station in Arandis, Erongo Region in Namibia (hereafter referred to as the Erongo Coal-fired Power Station) and serves as an assessment of the Concentrated Solar Power (CSP) technologies proposed on the same site in order to amend the Environmental Clearance Certificate (ECC), issued on 28 August 2012 from coal-fired technology to CSP technology.

**This Amendment Report, which can be read as a stand-alone document, includes information necessary for decision-making.** More detailed information on baseline site conditions and the approved coal-fired power station is available in the Erongo Coal-fired Power Station ESEIA[1] For ease of reference, where more detailed information on certain aspects considered for the Erongo Coal-fired Power Station (such as baseline conditions) is available, and is also applicable to the proposed CSP project, reference is made to the ESEIA.

A summary of the differences between the approved (i.e. coal-fired power station) and proposed (CSP) technologies are provided in Table 1 below.

**Table 1: Difference in infrastructure requirements of the proposed CSP facility and the approved coal-fired power facility**

| INFRASTRUCTURE COMPONENTS | APPLICABILITY | |
|---|---|---|
| | *COAL-FIRED POWER STATION* | *CSP* |
| **Power Facility** | | |
| **Power facility** | *Including boilers* | *No fuel fired boilers* |
| **Stack(s) to release flue gas** | √ | |
| **Radiator banks for cooling** | √ | √ |
| **Conveyors** | √ | |
| **Ash storage facility** | √ | |
| **Coal storage facility** | √ | |
| **Biomass storage area** | √ | |
| **Limestone storage area** | √ | |
| **Solar field (mirrors and collector)** | | √ |
| **Heat transfer fluid storage tanks** | | √ |
| **Solar tower** | | √ |

[1] *Aurecon, 2012. Environmental and Socio-Economic Impact Assessment for a coal-fired power station in the Erongo Region - Final ESEIA Report.*

| INFRASTRUCTURE COMPONENTS | APPLICABILITY | |
|---|---|---|
| | COAL-FIRED POWER STATION | CSP |
| **Associated Infrastructure** | | |
| Access roads from existing roads to site | √ | √ |
| Rail access from existing line to site | √ | |
| High voltage substation | √ | √ |
| Water storage and treatment facilities | √ | √ |
| Temporary waste storage sites | √ | √ |
| Internal roads on site | √ | √ |
| Transmission lines (alignment not fixed) | √ | √ |
| Water pipelines | √ | √ |
| Additional coal handling facilities at the Port of Walvis Bay | √ | |
| Limestone mine (potential development) | √ | |

The Amendment Report is structured as follows:

| SECTION | PURPOSE |
|---|---|
| **Section 1:** | Describe the context of this Amendment Report, the scope of work undertaken in the original ESEIA and the scope of work in this report. It also includes an overview of the need and desirability for the project. |
| **Section 2:** | Provides a description of the proposed project, the proposed amendment, the site and types are CSP technologies proposed. |
| **Section 3:** | Outlines the team and methodology used to undertake this amendment. |
| **Section 4:** | Describe the public participation and stakeholder engagement process undertaken for this amendment. |
| **Section 5:** | Describes the alternatives that were considered in terms of the proposed change in fuel source from coal to solar and specifically relate to the technology alternatives of CSP. |
| **Section 6:** | Describes and assesses the significance of the potential impacts anticipated to occur during the construction, operation and decommissioning of the proposed CSP facility Mitigation measures are proposed in response to these potential impacts. The impacts are also compared to the potential impacts that were assessed for the Erongo Coal-fired Power Facility. |
| **Section 7:** | Summarises the risks that were identified for the Erongo Coal-fired Power Station in terms of the ISO 31000 requirements and their applicability to the proposed CSP facility. |
| **Section 8:** | Identifies the significant impacts associated with the proposed CSP facility (assuming the mitigation measures proposed have been implemented). The intention is to provide an integrated overview of the impact significance predicted. |
| **Section 9:** | The purpose of this chapter is to summarise the recommendations arising from the various revised specialist studies as related particularly to design and pre-construction activities, prior to the implementation of the Construction and Operational Phase EMPs. |
| **Section 10:** | The purpose of this section is to understand the implications of the proposed CSP facility in the greater context of development within the Erongo Region and to assess how the project meets the goals identified for sustainable development in the region, as part of the Uranium Rush SEA (MME, 2010)). |
| **Section 11:** | This section concludes the report and provide the way forward that will be followed to allow for this project to proceed. |

# 1 INTRODUCTION

*The purpose of this section is to describe the context of this Amendment Report and the scope of work in this report. It also includes an overview of the need and desirability for the project.*

## 1.1 Project background and overview

Namibian Power Corporation (Pty) Ltd (NamPower) submitted an Environmental and Social Impact Assessment (ESEIA) to the Ministry of Environment and Tourism (MET) for the application of an Environmental Clearance Certificate (ECC) for a Coal-Fired Power Station situated at Arandis in the Erongo Region in 2012. The Environmental Clearance Certificate for the proposed coal-fired power station was granted and received on 28 August 2012.

The Government of Namibia has since then decided to rather pursue the development of a Concentrated Solar Power (CSP) or CSP hybridised with PV facility with thermal storage situated at the Arandis site. Therefore an amendment to the ECC is being sought for the development of CSP or CSP/ PV hybridisation technology at this site. The basis of the amendment is to use technology that can utilise solar energy as a fuel in the thermal power station, instead of imported coal.

The rationale behind utilising the Arandis site is to accelerate the implementation of the project as the critical studies are already completed. The intention is to fully optimise the site for a CSP or CSP hybridised with PV facility which could generate between 50 MW and 300 MW of electricity. The proposed CSP or CSP hybridised facility would either be of either of the solar tower or parabolic type; but this will depend on the project feasibility study currently underway.

The proposed CSP facility would include a thermal storage and steam generation component similar to that of the approved coal-fired power station which would transmit the power generated to the national grid. The proposed CSP technology would also employ a conventional steam turbine and a direct dry cooling system.

The proposed project site is located approximately, 9 km north-east of Arandis Town and is approximately 1,370.55 ha[2], which is 720.55 ha larger than the site that was approved for the 800 MW Erongo Coal-fired Power Station.

The major difference between the approved Erongo Coal-fired Power Station and the proposed CSP or CSP hybridised facility is the change in fuel source from coal to solar irradiance; and hence the elimination of coal handling, coal burning and coal storage mechanisms as well as the associated emissions (flue and solids)

### *1.1.1 Motivation for proposed amendment*

The Namibia Energy Institute (NEI) (previously known as Renewable Energy and Energy Efficiency Institute (REEEI)) at the Namibia University of Science and Technology (NUST) (previously known as Polytechnic of Namibia), on behalf of the Ministry of Mines and Energy (MME) and with support from the Energy and Environmental Program with Southern and East Africa (EEPS&EA), commissioned a

[2] Please note that the footprint for the CSP facility will not cover the entire area and will depend on the final design layout.

pre-feasibility study for the establishment of a pre-commercial concentrated solar power (CSP) facility in Namibia which was completed in 2012. The CSP pre-feasibility study focused on the establishment of a CSP facility in Namibia and assessed the technical, environmental, national solar resource, socio-economic and financial aspects of this project. The study concluded that CSP is a viable, mature technology, which is an economically attractive solution for Namibia, as Namibia has some of the best solar resources in the world.

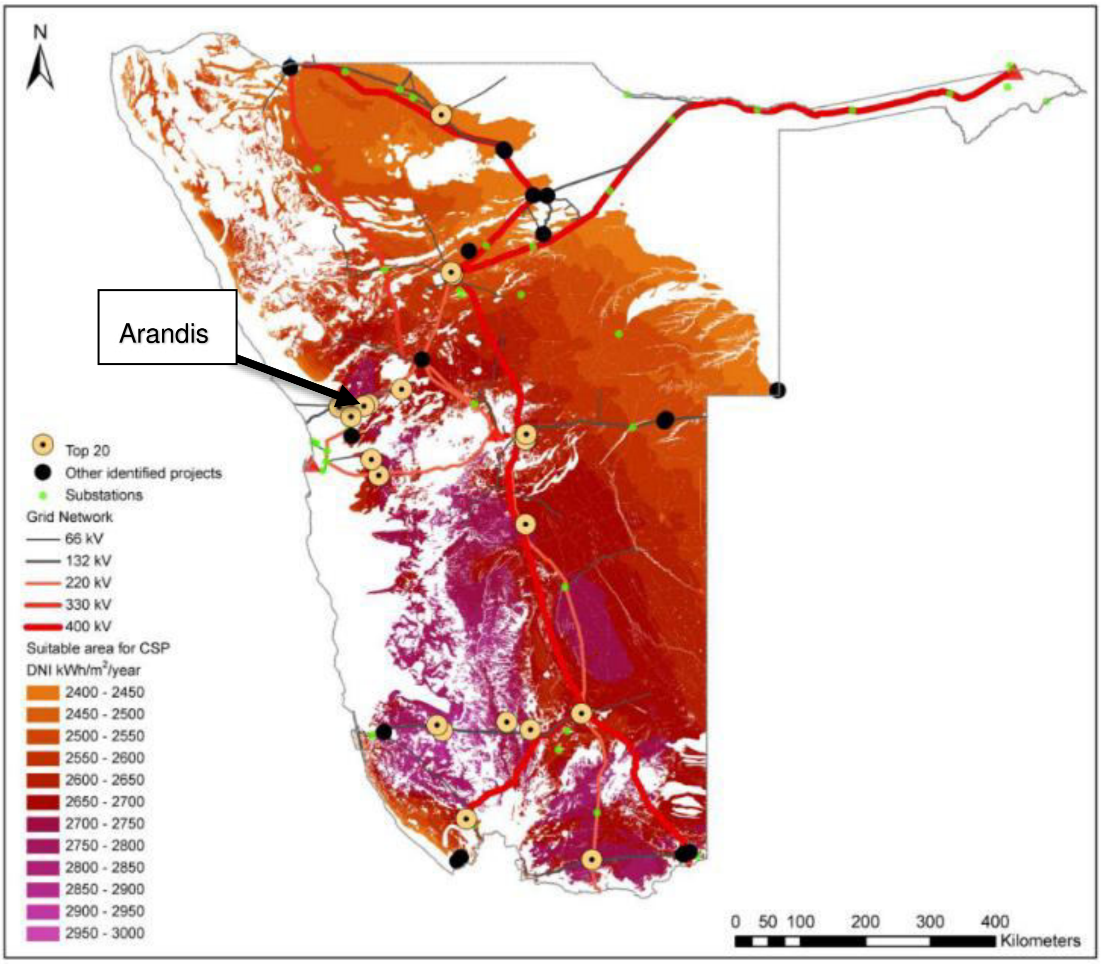



**Figure 1: Top 20 solar resource sites[3]**

According to this study, Namibia has more than 33,000 km$^2$ of potential sites for CSP development that could accommodate more than 250,000 Megawatt electric (MWe) of projects, of which the study identified the top five sites from 38 sites (Figure 1).

Although the Arandis site was ranked as number ten in the pre-feasibility study, the Namibian Power Corporation (Pty) Ltd (NamPower) identified the development of a CSP facility at Arandis as a feasible alternative to the approved 300 - 800 Megawatt (MW) Erongo Coal-fired Power Station which has not yet been developed.

The fact that critical specialist studies have already been completed will allow NamPower to accelerate the implementation of this project. The intention is to fully optimise the site for a CSP or CSP hybridised with Photovoltaic (PV), which could generate between 50 MW and 300 MW electricity.

[3] *Pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia (2012).*

**Table 2: Approved (in bold) and proposed fuel technologies to supply the Thermal Power Facility**

| STATUS | GENERATION PROCESS | FUEL SOURCE | CAPACITY | SITE | PURPOSE |
|---|---|---|---|---|---|
| **Approved** | **Thermal generation facility** | **Coal** | **300-800 MW** | **1061.05ha** | **Base load to mid-merit supply** |
| Proposed | | Solar | 50-300 MW | 1,370.55ha | |

### *1.1.2 Scope of work*

Aurecon Namibia (Pty) Ltd (Aurecon) was appointed by NamPower to compile and submit an Amendment Report to the Environmental and Socio-Economic Impact Assessment (ESEIA) from coal-fired to CSP or CSP/PV hybridisation technology with Thermal Energy Storage (TES) to amend the Environmental Clearance Certificate that was issued on 28 August 2012 for the Erongo Coal-fired Power Station. In terms of this report, the term CSP facility includes Thermal Energy Storage and potential hybridisation with PV, as the magnitude of potential impacts associated with CSP technology is considered to have greater significance than that of PV technology. Therefore the impact significance of PV technology has been assessed under that of the CSP technology as it would not exceed the anticipated impacts.

The Scope of Work for this amendment process includes:

- Determine changes to potential impacts assessed for the Erongo Coal-fired Power Station;
- Determine additional potential impacts related to the proposed technology change;
- Revise the following specialist impact assessments to consider the new technology alternatives:
  - Visual Impact Assessment;
  - Socio-economic;
  - Ecology; and
  - Air Quality.
- Undertake the following additional specialist studies to address potential impacts that were not assessed for the Erongo Coal-fired Power Station:
  - Avifauna
  - Climate Change
- Consult with the responsible authorities and stakeholders in a stakeholder engagement process to ensure that Interested and Affected Parties (I&APs) are given an opportunity to participate in the process;
- Identify additional mitigation measures for the design, construction, operation and closure phases of the project life cycle; and
- Compile an Amendment Report and update the Environmental Management Plan (EMP) for submission to the relevant authorities.

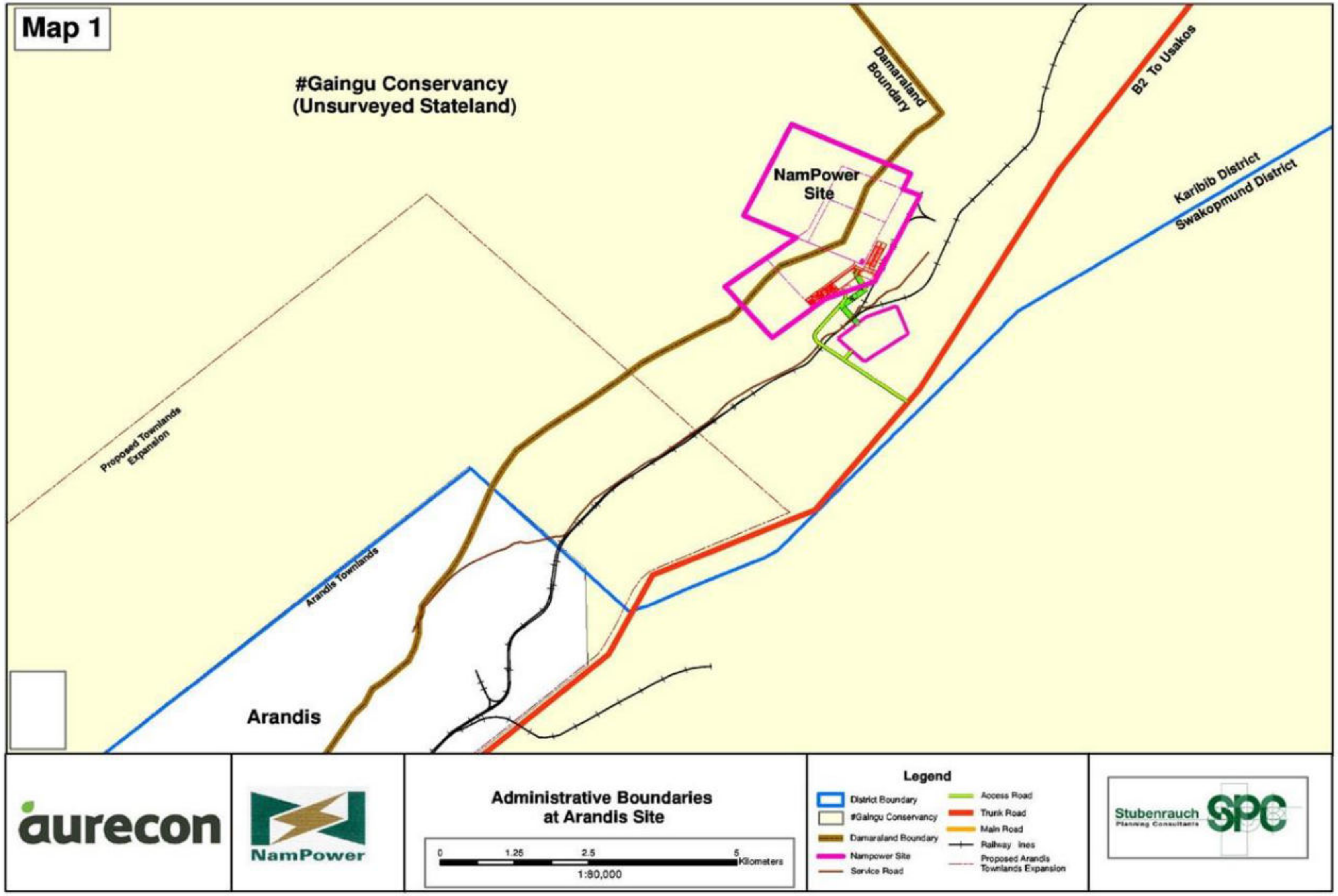



**Figure 2: Locality Map for the approved Arandis Coal-Fired Thermal Power Station**

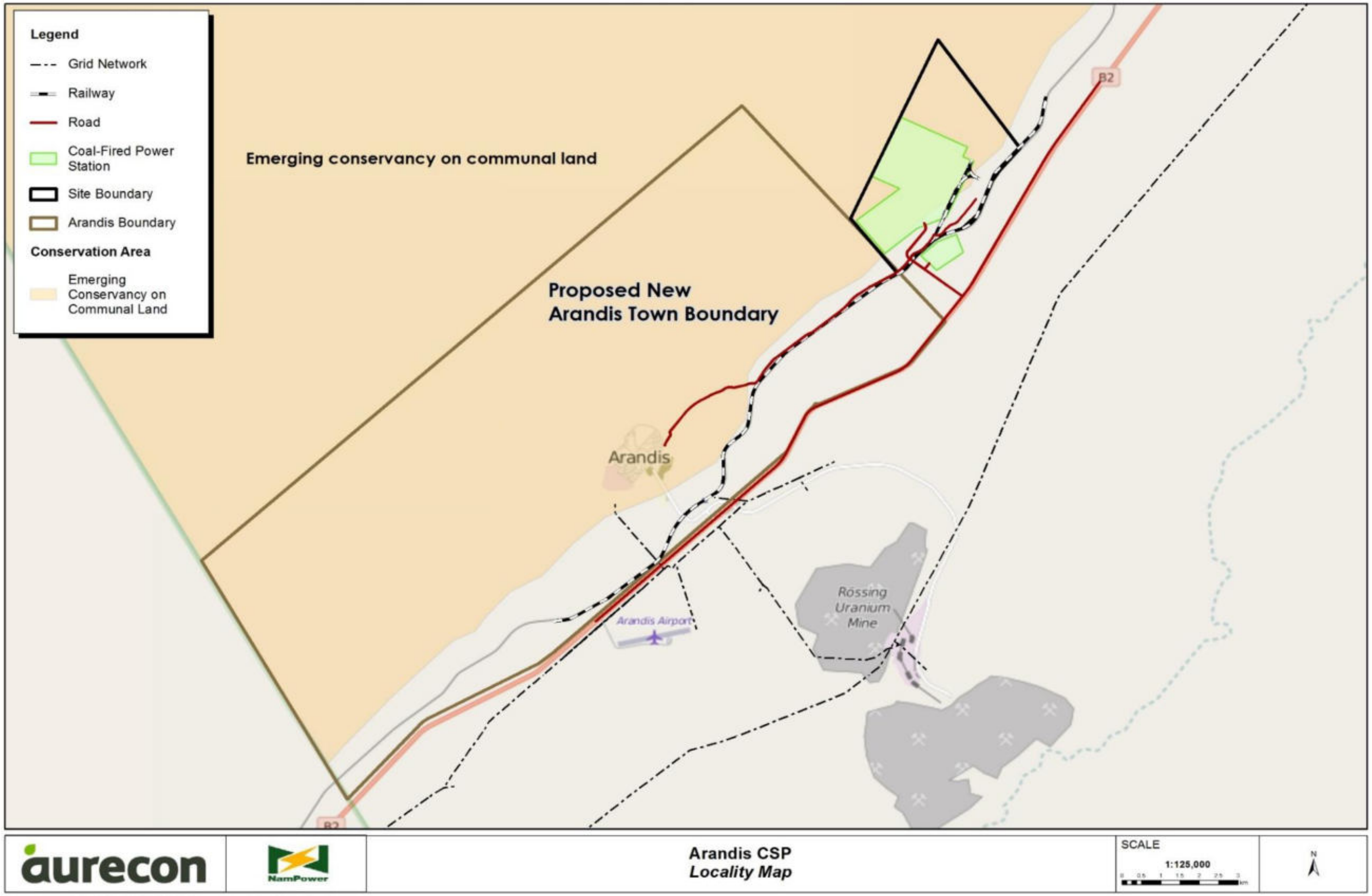
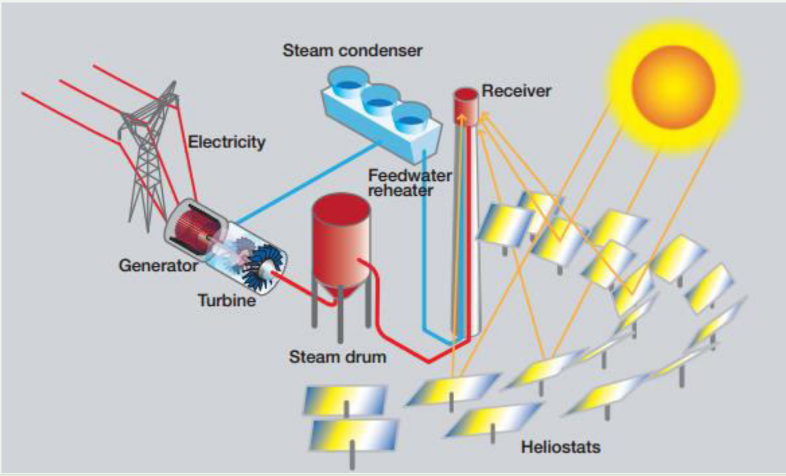
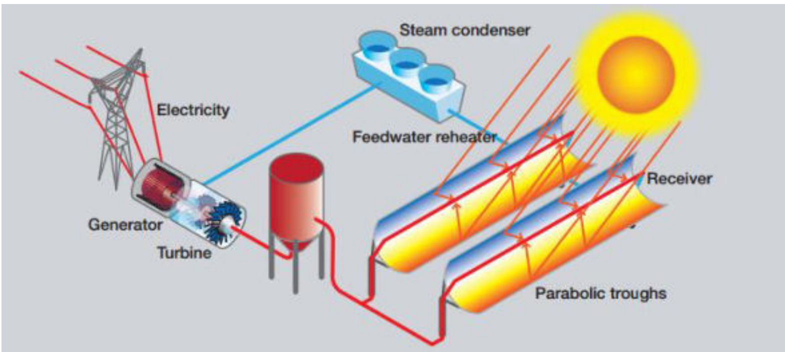
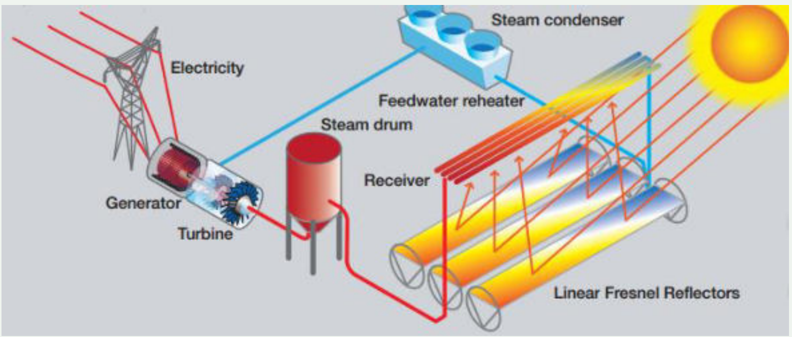



**Figure 3: Locality Map for the proposed Arandis CSP Thermal Power Facility**

### *1.1.3 Introduction to proposed technologies*

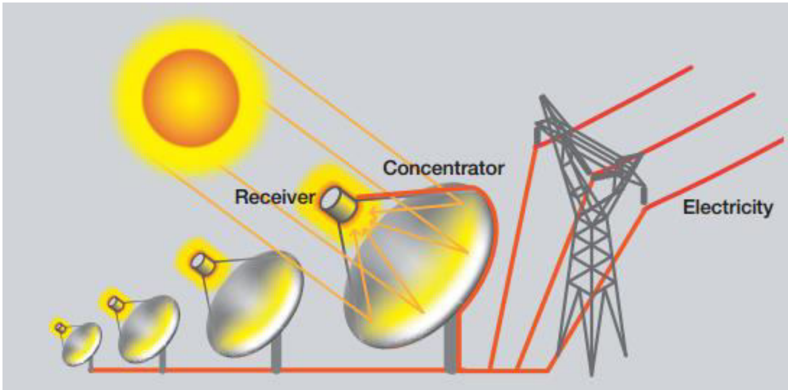
The proposed project would entail developing one of the CSP technologies in Table 3 with Thermal Energy Storage and potential hybridisation with PV[4] . For more detailed descriptions of the alternative technologies assessed, please also refer to Sections 2 and 4 of this report.

**Table 3: CSP technologies, storage and hybridization proposed (Source: NREL)**

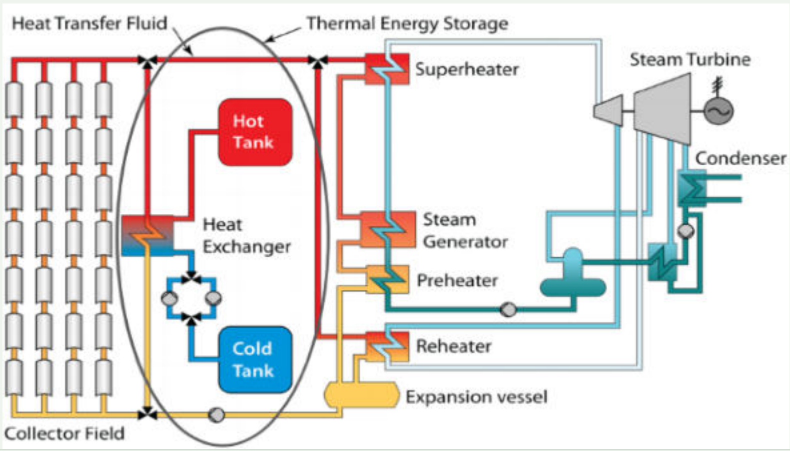
| PROPOSED TECHNOLOGY ALTERNATIVES | ILLUSTRATION OF CSP TECHNOLOGY |
|---|---|
| ***Solar Power Tower*** |   |
| ***Parabolic Trough*** |   |
| ***Linear Fresnel*** |   |

*[4] A hybrid energy system, or hybrid power, usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply.*

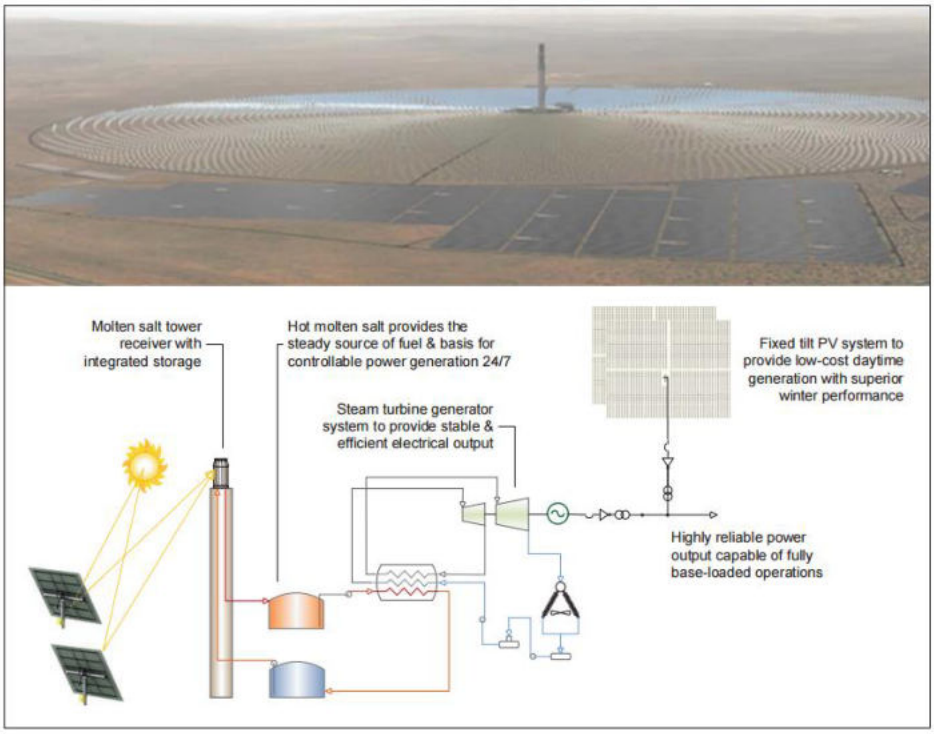
***Dish Engine***




***Thermal Energy Storage (TES)***




***TES and hybridized PV component***[5]




[5] *A. Green et al. / Energy Procedia 69 (2015)*

## 1.2 Legal and policy context

### *1.2.1 Applicable legislation*

A host of legal documents, policy documents, and guidelines have been consulted to ensure that the Amendment takes cognisance of all relevant Namibian environmental legislation, as well as taking into account international best practice. Please refer to Annexure G1 for a summary of the applicable listed activities and approval requirements as taken from the Draft Amendment Report.

## 1.3 Consultants' details

Aurecon has been appointed as the lead consultant for the amendment of the ECC. Aurecon provides engineering, management and specialist technical services to government and private sector clients such as NamPower. Aurecon assembled a team of professionals to provide specialist input during the initial ESEIA and for this Amendment, the details of which are provided in Section 3.1. The *curricula vitae* of the lead consultant team are included in Annexure B.

# 2 PROJECT DESCRIPTION

*This section provides a description of the proposed project, the proposed amendment, the site and types are CSP technologies proposed.*

## 2.1 Location

The project site, also known as Farm Arandis Power No. 247, comprises 1 370 hectares and is located approximately 9 km east of the centre of Arandis Town on government owned land that forms part of the ≠Gaingu Community Conservancy.

As the project site is located on communal land, NamPower is in the process of applying for a 99 year lease under the leasehold provision of the Communal Land Reform Act (Act no. 5 of 2002). In future, it is NamPower's intention to procure the project site. This proposed footprint has been overlaid with the approved coal-fired power stations footprint as a comparison of the study area (Figure 3).


**Figure 4: Approved footprint (green area) overlaid with the proposed footprint (solid black line)**

## 2.2 Proposed amended activity

NamPower's original proposal was to build a 150 to 300 MW coal-fired power station that could be upgraded to 800 MW in future. The site is near Arandis in the Erongo Region. NamPower now proposes to develop a CSP facility on the same site with a capacity of 50 MW to 300 MW comprising of either parabolic trough technology or solar tower technology with up to 12 hours storage capacity (or longer) and potentially also hybridised with PV technology.

The proposed CSP facility would include a thermal generation component and associated infrastructure similar to that of the approved coal-fired power station with the final objective of transmitting the power generated to the national grid. The CSP facility would also employ a conventional steam turbine and a direct dry cooling system. The proposed site for the CSP facility is 1,370.55 ha in size in comparison to the 400 ha required for the 300 MW or 650 ha for the 800 MW Erongo Coal-fired Power Station. It is not anticipated that the proposed CSP facility would utilise this entire area, however this would be largely depend on the final plat size and technology selected. For example the total aperture area for a typical 100 MW CSP facility is approximately 350 ha and the total parabolic collector area can reach a width of 2000 m with a length of 1500 m on average equating to 300 ha (NamPower).

The major difference between the approved Erongo Coal-fired Power Station and the proposed CSP or CSP hybridised facility is the change in fuel source from coal to solar irradiance; and hence the elimination of coal handling, coal burning and coal storage mechanisms as well as the associated emissions (flue and solids). All other components are however very similar as indicated in Table 1 and Section 2.2.2.

### *2.2.1 Technology overview*

Figure 5 below illustrates how solar tower CSP and PV technology works. In general a **CSP facility** produce electricity by utilising concentrated sunlight to heat a transfer fluid which in turn heats water to produce steam. In a solar tower power plant, the sun rays are concentrated directly on solar receivers ("boilers") which heat water to produce steam. The steam flows at a very high pressure into a turbine, which rotates a generator to produce electricity. The steam is then condensed back into water and returned to the solar receiver to be recycled through the process again. In parabolic trough CSP plants (see Figure 11) the sun rays are concentrated on absorber tubes which contain a heat transfer fluid, normally a mineral oil. The heated oil is then circulated through a heat exchanger to heat water to create steam. Any excess heat is stored in a suitable storage medium (see Figure 11). Typical thermal storage media are molten salts, concrete, pebbles etc. Thermal storage allows the CSP plant to utilise this stored energy to provide electricity during non-sunlight hours. **Conventional PV** technology on the other hand generates electricity using solar cells or photovoltaic cells, which converts sunlight directly into direct current (DC) electricity. An inverter is used to covert the DC power to alternating current (AC) power.

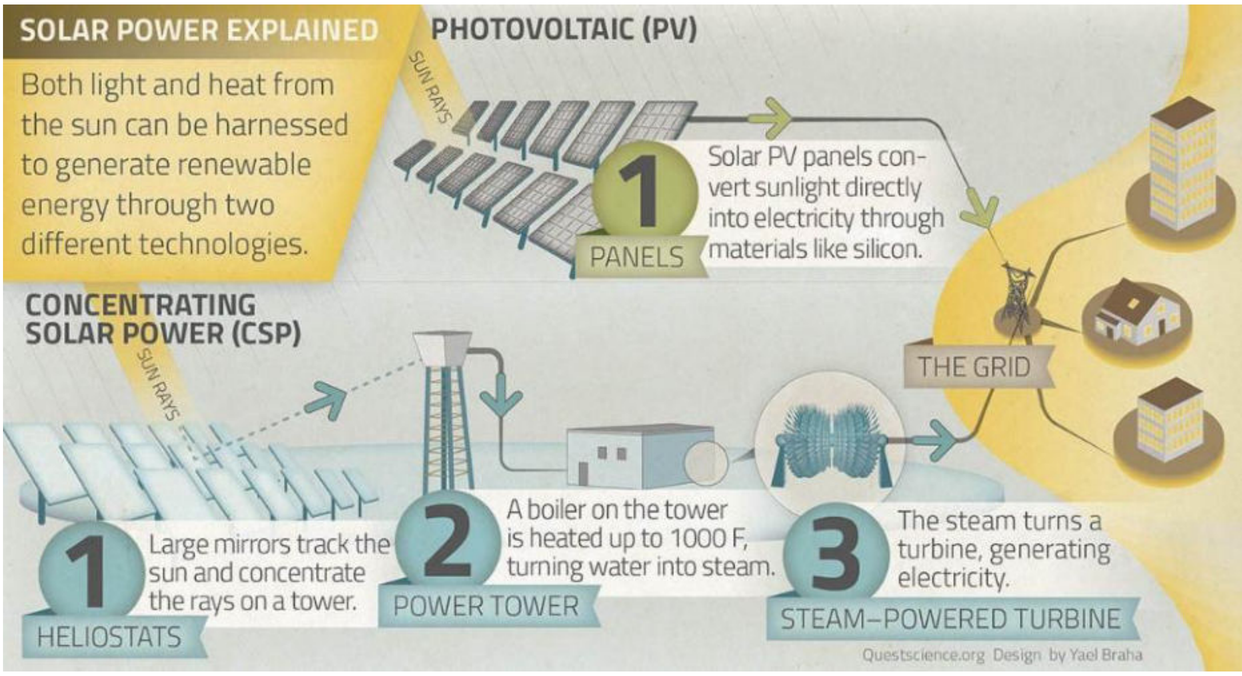



**Figure 5*:* Diagram illustrating how a CSP facility (solar power tower) and PV facility are hybridised to generate electricity[6]**

CSP technology utilises four alternative technological approaches:

- Parabolic Trough systems;
- Linear Fresnel systems;
- Solar power tower systems; and
- Dish/engine systems.

NamPower is considering the use of **(a) parabolic trough** or **(b) solar power tower (central receiver) CSP technology** which can be **(c)** hybridised with **PV technology**. The other two technologies, parabolic dish and Linear Fresnel, is not efficient for larger utility scale power generation applications and are therefore not considered in this Amendment Report.

#### *2.2.1.1 CSP Parabolic Trough with Thermal Storage[7]*

Parabolic trough technology uses large u-shaped (parabolic) mirrored panels, called reflectors, to focus solar energy on a heat collecting element (HCE). The HCE consists of a coated steel pipe that is surrounded by an evacuated glass tube to minimise heat loss. Through this HCE, a heat transfer fluid (HTF) (such as oil) is circulated to collect and transport heat from the solar field to the power block. The mirror reflectors are tilted toward the sun, and focus sunlight on the pipes to heat the HTF inside the HCE to approximately 400°C. The heat from the HTF is transferred to the water, converting the water to steam (superheated) which then drives a turbine and generator to produce electricity.

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[6] Source: *Questscience.org*

[7] NREL CSP Fact Sheet. 2012. *Pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia.*

**Figure 6: Photographs of the KaXu CSP facility, South Africa**

One of the advantages of CSP with Thermal Energy Storage (TES), over a non-dispatchable renewable power plant is that it can provide electricity during maximum demand periods (evening peaks) when there is reduced or no solar resource (see Section 2.2.1.3 for a detailed description of this TES systems). This is shown in Figure 7 below where the “portion of generation provided by Solar” does not need to follow the “sunshine” curve. During the day some of the sun’s energy is diverted into TES which is then called used during the evening peak demand period to produce electricity.

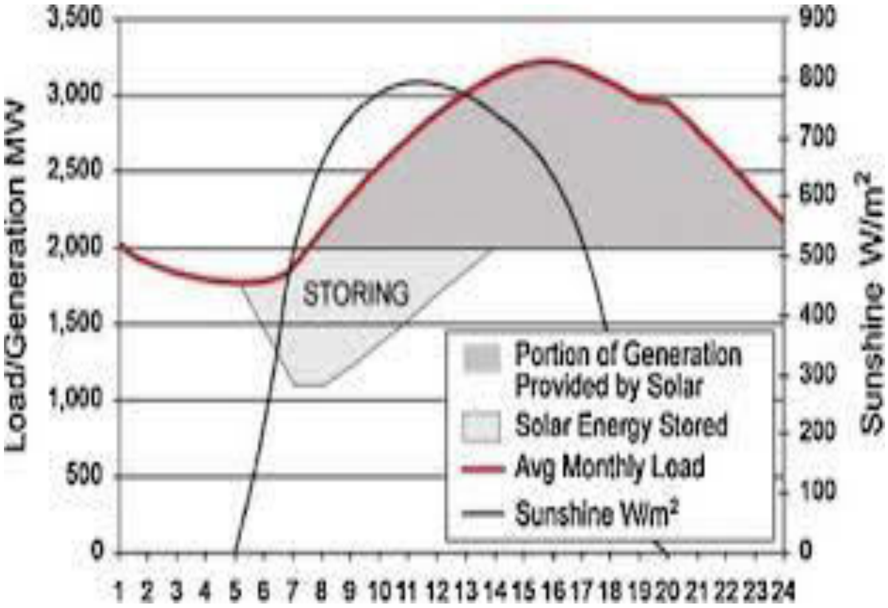


**Figure 7: Utilisation of thermal storage to produce electricity outside of daylight hours**

The size of the solar field, in conjunction with solar irradiance, determines the amount of thermal energy that will be available to the power block. The sizing of the solar field is important because the relative size of the solar field and power block will determine the capacity factor of the CSP plant and the extent to which thermal energy will be utilized.

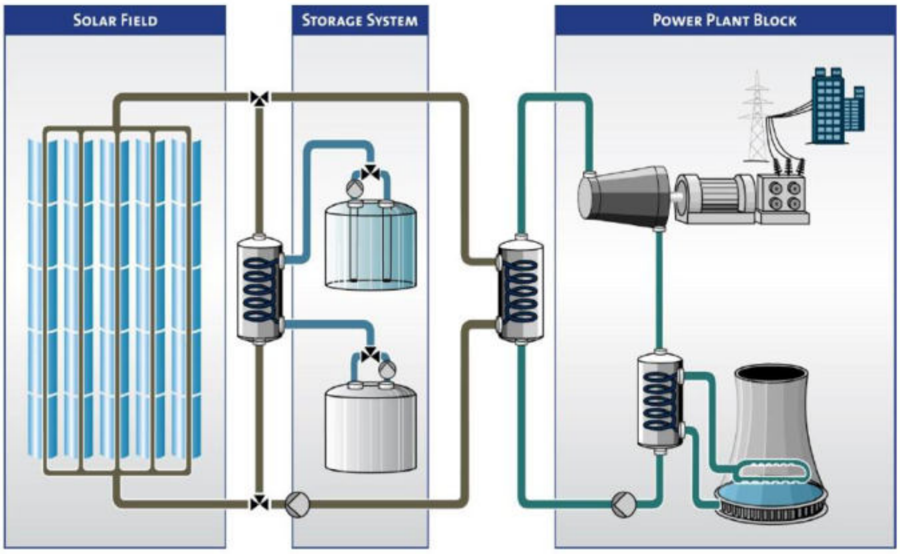


**Figure 8: Typical layout of a parabolic trough CSP facility[8]**

A further advantage of a CSP plant with storage over a PV power plant is that the CSP facility can overcome the intermittency of solar radiation. TES systems can collect energy during sunshine hours and utilise the storage thermal energy to smooth the electricity output of the power plant during cloudy weather conditions. Therefore the operation of a solar thermal power facilities have the advantage of extending their generation beyond periods of little or no solar radiation. Energy storage not only reduces the mismatch between supply and demand but also improves the performance and reliability of energy systems[9].

*2.2.1.2 Central Receiver CSP with TES[10]*

Solar power towers, also called central receivers, use a large number of flat heliostats (mirrors) to track the sun and focus its rays onto a receiver. As shown in Figure 9, the receiver sits on top of a tall tower in which concentrated sunlight heats the HTF. In the receiver, the HTF absorb the heat, which is then used to covert water to steam, which is sent to a conventional steam turbine-generator to produce electricity. The heated HTF can either be used immediately to make steam for electricity generation or stored for later use. Molten salt which is stored in the thermal insulated thermal tanks retains its heat efficiently, so heat can be stored for several days before being converted into electricity. That means electricity can be produced during periods of peak demand even on cloudy days or after sunset.

---

8 Pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia (2012).

9 Thermal energy storage for concentrating solar power plants. Sarada Kuravi, D. Yogi Goswami, Elias K. Stefanakos, Manoj Ram, Chand Jotshi, Swetha Pendyala, Jamie Trahan, Prashanth Sridharan, Muhammad Rahman and Burton Krakow Clean Energy Research Center, University of South Florida, Tampa FL 33620

10 Source: http://solareis.anl.gov/

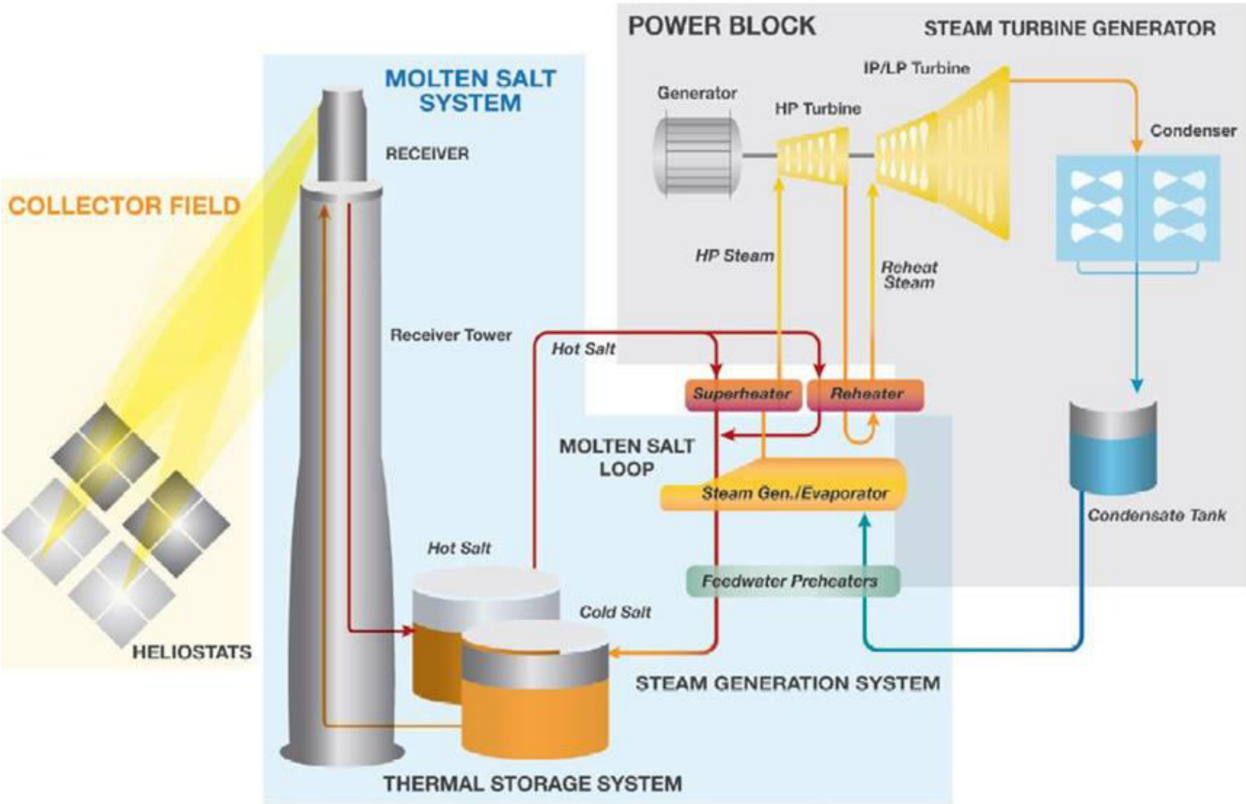


**Figure 9: Typical layout of a solar power tower CSP facility (Source: SolarReserve)**

For solar tower technology, the height of the tower is usually between 200 m to 250 m. The receiver structure absorbs the concentrated energy and transfers this heat to the HTF (molten salt or water). Temperatures at the external surface of the receiver could reach approximately 600°C. A central receiver CSP plant can have up to 70 000 heliostats of 25 $m^2$ aperture in the solar field. Depending on the facility's design, the heliostats can be raised up to 6 m off the ground.

**Figure 10: SolarReserve's Crescent Dunes CSP Project, near Tonopah, Nevada, has an electricity generating capacity of 110 megawatts. (Source: SolarReserve)**

#### 2.2.1.3 Thermal Storage Technology Options

A CSP plant with TES (either a two tank system or an indirect system) consists of three independent but interrelated components that can be sized differently: the power block, the collector field, and the thermal storage tank. An example of a parabolic trough with TES is illustrated in Figure 11.

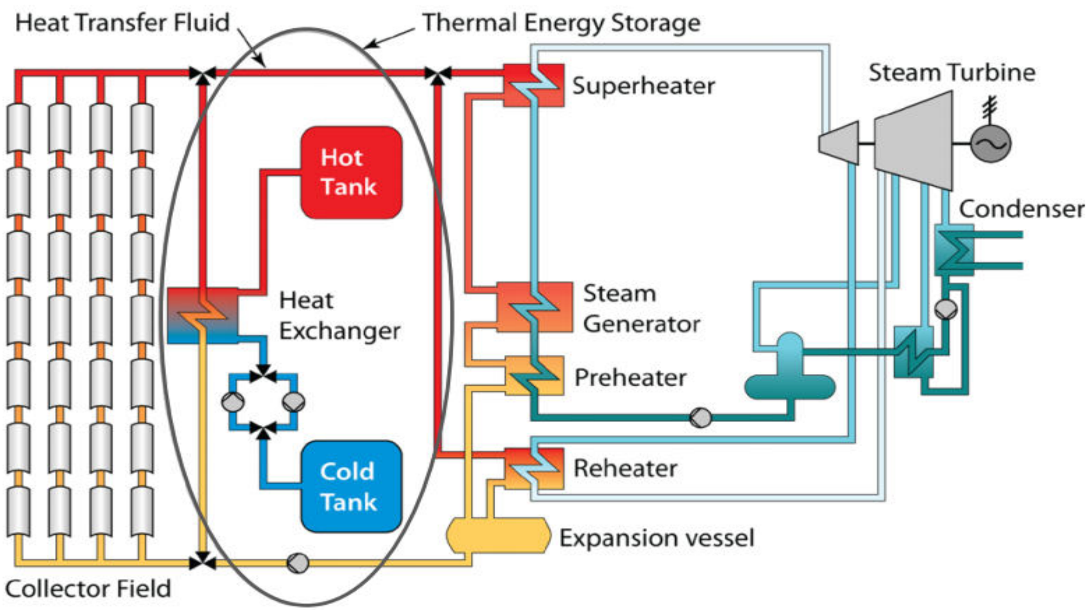


**Figure 11: Schematic of parabolic trough power plant with two-tank, molten-salt thermal storage. (Source: NREL)**

In a two-tank system, the fluid is stored in two tanks, one at a high temperature and the other at a low temperature. HTF from the low temperature tank flows through the solar collector or receiver, where it is heated and then flows to the high-temperature tank for storage. When required, the HTF is then pumped from the high temperature tank through a heat exchanger, where it coverts water to steam for electricity production. The HTF exits the heat exchanger at a low temperature and returns to the low-temperature tank.

An indirect system, on the other hand, uses different fluids for heat-collection and storage. This type of system is used in facilities in which the heat-transfer fluid is too expensive or not suited for use as the storage fluid. The storage fluid flows from the low-temperature tank through an extra heat exchanger, where it is heated by the high-temperature heat-transfer fluid. The high-temperature storage fluid then flows back to the high-temperature storage tank. The fluid exits this heat exchanger at a low temperature and returns to the solar collector or receiver, where it is heated back to a high temperature. Storage fluid from the high-temperature tank is used to generate steam in the same manner as the two-tank direct system. The indirect system requires an extra heat exchanger, which increases system cost.

Figure 12 lists a variety of TES options for CSP plants. They fall into three general categories: sensible, latent, and thermochemical storage. The only TES system that currently operates with multiple hours of storage is the sensible, two-tank, molten-salt system and is therefore the option considered in this Amendment Report. Furthermore, the components associated with molten-salt handling system (i.e. pumps, valves, tanks, and heat exchangers) have demonstrated reliable operation at commercial scale.

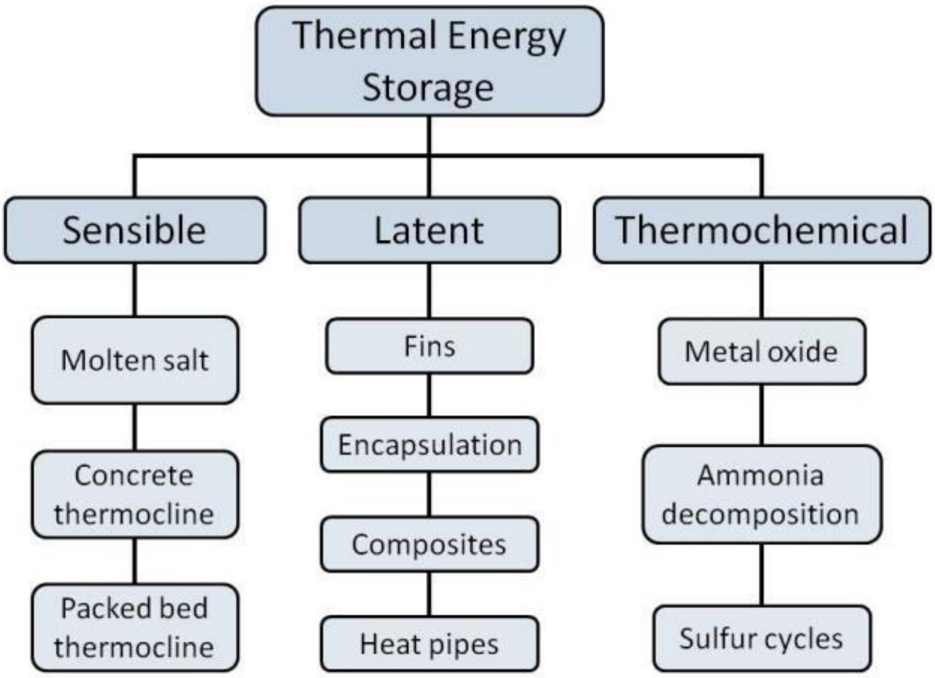


**Figure 12: Thermal energy storage options for CSP technologies (Source: NREL)**

The molten-salt storage fluid is a mixture of sodium nitrate ($NaNO_3$) and potassium nitrate ($KNO_3$). This fluid is liquid in both the charge and discharge states, so there are minimal heat-transfer limitations, making the heat-exchanger design relatively straight-forward. Molten salt operates at temperatures up to 550˚C, however the salt does solidify at a temperature of approximately 220˚C which can be problematic for continues operation of the CSP facility (Ombello, 2010)[11]. According to SolarReserve[12] a 100 MW CSP facility would be able to generate electricity for up to 24 hours during the summer months and between 12 and 16 hours from autumn to spring by making use of a molten salt TES system. Both sodium nitrate ($NaNO_3$) and potassium nitrate ($KNO_3$) are non-toxic, but can be an irritant if it comes into contact with skin, eyes or if inhaled[13]. It is also inert in nature and is thus considered an environmentally acceptable HTF[14].

### 2.2.2 Project components

Table 4 provides a short description of each of the project components that would be required for the proposed CSP facility.

[11] Ombello, C. 2010. Guardian Environment Network: The world's first molten salt concentrating solar power plant. Available online: http://www.theguardian.com/environment/2010/jul/22/first-molten-salt-solar-power.

[12] SolarReserve. 2012. Draft Environmental Impact Assessment Report for the proposed Arriesfontein Concentrated Solar Power Plant on the farm 267, near Danielskuil in the Northern Cape.

[13] Source: http://www.sciencelab.com/msds.php?msdsId=9927271 and http://www.sciencelab.com/msds.php?msdsId=9927232

[14] Way, J. 2008. Storing the Sun: Molten Salt Provides Highly Efficient Thermal Storage. Available online: http://www.renewableenergyworld.com/articles/2008/06/storing-the-sun-molten-salt-provides-highly-efficient-thermal-storage-52873.html

**Table 4: Physical and operational characteristics of the proposed CSP facility**

| CSP CAPACITY (NET POWER OUTPUT) | 100- 300 MW CSP FACILITY |
|---|---|
| **Physical characteristics** | |
| **Total extent (ha) – single site built in stages** | 700 - 1350 ha depending on selected technology |
| **Operating hours** | Up to 7500 hours per annum |
| **Power facility technology** | |
| **Heat exchanger** | • Solar tower receiver (direct steam)<br>• Solar tower receiver (molten salt)<br>• Steam generator system (thermal oil)<br>• Steam generator system (molten salt) |
| **Turbine** | Condensing steam turbine |
| **Cooling technology** | • Direct dry cooling system (air cooled condenser) with option of spray water supplement during peak times |
| **Fuel** | |
| **Fuel type** | Concentrated Solar Power and hybridised PV |
| **Thermal Storage** | |
| **Storage tanks** | Thermal storage tanks required for up to 12 hours of plant capacity, or longer |
| **Raw process water requirements** | |
| **Demand ($Mm^3/a$)** | Approximately 150k to 300k $m^3/a$ for 125 MW with dry cooling technology (make up water and cleaning)[15] |
| **Water storage on site** | 2 tanks of 4,000 $m^3$ |
| **Roads** | |
| **Access Road** | Approximately 2.5 km from the national road, B2[16], to the site (asphalt) |
| **Internal roads** | Approximately 5 km (all roads except to be asphalt) |

## 2.3 Comparison between authorised and proposed technologies

As mentioned earlier, the proposed CSP facility (regardless of tower or trough technology) would be utilising very similar infrastructure components to what would have been required for the Erongo Coal-fired Power Station (see Table 1). Additional infrastructure required for the CSP facility includes:

- Solar field (mirrors and collector);
- Heat transfer fluid storage tanks; and
- A solar tower (for the solar power tower CSP technology alternative).

[15] Please note that the final volume of cooling water may change depending on the hours of storage, dispatch regime and final plant design. However, the total volume of water required for the proposed CSP facility will not exceed the volume approved for the Erongo Coal-fired Power Station.

[16] Road between Swakopmund and Windhoek.

## 2.4 Project timeframes

The proposed CSP facility would take approximately 27 to 36 months to construct and should be in operation by the second half of 2019, if commenced in 2017. It would operate for approximately 40 years after which the facility would either be upgraded or decommissioned. Figure 13 indicates the development lifecycle with relevant timelines.

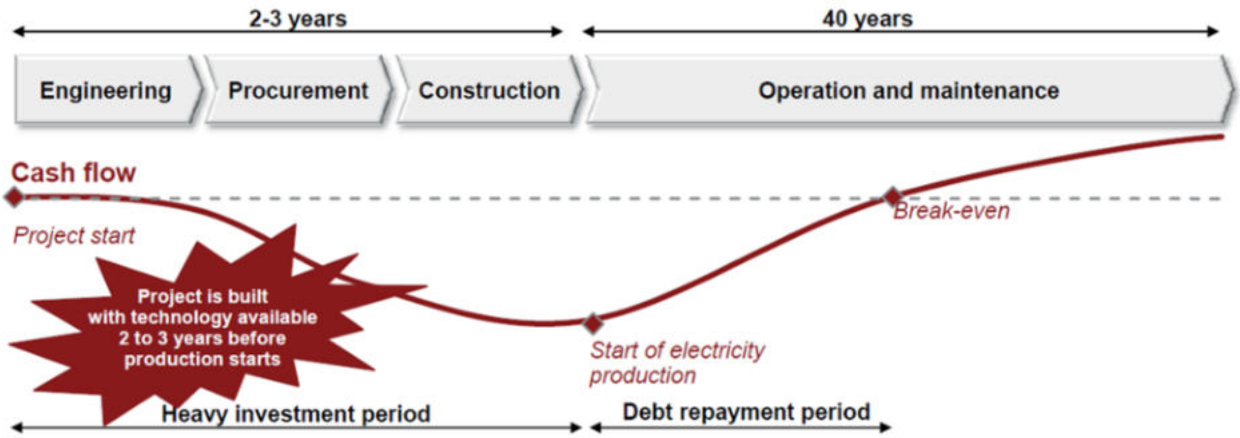


**Figure 13: Development timeline (Source: NamPower)**

# 3 METHODOLOGY

*This section outlines the team and methodology used to undertake this amendment.*

## 3.1 Professional team

### *3.1.1 The Environmental Team*

Aurecon has selected a number of the original ESEIA team members given their experience with and knowledge of the Coal-fired Power Station ESEIA to assist with the compilation of a robust amendment report. In addition, highly qualified team members that have technical expertise in CSP and PV technologies have also been involved (Table 5). The *Curriculum Vitae's* of the key Aurecon staff and Specialists are attached as Annexure B.

As emphasised in the original ESEIA, independence of the environmental consultant from the project proponent reduces the potential for bias in the environmental process. Therefore, neither Aurecon nor any of its sub-consultants are subsidiaries of NamPower nor is NamPower a subsidiary to Aurecon. Furthermore, none of these parties have any interests in secondary or downstream developments that may arise out of the authorisation of the proposed project.

**Table 5: The ESEIA Project Team**

| NAME | FIRM | AREA OF EXPERTISE | POSITION ASSIGNED | TASK ASSIGNED | ORIGINAL TEAM MEMBER |
|---|---|---|---|---|---|
| **Andries van der Merwe** | Aurecon (South Africa) | Environmental Process (EIA) | Project Director | Internal Reviewer | √ |
| **Diane Erasmus** | Aurecon (South Africa) | Environmental Process (EIA) | Project Reviewer | Internal Reviewer | √ |
| **Franci Gresse** | Aurecon (South Africa) | Environmental Process (EIA) | Project Leader | EIA Process and project overview | |
| **Ilze Rautenbach** | Aurecon (Namibia) | Environmental Process (EIA) | Project Staff | EIA Process | |
| **Simon Clark** | Aurecon (South Africa) | Environmental Process (EIA) | Project Staff | EIA Process | |
| **Kobus van der Merwe** | Aurecon (South Africa) | CSP technology | Specialist | Technical Review (facility design) | |
| **Shane Eglington** | Aurecon (South Africa) | PV technology | Specialist | Technical Review (facility design) | |
| **John Irish** | Biodata Consultancy cc | Biodiversity Specialist | Specialist | Specialist investigations | √ |

| NAME | FIRM | AREA OF EXPERTISE | POSITION ASSIGNED | TASK ASSIGNED | ORIGINAL TEAM MEMBER |
|---|---|---|---|---|---|
| **Chris van Rooyen** | Chris van Rooyen consulting | Avifauna | Specialist | Specialist investigations | |
| **Daniel Brink & Dave Ogier** | Aurecon (South Africa) | Climate Change | Specialist | Specialist investigations | |
| **Noeleen Greyling** | Aurecon (South Africa) | Socio-economic | Specialist | Specialist investigations | |
| **Stephen Stead** | VRMA cc | Visual Assessment | Specialist | Specialist investigations | √ |
| **Hanlie Liebenberg-Enslin** | Airshed Planning Professionals | Air quality | Specialist | Specialist investigations | √ |

## 3.2 Process to date

A meeting was held between NamPower and MET: DEA on 20 August 2015 to confirm that an amendment process would be allowed to change the electricity generation technology from coal-fired to CSP (see Annexure A). Following this meeting, Aurecon was appointed to undertake the amendment process in February 2016. Specialist were appointed to assess the proposed change in technology as described in Section 3.3 below. Meetings were also arranged with various stakeholders, including the Directorate Civil Aviation, (see Section 4.2) to introduce the proposed technology amendment and identify potential issues and concerns to be addressed as part of this amendment process. Currently the Draft Amendment Report is out for public comment from 16 June 2016 to 5 July 2016.

## 3.3 Methodology to amend approved ESEIA and EMP

The amendment process utilised the same methodology as the ESEIA as detailed in Section 10 of the Scoping Report (Aurecon, 2012a). This includes the update of a number of the original studies and additional impact assessments relating to the proposed CSP facility used in the preparation of the Amendment Report, as detailed below:

- An assessment of the full range of potential impacts including design, construction, operational, decommissioning and cumulative impacts. The studies considers the extent (spatial scale), magnitude (size or degree of scale) and duration (time scale) to determine the significance of the impact. The probability of this impact occurring, the confidence in the assessment, and the reversibility of the impact are then evaluated.
- The identification of potential mitigation measures.
- The preparation of an Amendment Report for public comment and submission to authorities, including:
    - A description of the process to date;
    - A description of the updated specialists findings and assessment ratings;
    - Recommended impact mitigation measures; and
    - Detailed conclusions and recommendations.

The Environmental Management Plan (EMP) (consisting of a Construction Phase EMP and an Operational Phase EMP) has also been revised to include a set of feasible and cost-effective measures to monitor and manage potential negative impacts and enhance positive impacts (Annexure D). The Construction and Operational EMPs include:

- Guidelines for the Environmental Control Officer (ECO);
- A detailed monitoring programme for the ECO;
- A basic environmental awareness training course; and
- Clear responsibilities to ensure environmental control and accountability during the construction and operational phases.

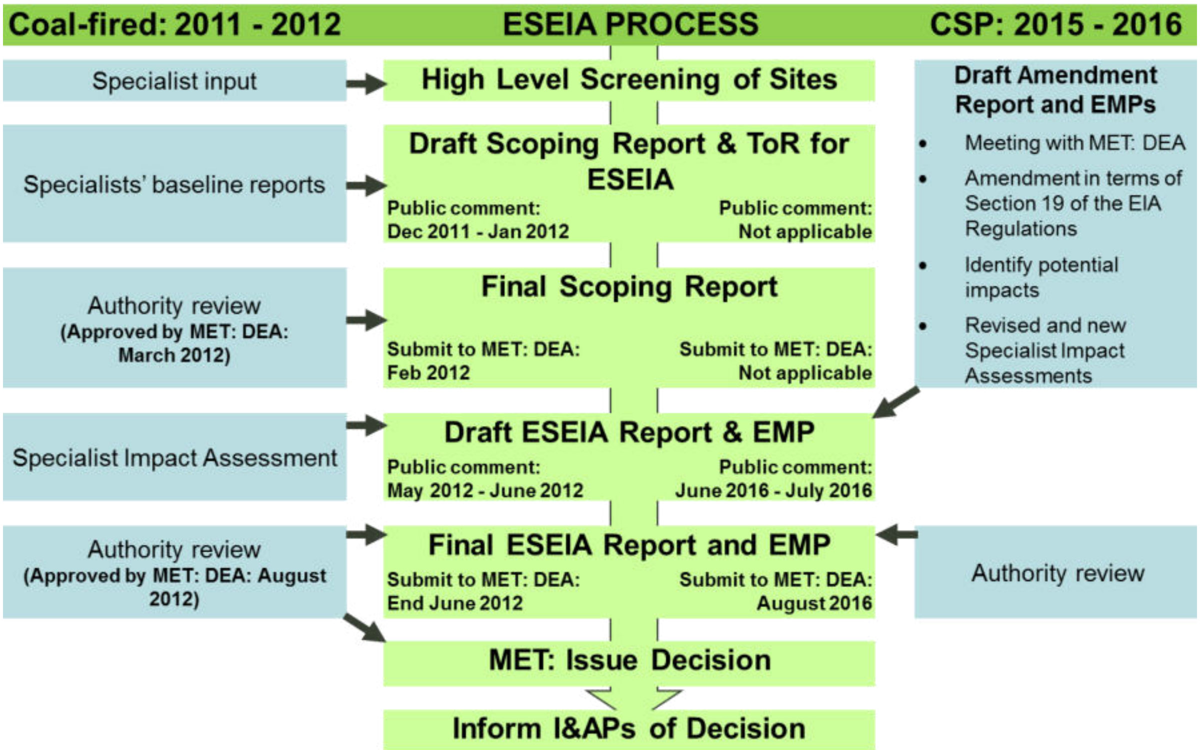


**Figure 14: Diagram of the ESEIA process followed to date**

# 4 PUBLIC PARTICIPATION AND STAKEHOLDER ENGAGEMENT

*This section outlines the public participation and stakeholder engagement process undertaken for this amendment.*

## 4.1 Introduction

A critical component of any environmental process is genuine, open and transparent engagement with the public and stakeholders who may be interested in or affected by development proposals. Legislation requires that Interested and Affected Parties (I&APs) are afforded an opportunity to gain more knowledge about the proposed project, to provide input and to voice any issues of concern at various stages throughout the Environmental and Socio-Economic Impact Assessment (ESEIA) process. The process of stakeholder engagement or public participation is defined in terms of international best practice as a process by which an organisation consults with interested or affected individuals, organisations and government entities before making a decision. The aim is to ensure a two-way communication system and promote collaborative problem solving with the goal of achieving better and more acceptable decisions. In environmental processes, the intention is to ensure informed decision-making by the project proponent and relevant authorities.

The following records (Table 6) related to the public participation and stakeholder engagement process for the Amendment Report can be found in Annexure C:

**Table 6: Record of stakeholder engagement process**

| STAKEHOLDER ENGAGEMENT RECORD | PROOF |
|---|---|
| Non-technical summary of the Final Amendment Report | **Annexure C0** |
| Updated list of registered Interested and Affected Parties | **Annexure C1** |
| Photographs of site notices | **Annexure C2** |
| Advertisements for release of Amendment Report and Revised EMP | **Annexure C3** |
| Proof of notification | **Annexure C4** |
| Key notes from meetings with Councils and the Directorate Civil Aviation | **Annexure C5** |
| Comments and Response Report (CRR) | **Annexure C6** |
| Received comments | **Annexure C7** |
| Record of meetings held to present Amendment Report | **Annexure C8** |
| Attendance Register and photo record for Amendment Report meetings | **Annexure C9** |

## 4.2 Stakeholders Consulted

Stakeholder engagement has been an integral part of this amendment process as outlined in Table 7 below. This includes a range of stakeholder meetings (including focus group meetings), advertising, stakeholder notification and the circulation of the report for comment. Records of attendees, minutes for the meetings, and copies of the newspaper advertisements as listed in Table 7 are included in Annexure C, as well as a full list of the stakeholders consulted to date.

*Note that all registered I&APs from the original ESEIA process have been included in the updated database for this amendment process. However, I&APs who were part of the original ESEIA process whose contact details have changed since 2012 or are aware of someone's details that may have changed were respectfully requested to contact Aurecon with the updated information.*

**Table 7: Record of stakeholder engagement carried out during this Amendment**

| DATE | TYPE | DETAILS | PURPOSE |
|---|---|---|---|
| **5-6 April 2016** | Meetings with key stakeholders (Councils) | The following stakeholder meetings were undertaken:<br>• Arandis Town Council, Arandis<br>• Swakopmund Town Council, Swakopmund<br>• Erongo Regional Council, Swakopmund<br>• !Oe-≠Gân Traditional Authority, Spitzkoppe<br>• ≠Gaingu Community Conservancy, Spitzkoppe<br>The purpose of the meetings was to provide an overview of the proposed CSP technologies, confirm socio-economic baseline conditions as described in the 2012 Final ESEIA and to understand concerns and potential requirements from these stakeholders with regards to the proposed new technology. | Stakeholder engagement |
| **19 May 2016** | Meeting key stakeholders (Directorate Civil Aviation) | A meeting took place with representatives of the Directorate Civil Aviation in Windhoek. The purpose of the meeting was to provide an overview of the proposed CSP technologies and international aviation requirements for CSP facilities, identify specific concerns from the DCA with regards to potential impacts on aviation safety and confirm the correct permitting procedures to follow, if applicable. | Stakeholder engagement |
| **9 June 2016 &**<br>**15 June 2016** | Advertising | The availability of the Amendment Report was advertised in The Namibian and The Republikein during two consecutive weeks | Notification of the project |
| **6-10 June 2016** | Mailing | A notification letter was sent via mail and email to registered I&APs regarding the availability of the Amendment Report for comment and the opportunity to attend public meetings. | Notification of the project |
| **16 June 2016** | Lodging of Amendment Report for comment | Printed copies of Amendment Report were made available for public review at the following locations:<br>• NamPower control building (Windhoek)<br>• Swakopmund Public Library<br>• Walvis Bay Public Library<br>• Arandis Community Library<br>The report was also available to download on the NamPower and Aurecon websites:<br>• www.nampower.com.na<br>• www.aurecongroup.com/en/public-participation.aspx | Amendment Report made available for review and comment |

| DATE | TYPE | DETAILS | PURPOSE |
|---|---|---|---|
| **20-23 June 2016** | Public Meetings | Public meetings will take place at:<br>• NamPower Convention Centre, Windhoek<br>• Prost Hotel, Swakopmund<br>• Arandis Town Hall, Arandis<br>• Spitzkoppe Community Centre, Spitzkoppe | Presentation of the main findings of the Amendment Report |
| **22 June 2016** | Stakeholder meeting | Meetings with the Arandis Town Council will take place. | Presentation of the main findings of the Amendment Report |

## 4.3 Summary of main issues raised

The main issues that were raised as part of the public participation and stakeholder engagement process for the Erongo Coal-fired Power Station are listed below. In addition, concerns that have been raised to date by the various stakeholder groups have been added as a comparison to the CSP facility.

**Table 8: Summary of main issues raised by stakeholders for the Erongo Coal-fired Power Satiation and the CSP facility**

| ISSUE | DESCRIPTION: COAL-FIRED POWER STATION | DESCRIPTION: CSP FACILITY |
|---|---|---|
| **Site location** | The proximity of the proposed location to Arandis town (air quality and noise impacts). | Not raised as a concern.<br>Location of additional CSP facilities considered by NamPower. |
| **Air quality** | The contribution to air pollution in Arandis that would be made by the power plant. | Dust resulting from access and internal roads. |
| **Biodiversity** | The possibility of endemic and protected flora and fauna species in the proposed site near Arandis. | The impact on biodiversity species and insects, including birds. |
| **Technology** | The management of fly ash on the site; and the reduction of noxious fumes on the site. | The dis-/advantages of the different CSP technology; the level of resource dependency; cooling system and the type of steel that would be used for construction. |
| **Social** | Prioritisation of locals for employment opportunities. | Reduced negative impact on tourism; site security measures; and employment opportunities. |
| **Climate Change and alternative energy** | Consideration of cleaner forms of energy; reliance on coal imports. | Not raised as a concern. A question was asked regarding expected future rainfall. |
| **Water capacity and infrastructure** | Insufficient supply of water from aquifer: may need to use desalinated water; ability of infrastructure to cope. | Source of water supply; volume of water required; and stormwater management. |

| ISSUE | DESCRIPTION: COAL-FIRED POWER STATION | DESCRIPTION: CSP FACILITY |
|---|---|---|
| **Rail capacity and infrastructure** | Ability of railway to cope with increased traffic; lack of signalling system. | Not applicable. |
| **Roads capacity and infrastructure** | Increased vehicle access during construction and operation; access roads to power plant. | Access through the Arandis Town should be considered; and impact of glint and glare on B2 road users. |
| **Coal storage and handling; Port facilities** | Upgrading of existing NamPort handling facilities at Walvis Bay (not in Scope of this ESEIA); noise and dust impacts. | Not applicable. |
| **Civil aviation** | Not raised as a concern. | Impact on aviation safety due to glint and glare from parabolic troughs, heliostats and PVs. |
| **Avifauna** | Not raised as a concern. | Impact on avifauna due to collision and electrocution from transmission lines. |
| **Glint and Glare** | Not raised as a concern. | Impact on road users safety due to glint and glare from parabolic troughs, heliostats and PVs. |

# 5 ALTERNATIVES

*This section describes the alternatives that were considered in terms of the proposed change in fuel source from coal to solar and specifically relate to the technology alternatives of CSP.*

## 5.1 Introduction

Alternatives considered in the ESEIA were screened to those that met the project objectives (namely an increase in the power generation capabilities of Namibia to ensure that the capacity for domestic power could be achieved within the mid- to long-term time period). This was in order to limit the effort and cost associated with specialist studies and assessment. All options that were considered were technically, financially and socially appropriate and viable. This Amendment Report specifically deals with the change in fuel source and technology (i.e. coal and solar) and does not consider alternatives such as site location as this was previously considered.

## 5.2 Activity alternatives

The aim of considering alternatives is to ensure that the best possible location, activity, technology and site layout is adopted for the proposed activity in order to minimise adverse environmental and socio-economic impacts and enhance positive impacts. The option of not implementing the proposed activity, *viz.* the "no-go" option, was also considered, as legally required and in terms of environmental best practice. The alternatives that were considered in this new assessment relate to the proposed change in fuel source from coal to solar and specifically relate to the technology alternatives of CSP.

**Table 9: Activity alternatives originally considered and those proposed as part of this amendment process**

| ALTERNATIVES CONSIDERED | ALTERNATIVE ORIGINALLY SELECTED | NEW ALTERNATIVE PROPOSED |
|---|---|---|
| **Energy Alternative** | | |
| Coal<br>Diesel<br>Renewable<br>Nuclear | Coal | Renewable |
| ***Capacity*** | | |
| Capacity size 150 MW to 300 MW with upgrade to 800 MW | 150 MW to 300 MW initially with potential to upgrade to 800 MW in future, if required | 50 MW to 300 MW |
| ***Coal transport*** | | |
| Rail<br>Road | Rail | Not required |

## 5.3 Technology alternatives

The economic considerations of a concentrated solar energy facility are intimately linked to the solar resource available at the site. The 2012 CSP pre-feasibility study[17] found that solar is a highly viable fuel source in Namibia and specifically at the Arandis site. More specifically, NamPower has been measuring the solar resource at Arandis since July 2015. The measurements show that the Arandis site has excellent solar resource for both CSP and PV technology (NamPower, pers. comm.).

There are a number of technologies available that can harness this viable solar resource, such as CSP and PV, which require different levels of investment and varying levels of dispatchable power. Furthermore there are a number of specific technologies that can be employed within these technology groups. A number of considerations will determine the ultimate deployment of a preferred technology. NamPower has not yet identified a preferred option as the supply-demand scenarios are currently being investigated and the economics of the solar facility will be key in determining the final technology combination. The selection process will utilise a multifaceted decision-making framework similar to the South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) to appoint suitably qualified Engineering, Procurement, and Construction partners. The current technology options considered on the Arandis site are described in Table 10 below. The details of these technologies are discussed in Section 2.2.

**Table 10: Alternative technologies originally considered and those proposed as part of this amendment process**

| ALTERNATIVES CONSIDERED | ALTERNATIVE ORIGINALLY SELECTED | NEW ALTERNATIVE PROPOSED |
|---|---|---|
| ***Technology*** | | |
| Pulverised Fuel | Circulating Fluidised Bed (CFB) boiler | CSP, parabolic trough with thermal storage |
| Fluidised Bed | | CSP, solar power tower with thermal storage |
| Coal Gasification Combined Cycle | | hybridisation with PV |
| ***Cooling system*** | | |
| Once through wet cooling | Dry cooling | Dry cooling |
| Hybrid cooling systems | | |
| Dry cooling (radiator banks) | | |
| ***Fuel types*** | | |
| Coal | High quality export coal, with lowest sulphur content commercially available | Solar irradiance (CSP and PV) |
| Gas | | |
| Biomass | | |
| Solar | | |

[17] *Pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia (2012)*

| ALTERNATIVES CONSIDERED | ALTERNATIVE ORIGINALLY SELECTED | NEW ALTERNATIVE PROPOSED |
|---|---|---|
| ***Abatement Technologies*** | | |
| Carbon capture and geological sequestration (CCS) | In-bed addition of limestone to CFB;<br>CFB technology<br>Minimum stack height of 100m | Not required |
| Flue Gas Desulphurisation (FGD) or in-bed addition of limestone to CFB, to reduce sulphur dioxide ($SO_2$); | | |
| Electrostatic precipitators or Fabric Filter Plants (to remove particulate matter from flue gas); | | |
| CFB technology with combustion at low temperature | | |
| Height of the flue gas stacks: 50 m, 100 m, 150 m | | |

## 5.4 Site location and layout alternatives

**Four sites were originally considered for the Erongo Coal-fired Power Station as shown in**

Table 11 below. A high-level screening process was carried out on these sites involving the Ideal Mode Analytical Hierarchy Process Pairwise Comparison Model, a version of a Multi Criteria Decision Making. This allowed for the evaluation of these sites using technical, biophysical and socio-economic criteria, based on issues identified as critical to the site selection. Based on the outcome of this assessment, the approved site, located east of Arandis was identified.

No further site alternatives will be considered as part of this assessment for the following reasons:

- The site has been approved by MET: DEA for electricity generation.
- Site constraints are well-known as a number of specialist assessments have already been undertaken for this site in 2012 and again in 2016.
- The site was identified as a feasible location for a CSP plant by the pre-feasibility study for the establishment of a pre-commercial concentrated solar power (CSP) facility in Namibia (as explained in Section 1.1 of this Amendment Report).

**Table 11: Alternative sites originally considered and those proposed as part of this amendment process**

| ALTERNATIVES CONSIDERED | ALTERNATIVE ORIGINALLY SELECTED | NEW ALTERNATIVE PROPOSED |
|---|---|---|
| ***Site locations*** | | |
| Erongo Region | East of Arandis | Approved site located east of Arandis |
| North of Swakopmund | | |
| West of Walvis Bay | | |
| West of Arandis | | |
| East of Arandis | | |
| No development | | |

Since NamPower has not yet identified a preferred technology alternative due to the supply-demand scenarios currently being investigated, no layout alternatives have been developed. The facility layout will be finalised as part of the REIPPPP by the appointed engineering firm, based on the environmental constraints and mitigation measures identified in this Amendment Report.

# 6 ASSESSMENT OF IMPACTS RELATED TO THE PROPOSED AMENDMENT

*This section describes and assesses the significance of the potential impacts anticipated to occur during the construction, operation and decommissioning of the proposed CSP facility Mitigation measures are proposed in response to these potential impacts. The impacts are also compared to the potential impacts that were assessed for the Erongo Coal-fired Power Facility.*

*Note that the impacts in this section are summarised from the updated specials reports. Please refer to Annexure E for the complete specialist reports.*

## 6.1 Introduction

A number of impacts were identified and assessed in the Final ESEIA Report (Aurecon, 2012) relating to the Erongo Coal–fired Power Station (see Annexure F1). These impacts have been re-assessed based on the introduction of solar energy as a new fuel source for the thermal power facility. A comparison between the two technologies alternatives (coal and solar) are provided, as well as additional mitigation measures required to address these concerns. The mitigation measures have also been included in the EMP. For the complete list of applicable mitigation measures (additional and approved), please refer to Section 9.

Table 12 indicates the new and updated specialist studies required for the amendment from coal technology to solar technology for the CSP facility.

**Table 12: Updated and new specialist reports undertaken for the amendment**

| ANNEXURE | IMPACT ASSESSMENT | SPECIALISTS | APPLICABILITY | |
|---|---|---|---|---|
| | | | COAL-FIRED POWER STATION | CSP |
| **E1** | Biodiversity Impact Assessment | Biodata Consultancy cc | √ | √ |
| **E2** | Visual Impact Assessment | VRMA cc | √ | √ |
| **E3** | Air Quality Impact Assessment | Airshed Planning Professionals | √ | √ |
| **E4** | Socio-economic Assessment | Aurecon (South Africa) | √ | √ |
| **E5** | Avifauna Impact Assessment | Chris van Rooyen consulting | | √ |
| **E6** | Climate Change | Aurecon (South Africa) | | √ |

*Note that the hybridized PV option is automatically included with all CSP options since potential impacts associated with PV technology is of a much smaller scale compared to the CSP alternatives. Mitigation measures identified for CSP facilities are therefore considered to be sufficient for all technology options considered unless specified separately. Furthermore, the "no-go" option is not re-assessed since the status quo implies that the Erongo Coal-fired Power Station will be constructed.*

## 6.2 Socio-economic

A socio-economic impact assessment study was carried out by Jan Perold of Digby Wells in 2011 in order to assess the impacts of the Erongo Coal-fired Power Station on the population of the Erongo Region. It sought to identify the socio-economic characteristics of the communities that may be affected, determine the anticipated positive and negative impacts of the proposed facility and to develop practical, cost-effective and auditable management measures to avoid, ameliorate or manage negative social impacts and enhance positive ones.

Noeleen Greyling of Aurecon was subsequently appointed to determine the potential impacts associated with the proposed amendment of the ECC for a coal-fired power station to CSP technology.

Both the original and amendment studies comply with the relevant Namibian legislation and take note of relevant international best-practice principles and performance standards such as the Equator Principles and those advocated by the IFC. For the complete copy of the Amended Socio-Economic Impact Assessment (SEIA), please refer to Annexure E4.

### *6.2.1 Impact Statement*

According to the specialist assessment, the socio-economic baseline as well as the broader socio-economic characteristics of the Erongo area have not changed significantly between 2011 and 2016. It was found that the potential socio-economic impacts associated with the proposed CSP technology would be similar to the Erongo Coal-fired Power Station for both the Construction and Operational Phases. However, the following two Operational Phase impacts differed and are discussed in more detail below:

- Operational-related health, safety and physical intrusion impacts; and
- Operational impacts on tourism.

Additional mitigation measures to manage the potential impacts are included in Section 6.3.2, while Annexure F1 includes the complete list of mitigation measures that were approved for the Erongo Coal-fired Power Station.

Note that the cumulative impacts assessed for the Erongo Coal-fired Power Station remains applicable to the proposed CSP facility.

**Table 13: Potential socio-economic impacts during the operational phase of the proposed CSP facility**

| OPERATIONAL-RELATED HEALTH, SAFETY AND PHYSICAL INTRUSION | |
|---|---|
| **Erongo Coal-fired Power Station** | Health and safety impacts will be largely restricted to plant personnel; however, the aesthetic character of the landscape will be adversely affected by the visual intrusion of the power plant. |
| **CSP** | Health and safety impacts are expected to be minimal and will be restricted almost exclusively to plant personnel. Increases in the traffic loads on the B2 highway will be mostly due to organic growth, with a very limited contribution from the CSP facility itself. However, the aesthetic character of the landscape will be adversely affected by the visual intrusion from the CSP facility[18] (especially for the solar power tower technology alternative). |

[18] *This is assessed in more detail in Section 7.4 – Visual*

| OPERATIONAL IMPACTS ON TOURISM | |
|---|---|
| **Erongo Coal-fired Power Station** | The landscape is one of vast open spaces and the facility can impact negatively on tourism operators (e.g. balloon flights, chartered flights, film industry). However, people can view landscape changes positively if the changes results in additional jobs. |
| **CSP** | The proposed CSP facility (especially the solar power tower technology alternative) could also reduce the scenic quality of the landscape as explained above. However, the impact in the immediate vicinity of Arandis is expected to be less significant. Hot air balloon operators may also be impacted in terms of Civil Aviation and safety issues and may need to reroute current tours (See Section 7.5). |

### 6.2.2 Key Mitigation Measures

No additional mitigation measures are required for the proposed amendment. The following mitigation measure from the Erongo Coal-fired Power Station needs to be amended since the proposed CSP facility would not generate fly ash:

**Table 14: Additional mitigation measures required to address potential socio-economic impacts**

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| No additional mitigation measures are required. |

### 6.2.3 Impact Rating

Table 15 provides a comparison of the construction and operation impact significance after mitigation of the Erongo Coal-fired Power Station against those of the proposed CSP facility (with mitigation).

**Table 15: Significance of the construction and operation phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction Phase** | | |
| Job creation | High (+) | High(+) |
| Multiplier effects on local economy | Moderate (+) | Moderate (+) |
| Displacement of current land uses | Very low (+) | Very low (+) |
| Construction-related health safety, and aesthetic impacts | Low (-) | Low (-) |
| Disruption of daily movement patterns | Very low (-) | Very low (-) |
| Population influx | Low (-) | Low (-) |
| Increased social pathologies | Medium (-) | Medium (-) |
| Negative impacts related to a construction camp | Low (-) | Low (-) |
| **Operational Phase** | | |
| Electricity benefits | Very high (+) | Very high (+) |
| Job creation | High (+) | High (+) |
| Diversification & growth of the local economy | High (+) | High (+) |

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| Corporate Social Investment | High (+) | High (+) |
| Operational health, safety and physical intrusion impacts | Low (-) | Very low (-) |
| Tourism | Moderate (-) | Low (-) |

## 6.3 Visual

The original and revised study was carried out by Stephen Stead of Visual Resource Management Africa (VRM Africa). The detailed amended report is attached in full in Annexure E2 of this report, while the main impacts and their mitigation measures are outlined below.

Based on the viewshed of the proposed technologies, the visual receptors that would be influenced by the different technologies are indicated in Table 16.

**Table 16: Visual receptors that could be potentially be impacted by the approved Erongo Coal-fired Power Station and the proposed CSP facility**

| RECEPTORS | APPLICABILITY | | |
|---|---|---|---|
| | COAL-FIRED POWER STATION | SOLAR POWER TOWER | PARABOLIC TROUGH |
| Arandis Town | √ | √ | √ |
| B2 National Road | √ | √ | √ |
| Namib Naukluft National Park and Welwitschia Flats | √ | √ | |
| Rössing Mountain | √ | √ | |
| Spitzkoppe Landmark | √ | √ | |
| Swakop River Moon Landscapes | √ | √ | |
| C34 National Road within the Dorob National Park | | √ | |

The above receptors except for Spitzkoppe were also identified as Key Observation Points (KOPS)[19] in the viewshed analysis. Spitzkoppe was eliminated due to the distance, the northerly orientation and the topographic screening that would obscure views from ground-based users.

Note that a Class III visual objective, as per the methodology indicated in the footnote, was assigned to the site in order to protect the surrounding landscape character which is regionally important for the Erongo tourist economy. The Class III objective is to partially retain the existing character of the landscape, and the level of change to the characteristic landscape should thus be moderate.

[19] Defined by the Bureau of Land Management as the people (receptors) located in strategic locations surrounding the property that make consistent use of the views associated with the site where the landscape modifications are proposed.

## Solar Power Tower Technology Alternative

The solar power tower technology alternative has a probable zone of visual influence (ZVI)[20] of 60 km because of the height (200 to 250 m) of the tower component (see Figure 15). Receptors located within the high exposure viewshed[21] areas would be limited to the B2 National Road and train receptors. Medium exposure receptors include Arandis as well as distant views from B2 receptors. Medium to Low exposure receptors would include Rössing Mountain and the Welwitschia Flats areas of the Namib Naukluft Park. Low to very low exposure receptors would include the Moon Landscapes, some locations along the C34, and sections of the Dorob National Park, as well as the roads through the Namib Naukluft National Park.

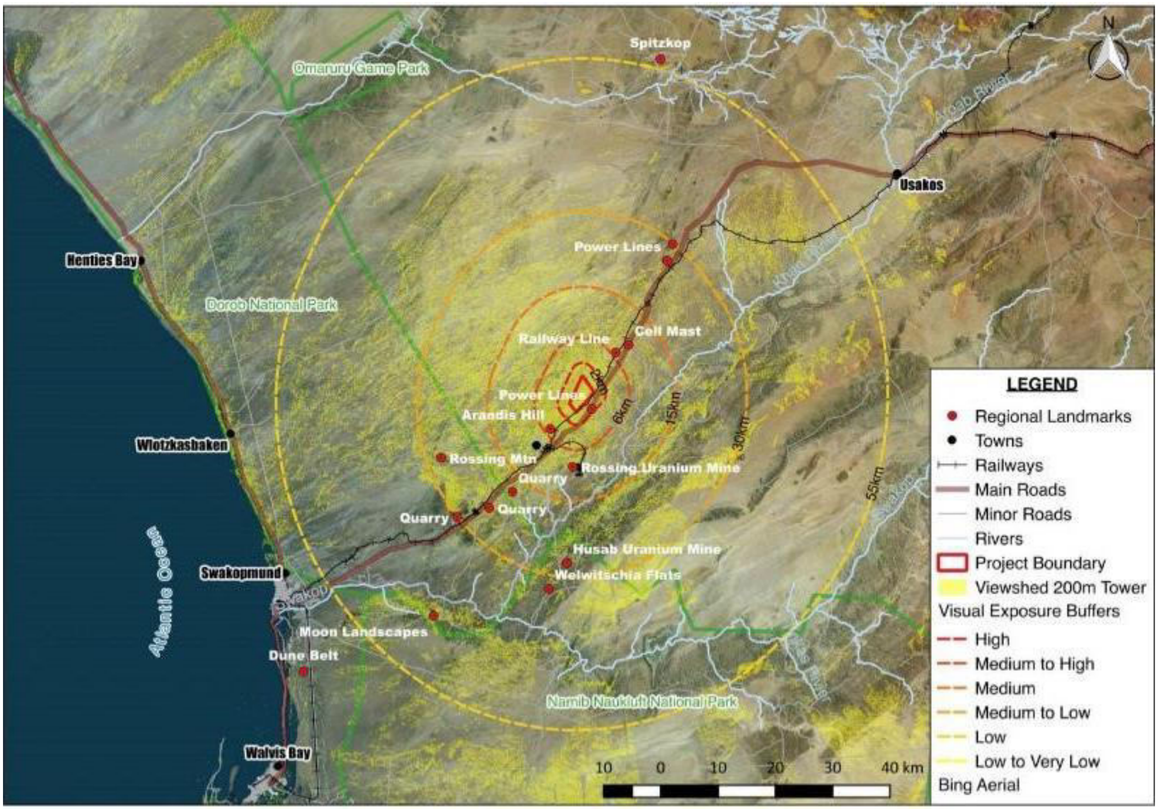


**Figure 15: Viewshed of the proposed solar power tower alternative at a height of 200 m above ground**

## Parabolic Trough Technology Alternative

The ZVI for this CSP technology alternative (with a height of 10m above ground level) is 12 km, limiting affected receptors to the B2 and the train receptors.

[20] Zone of Visual Influence: Defined as 'the area within which a proposed development may have an influence or effect on visual amenity.

[21] Viewshed: Defined as the outer boundary defining a view catchment area, usually along crests and ridgelines. Similar to a watershed. This reflects the area in which, or the extent to which, the landscape modification is likely to be seen.

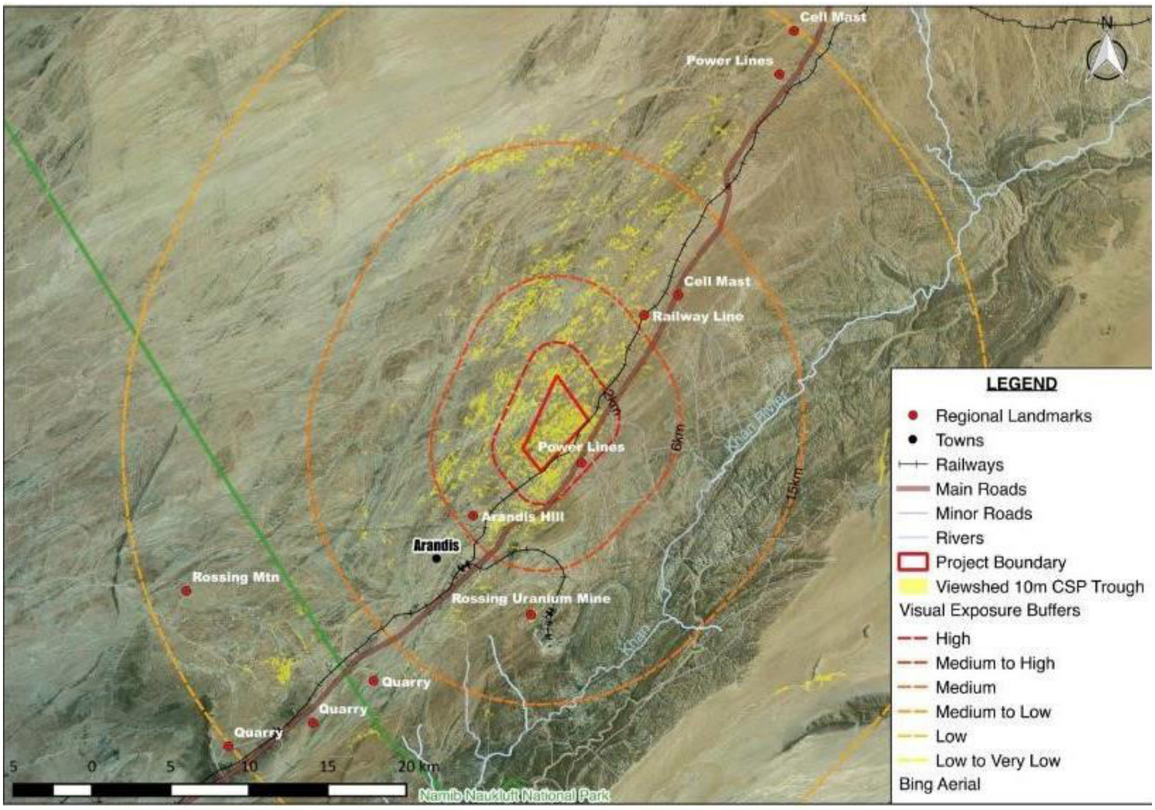


**Figure 16: Viewshed of the proposed CSP Trough alternative at a height of 10 m above ground**

### 6.3.1 Impact Statement

According to the specialist assessment neither of the proposed CSP development technologies are fatally flawed; however parabolic trough technology is preferred. This is due to the significantly reduced ZVI, which would not intrude into any of the tourist based visual resources that are an important factor for the Erongo Region economy.

## Solar Power Tower Technology Alternative

The locations of the receptors listed in Table 16 are illustrated in Figure 17 to Figure 24 to depict various viewpoints relative to the proposed solar power tower. Note that this analysis was only done for the solar power tower technology alternative due to the limited available information on the proposed parabolic trough technology alternative (as well as reduced visual impact).

**Figure 17: Photomontage – illustrated view of the tower from Arandis Town**

**Figure 18: Photomontage - illustrated view of the tower from the B2 National Road Northbound (from a distance)**

**Figure 19: Photomontage - illustrated view of the tower from the B2 National Road Southbound (from a distance)**

**Figure 20: Photomontage - illustrated view of the tower from the B2 National Road Southbound (proximal view)**

**Figure 21: Photomontage - illustrated view of the tower from Rössing Mountain**

**Figure 22: Photomontage - illustrated view of the tower from the C38 Coastal Road**

**Figure 23: Photomontage - illustrated view of the tower from the Moon Landscape**

**Figure 24: Photomontage - illustrated view of the tower from the Welwitschia Flats**

According to the specialist assessment, the majority of the more proximate receptors would experience the landscape change strongly. As the recommended Class Objective was for medium levels of contrast[22] as seen from the surrounding KOPs, the proposed solar power tower technology alternative would not meet the visual objectives. Mitigation could include (a) reducing the height of the tower that would reduce the visual envelope, (b) reducing the number of reflective mirrors could mitigate the glare[23] and/or (c) altering the form of the solar power tower by making it more architectural in design (less solid). However, due to the nature of the technology, the two factors increasing visual intrusion are the same factors increasing energy efficiency. As such mitigation opportunities are limited as they would

[22] To determine impacts, a degree of contrast exercise was undertaken by the specialist. This is an assessment of the expected change to the receiving environment in terms of the form, line, colour and texture, as seen from the surrounding KOPs.

[23] Based on his experience with solar power tower technology in South Africa, the visual specialist confirmed that the intensity of light reflected from the heliostats should not be blinding. It would however be bright enough to not look at it directly without sunglasses (S. Stead, pers. comm.).

reduce energy producing performance, with only a moderate reduction in visual intrusion i.e. there will still be some sort of tower and a resultant reflective glare.

Furthermore, when considering the opportunities and constraints of the proposed CSP facility, opportunities outweigh the constraints, as shown in Table 17.

**Table 17: Opportunities and constraints identified for the proposed solar power tower technology alternative**

| OPPORTUNITIES | CONSTRAINTS |
|---|---|
| • Generation of electricity from a renewable energy source.<br>• Economic benefits to the Erongo Region and Arandis Town.<br>• The remoteness of the location limits high exposure receptors to those using the B2 National Road.<br>• The desert haze significantly reduces visual clarity.<br>• The fog belt along the coastline would limit visibility as seen from the coast town receptors.<br>• The higher Visual Absorption Capacity (VAC) created by the scattered mining and larger infrastructure developments in the desert.<br>• Topographic screening between the proposed development and Spitzkoppe Inselberg will screen ground levels receptor views of the tower. Views of the tower from the receptors using the access road from the B2 to the inselberg are also most likely to be topographically screened.<br>• The sense of place of the tower is one of intense light, heat and haziness, and from most of the key observation points, the tower and glare will be viewed from a sense of place that includes intense light, heat and haziness from the desert environment. Typically, the CSP project will be viewed in conjunction with a desert mirage effect on flatter terrain areas.<br>• The tower and light has the potential to be viewed as an interesting structure, which can be enhanced if an interesting architectural design is incorporated into the tower structure.<br>• The visual intrusion reduction advantages of this technology are that the focal point is contained limiting light spillage to the sides and that mirrors are only to the south side, which reduces the glare effects to the east and west (as opposed to projects such as Khi Solar 1 in South Africa which has three solar focal points (East, | • The very large ZVI is most likely to extend to approximately 30 km (assuming normal desert haze conditions).<br>• There is a possibility in clear weather conditions that the tower will be visible from approximately 60 km.<br>• The loss of some visual resources used for by filming industry relating to open, desert wilderness views from Rössing Mountain.<br>• The introduction of a light source into the Moon Landscape vista which would attract the attention of the casual observer. |

| OPPORTUNITIES | CONSTRAINTS |
|---|---|
| South and West), creating an almost 300 degree light source). | |

### Parabolic Trough Technology Alternative

The contrast rating undertaken for the CSP Parabolic Trough technology found that the majority of the more proximate receptors would ***moderately*** experience the landscape change. As the recommended Class Objective was for medium levels of contrast as seen from the surrounding KOPs, the proposed parabolic trough alternative would meet the visual objectives defined for the site. Mitigation would be required to reduce the colour contrast generated from the structures as much as possible as well as management of lights at night.

An opportunities and constraints exercise identified only one constraint for this technology alternative whereas the opportunities are multiple (see Table 18).

**Table 18: Opportunities and constraints identified for the proposed parabolic trough technology alternative**

| OPPORTUNITIES | CONSTRAINTS |
|---|---|
| • Generation of electricity from a renewable energy source.<br>• Economic benefits to the Erongo Region and Arandis Town.<br>• The remoteness of the location that limits exposure receptors to those using the B2 National Road.<br>• The desert haze that significantly reduces visual clarity.<br>• The higher VAC created by the scattered mining and larger infrastructure developments in the desert.<br>• Topographic screening which contains the project ZVI to the local level.<br>• Research has indicated that people viewing renewable wind energy projects are more likely to view facilities in a positive manner. Although the research was for Wind Energy Facilities in Scotland (Braunholtz, 2003), it is possible that the perception would also be favourable for other renewable energy if the design was interesting.<br>• The sense of place created by the tower is one of intense light, heat and haziness, and from most of the key observation points, the tower and glare will be viewed from a sense of place that includes intense light, heat and haziness from the desert environment. Typically, the CSP project will be viewed in conjunction with a desert mirage effect on flatter terrain areas. | • Loss of natural desert landscape character at the site. |

### Summary of impacts on KOPs

To summarise, Table 19 and Table 20 lists the significance of the main impacts on KOPs that were identified for the two CSP technologies.

**Table 19: Solar power tower technology alternative: Summary of main impacts on KOPs**

| RECEPTOR | DISTANCE (KM) | DISTANCE ZONE | MAGNITUDE | IMPACT SUMMARY |
|---|---|---|---|---|
| **Rössing Mountain** | 34 | Background | Medium to High | The proposed project will result in a medium to strong degree of contrast to the existing landscape. Strong contrast will be generated by the tower form and white light glare reflected from the tower. Line and texture contrast will be reduced to some degree due to the 34 km distance between the mountain and the proposed site. |
| **Arandis Residential / Arandis Airport** | 9.2 | Background | High | The proposed project will result in a ***strong*** level of visual contrast as seen by the Arandis residents. This is mainly due to the strong vertical line rising out of the landscape and the white light glare reflected from the tower. |
| **B2 Westbound** | 2 - 40 | Foreground | High | The proposed project will result in a ***strong*** level of visual contrast as seen by the B2 road users. Although there will be some moderation of the colour and texture impact due to distance and existing vertical power line elements in the environment, the overall impact will be strongly experienced, caused mostly by the rectangular block form of the tower, and the bright glare of the reflective light from the tower in the foreground. |
| **B2 Eastbound** | 2 - 40 | Foreground | Medium to High | The proposed project will result in medium to strong levels of visual contrast as seen from the B2 Eastbound receptors. This is partly due to the undulation of the road, which results in partial topographic screening from more distant views. The strong mining sense of place created by the landscapes of Rössing Mine, the entrance to Husab Mine and clear views of quarry activity increase the visual absorption capacity of the locality. |
| **Moon Landscapes** | 46 | Background | Medium to High | The distance from the site, in conjunction with the desert haze, will reduce clear visibility of the forms of the tower structure. The strong undulations of the Swakop River erosion also increases the landscape VAC levels for form and line, and thus reduces the degree of contrast for form and line elements. However, the white light reflected south from the tower would be clearly noticeable at this distance, with some haze distortion likely. The existing lack of any views of a built nature and the predominantly grey-brown colour and grey skies, are likely to emphasise and |

| RECEPTOR | DISTANCE (KM) | DISTANCE ZONE | MAGNITUDE | IMPACT SUMMARY |
|---|---|---|---|---|
| | | | | focus the attention on the small white light spot in the distance, making the tower light a focus point for casual observers. |
| **C34 Road** | 60 | Background | Low | The distance from the site, in conjunction with the desert haze, will reduce the visibility of the forms of the tower structure clearly. The support structures of the NamWater pipeline in the middleground also increase the VAC levels for form and line, reducing contrast for form and line elements. |
| **Welwitschia Flats / NNNP** | 34 | Background | Medium to Low | The distance from the site, in conjunction with the desert haze, reduces the ability to determine the forms of the tower structure clearly. The structures of the Husab Uranium Mine in the foreground, also increase the VAC levels for form and line, and thus reduces the degree of contrast for form and line elements. |

**Table 20: Parabolic trough technology alternative: Summary of main impacts on KOPs**

| RECEPTOR | DISTANCE (KM) | DISTANCE ZONE | MAGNITUDE | IMPACT SUMMARY |
|---|---|---|---|---|
| **B2 National Road** | 2 - 6 | Foreground | Medium to Low | Due to the constrained visibility of the proposed Parabolic Trough project, the extent of the landscape change is limited. The change is also within the visual context of the Rössing Mine TSF / Arandis town which increases the visual absorption capacity to some degree. The bulk of the proposed project will be located on lower lying ground that would reduce the massing effect. |

### Cumulative impacts

Cumulative visual effects can include the degradation of the surrounding landscapes as other ad hoc development is attracted to the site from the improved access and economic opportunity. The significance of cumulative impacts associated with the Erongo Coal-fired Power Station was considered to be highly negative. However, the cumulative visual impacts identified for the proposed CSP facility were rated very low negative for both construction and operation phases. This is due to the surrounding strong association of the surrounding landscape with a historic mining sense of place which has increased the VAC and thus the perceptions that larger landscape modifications are acceptable as seen from the B2 National Road. In addition, ad hoc development being attracted to the surrounding areas would fall within the Arandis industrial development design and planning.

### *6.3.2 Key Mitigation Measures*

Additional mitigation measures would be required for each of the two technology options assessed for the proposed CSP facility as summarised in Table 21.

**Table 21: Additional mitigation measures required to address potential visual impacts**

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| **Solar Power Tower Technology** |
| **<u>Planning and design</u>**<br>The following recommendations should be considered during the design phase of the CSP facility:<br>• Assess the possibility of setting up a renewable energy demonstration centre which could be used as a tourist attraction.<br>• Assess the feasibility of introducing an architectural design element into the tower structures as was the case in the PS10 project at the Solucar Platform in the Spanish province of Seville.<br>**<u>Construction and operation</u>**<br>The following additional mitigation measures would be required:<br>• Colour mitigation of plant – a desert grey-brown colour should be used for those structures that have painted walls. Sheet metal covered structures should be a mid-grey colour (and not yellow which is more reflective and increases colour contrast). However, civil aviation safety regulations require that the entire tower is painted from ground level to the top with red and white stripes (Section 7.5.2). This will increase visibility of the structure but it is acknowledged that safety issues come first. Impacts from the tower will in this case be the unmitigated impact.<br>• Manage windblown dust.<br>• Manage lights at night to reduce lighting of the desert environment as much as possible. |
| **Parabolic Trough Technology** |
| **<u>Planning and design</u>**<br>The following recommendations should be considered during the planning and design phase of the CSP facility:<br>• Assess the possibility of setting up a renewable energy demonstration centre which could be used as a tourist attraction.<br>**<u>Construction and operation</u>**<br>The following additional mitigation measures would be required:<br>• Colour mitigation of plant – a desert grey-brown colour should be used for those structures that have painted walls. Sheet metal covered structures should be a mid-grey colour (and not yellow which is more reflective and increases colour contrast).<br>• Continuation of windblown dust management.<br>• Continuation of lights at night management. |

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| **Erongo Coal-fired Power Station** |
| The following approved mitigation measures for the Erongo Coal-fired Power Station would be redundant should the amendment application receive approval:<br>**Construction and operation of plant**<br>• Limit use of glass or reflective materials.<br>• Cover workings as much as possible.<br>• Limit windows on the upper and more visible sections of the plant to contain light spillage.<br>• Implementation of all other mitigation measures related to the stack(s).<br>• Implementation of all other mitigation measures related to the coal stockpile and associated railway infrastructure.<br>• Implementation of all other mitigation measures related to the ash storage facility.<br>• Implementation of all other mitigation measures related to the closure of the ash storage facility. |
| **Proposed changes to approved mitigation measures** |
| **From:** **Closure – Power plant, coal stockpile structures and stack**<br>• The power plant and stack structures should be demolished upon closure of the power plant (assuming that plant workings will be removed, decontaminated or recycled). |
| **To:** **Decommissioning – Power plant**<br>• All CSP structures should be demolished upon decommissioning of the facility (assuming that plant workings will be removed, decontaminated or recycled). |

### 6.3.3 Impact Rating

Table 22 provides a comparison of the construction and operation impact significance after mitigation of the Erongo Coal-fired Power Station against those of the proposed CSP facility (with mitigation).

**Table 22: Significance of the construction and operation phase impacts (with mitigation)**

| IMPACT | COAL-FIRED POWER STATION | SOLAR POWER TOWER | PARABOLIC TROUGH |
|---|---|---|---|
| **Construction phase** | | | |
| Facility (and lights at night) | High (-) | High(-) | Very Low (-) |
| Stack/Tower (and safety lights at night) | High (-) | High(-) | - |
| Coal Stockpile and Railway | Low (-) | - | - |
| Ash Storage Facility | Low (-) | - | - |
| Access road | Low (-) | Low (-) | Low (-) |
| **Operational Phase** | | | |
| Facility (and lights at night) | High (-) | Low (-) | Low (-) |
| Stack/Tower (and safety lights at night) | High (-) | High (-) | - |

| IMPACT | COAL-FIRED POWER STATION | SOLAR POWER TOWER | PARABOLIC TROUGH |
|---|---|---|---|
| Coal Stockpile and Railway | **Low (-)** | - | - |
| Ash Storage Facility | **Low (-)** | - | - |
| Access road | **Low (-)** | **Low (-)** | **Low (-)** |

## 6.4 Aviation Safety

This section identifies the potential impacts that the proposed CSP facility may have on aviation and air safety at Arandis and on the greater navigational space of Erongo in Namibia. It also provides mitigation measures and recommendations applied to similar facilities elsewhere that can be implemented to prevent or minimise potential impacts.

Concentrated solar energy is a growing alternative energy resource. Two of the major safety concerns frequently expressed by pilots and airport operators regarding CSP solar collectors relates to:

a. **Glint and glare:** has the potential to cause temporary visual impairment to pilots or controllers

b. **The physical location of the facility:** the improper placement of the CSP infrastructure closely to an airport can adversely affect the safety of airport operations (ARCP, 2011).

Note that the above concerns are not applicable to PV technology which is demonstrated by the numerous PV facilities located adjacent to airports internationally, for example:

- South Africa (at six regional airports): Kimberley, George, Upington, Port Elizabeth, Bloemfontein, East London
- Greece: Athens International Airport
- India: Cochin International Airport

### Policy, legislation and guidelines

The Namibian regulatory framework for aviation is contained in the Civil Aviation Bill (B. 1 - 2015). One of the Directorate of Civil Aviation's (DCAs) mandates is to ensure the safety of air navigation and the efficient utilisation of navigable airspace by aircraft (Regulation 55). Structures and activities that infringe on airspace need to be evaluated to determine their significance on aviation safety (Namibia Civil Aviation Regulations (NAMCAR) 139.01.34). When conflicts arise concerning a structure being studied, the DCA may advocate the need for conserving the airspace and protecting air navigation facilities from encroachments affecting safety or security, national security that would impact upon normal operation (Regulation 54). For more information on these regulations, please refer to Annexure G4.

### Identification of aviation scope

The scope of this study considers the potential for the proposed CSP facility to have a negative impact on the aviation safety in terms of the navigation and operations. Consideration has been given to aviation infrastructure within operational range of the proposed facility. Namibia's operational range, as defined by the Directorate of Civil Aviation for airports, requires that no obstacle exceeding 45.72 m (150 feet) in height (measured from the mean level of the landing area) may be located within a radius of 8 km from the aerodrome reference point, unless it has been approved by the Directorate. Arandis Airport is the closest airport at approximately 15 km from the centre point of the proposed site where the proposed power generation facility would likely be situated.

### Arandis baseline conditions

Arandis Airport is a private aerodrome which serves the town of Arandis and is approximately 5 km south of Arandis town and 55 km east of the town, Swakopmund (Figure 25). The Arandis town and airport also provide services to the Rössing Uranium Mine, one of the world's largest open-pit uranium mines. The airport is located at an elevation of 581 m (1 905 ft) above mean sea level and it has one runway designated 10/28[24] with an asphalt surface measuring 1 920 m by 20 m according to the Aeronautical Information Publication (AIP) of 12 November 2015. The AIP notes that the airfield is also registered as a permanent parachute drop zone. It has also been noted by the DCA that hot air ballooning occurs in the area (pers. comm. 19 May 2016), although it is mostly limited to the area between Walvis Bay and Swakopmund; over the Spitzkoppe Mountain, Moon Landscape, Naukluft and Sossusvlei[25].

The airport is located approximately 12 km south west of the nearest boundary of the proposed solar power generation facility. In addition, the AIP identifies two high mast towers at the Rössing mine which are 634 and 652 m above mean sea level at 3.5 km and 8 km from the airport respectively. The proposed solar power tower technology alternative will be much lower than these high masts and should be indicated on the latest aeronautical charts

The solar power tower technology alternative could change the airspace and therefore have the potential to affect one or more of the user groups mentioned above.

[24] Runway orientation relating to true North.

[25] Source: http://www.namibweb.com/baloon.html

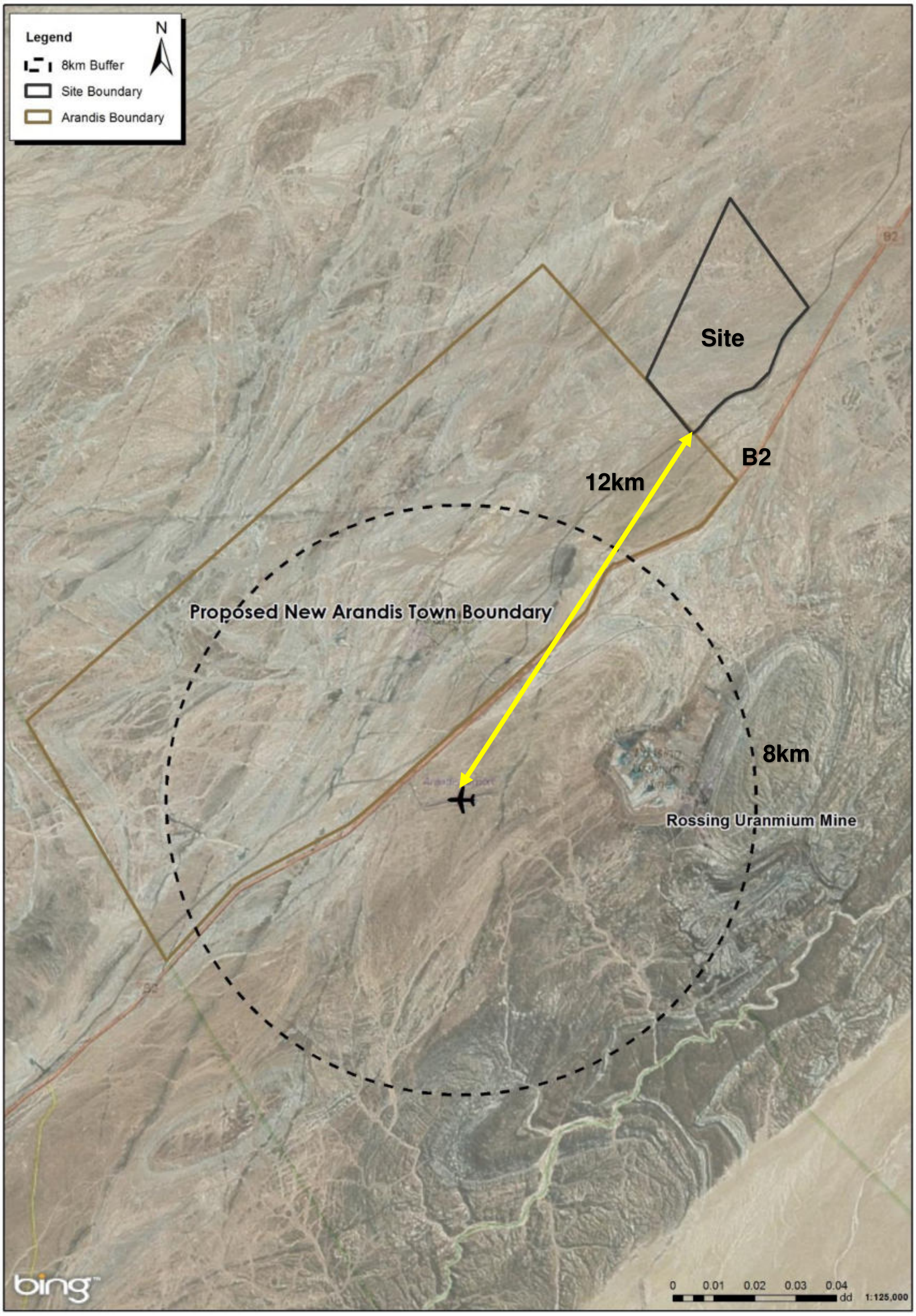


**Figure 25: Arandis Airport relative to the site**

### 6.4.1 Impact Statement

According to available literature, CSP facilities could potentially impact on aviation infrastructure as listed below[26]. Each of these potential impacts are discussed in more detail in the subsequent sections.

1. **Physical penetration of navigable airspace** - Intrude into airspace.
2. **Communications interference** - Electromagnetic interference caused by large structures that may reflect radar signals causing loss of radar coverage.
3. **Visual Impacts from glare and glint** - CSP components are known to produce glint (a momentary flash of bright light) and glare (a continuous source of bright light), which can disrupt a pilot's field of vision.
4. **Turbulence from thermal plumes** -Thermal plumes are created by power facilities using dry cooling systems releasing hot air that rises at a measurable rate and causes air turbulence. This type of turbulence cannot be identified in advance by a pilot, which increases the potential risk to aviators.

**Table 23: Potential impaction on aviation safety during the operational phase**

| OPERATION PHASE IMPACTS - PHYSICAL PENETRATION OF NAVIGABLE AIRSPACE | |
|---|---|
| **Erongo Coal-fired Power Station** | Physical intrusion was also considered as a potential impact for the approved Coal-fired Power Station in terms of its stacks (reaching a height of 100 to 150 m). This impact was however mitigatable by implementing warning lights, subject to aviation safety standards, at the top of the stacks. |
| **CSP** | CSP facilities have the potential to penetrate airspace. PV and Parabolic Trough CSP technologies utilise low profile (height) equipment which is less likely to impact on airspace unless it is located very close to an airport runway. The solar power tower technology alternative, specifically, very often interrupt regulated airspace due to the height of the tower. The proposed solar power tower would be approximately 200 to 250 m in height and would therefor penetrate the physical airspace which is internationally set at 150 m (500 ft) above ground level[27]. However it should be noted that the facility distance is further than 8 km away from the aerodrome reference point. |
| **OPERATIONAL PHASE IMPACTS – COMMUNICATIONS INTERFERENCE** | |
| **Erongo Coal-fired Power Station** | Communication systems interference was not identified as a potential impact by the Coal-fired Power Station on aviation safety. |
| **CSP** | Communication systems interference can be produced by either an electrical interference or as a physical obstacle between the communicator and receiver and is directly dependent on the size of the structure and its proximity to a radar facility. With regards to the potential for CSP facilities to interfere with communication systems, the ARCP study (2011) notes that electrical interference has not been a concern during airspace reviews undertaken to date. Reviews of South African Environmental Impact Assessments on CSP facilities (Savannah Environmental 2010 and WorleyParsons, 2012) also did not identify communication system interference as a concern for aviation safety, although it was highlighted as an impact for assessment in the Bokpoort II Solar Development Draft Scoping Report (Golder Associates, 2015). **The DCA did not identify this impact as a concern during the meeting that took place with them on 19 May 2016.** |

[26] As taken from ARCP, 2011. *Investigating Safety Impacts of Energy Technologies on Airports and Aviation.*
[27] According to the International Civil Aviation Organization's Visual Flight Rules, a minimum flight height of 150 m above the ground or water is required (ICAO, 2005).

| OPERATIONAL PHASE IMPACTS – VISUAL IMPACTS FROM GLARE AND GLINT[28] | |
|---|---|
| **Erongo Coal-fired Power Station** | Not assessed as not applicable to the facility. |
| **CSP** | The potential impacts of reflectivity are glint and glare, which can cause a brief visual impairment (also known as after- image or temporary flash blindness)[29] (FAA 2008a). Examples of the glare effect of various CSP technologies are provided in Figure 26 and is also discussed in Section 1.4.1 in terms of potential visual impacts of the proposed CSP facility. **This impact is applicable to pilots, including hot air balloon operators.**<br><br>CSP systems are designed to maximise reflection and focus the reflected sunlight and associated heat on a specific absorptive point (in other words the HCE) to produce steam that generates electricity. According to the ARCP, approximately 90% of incoming sunlight is reflected from a CSP mirror; whereas the remaining sunlight is experienced as diffuse solar radiation which is reflected in random directions as illustrated in Figure 27. Due to the reflected sunlight being controlled and focused on the HCE, it generally is not reflected back to other sensitive receptors. A small fraction of the sunlight may not be absorbed by the HCE which could result in diffuse reflection or scatter.<br><br>The sunlight that is concentrated directly on the receiver can reach up to a thousand times the sun's normal irradiance. Therefore, reflections from a central receiver, although approximately 90% absorptive, can still reflect a great deal of sunlight noted as glare or glint (as shown in Figure 26 and Figure 28). Different analyses are therefore necessary to understand the potential for glare and glint impacts for each of these systems. |
| OPERATIONAL PHASE IMPACTS – TURBULENCE FROM THERMAL PLUMES[30] | |
| **Erongo Coal-fired Power Station** | The authorised Coal-fired Power Station could produce heat plumes from the stacks and the dry-cooling system. However, thermal plume turbulence was not identified as a potential impact by the Coal-fired Power Station on aviation safety. |
| **CSP** | A localised CSP thermal plume is produced via the dry cooling systems often used by power plants (including CSP). These systems use fans that are located below the air-cooled condensers that blow hot air up to enhance cooling which can cause air turbulence. The impact of thermal plumes are generally more visible when low wind and large temperature differences occur, which is typically at sunrise during spring and summer for projects proposed in the Southern California desert area according to the ACRP (2011). The issue with thermal plumes which also occur naturally is when it makes contact with only one wing of an aircraft which can cause turbulence. This should however not cause any damage to the aircraft (B. van Wyk, pers. comm.).<br><br>Thermal plumes may impact on the operation of hot air balloons as part of the tourism activities that occur in the area. The skills of the pilot are paramount in catching alternating wind directions and the direction of the ascending and descending balloon cannot be determined. Thus no flight paths can be pre-planned or arranged[31]. This may impact on the ability of balloon operators in the area of the CSP facility and they will need to liaise with the DCA.<br><br>**The potential impact of turbulence from thermal plumes was not considered to be of significance by the DCA** (pers. comm. 19 May 2016; also see Annexure C5). |

[28] As taken from ACRP, 2011. *Investigating Safety Impacts of Energy Technologies on Airports and Aviation.*
[29] FAA Order 7400.2f defines flash blindness as "Generally, a temporary visual interference effect that persists after the source of illumination has ceased".
[30] As taken from ACRP, 2011. *Investigating Safety Impacts of Energy Technologies on Airports and Aviation.*
[31] Source: http://www.air-ventures.co.za/eco_friendly.asp

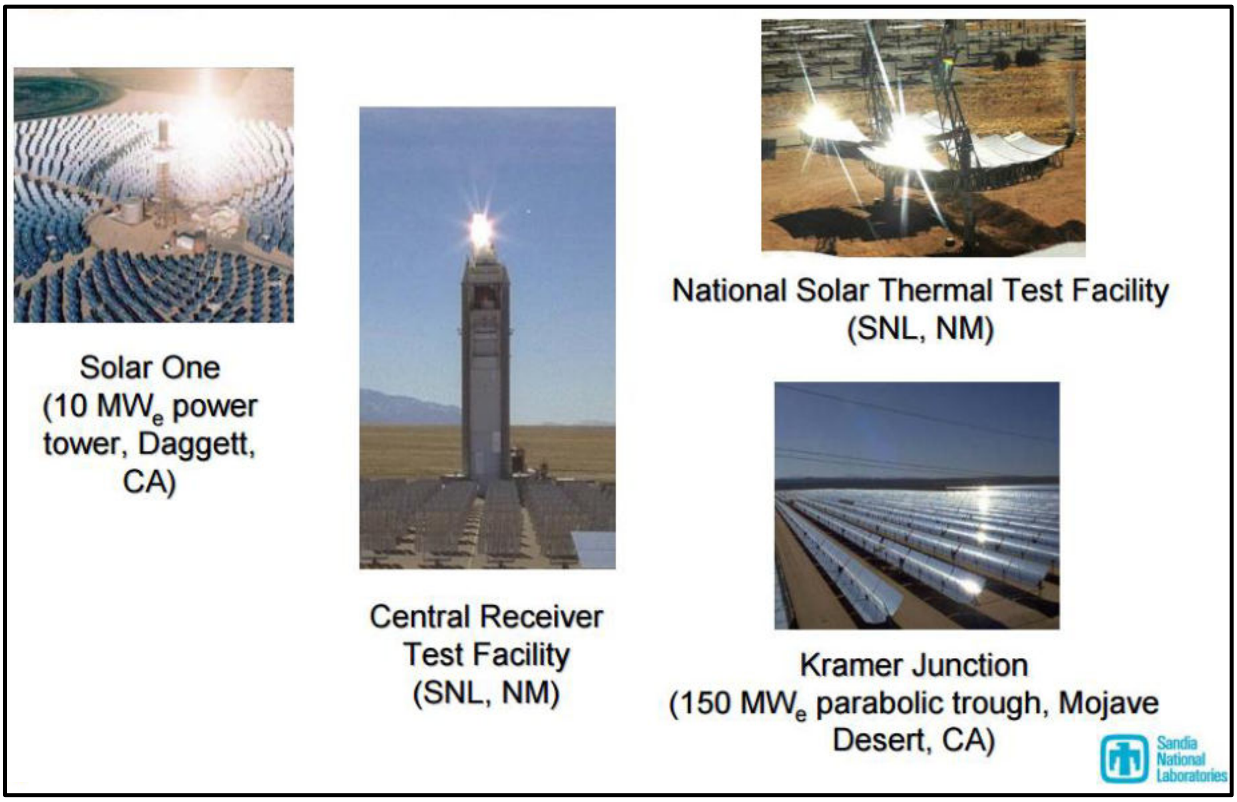


**Figure 26: Example of the glare effect of CSP facilities**

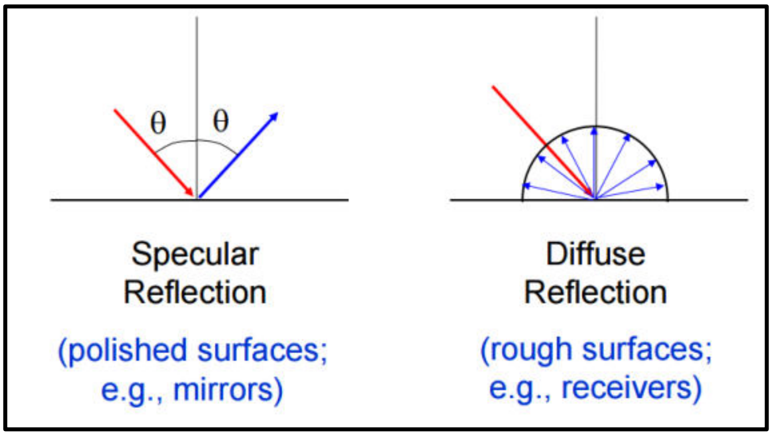


**Figure 27: Direct (specular) and Diffuse reflection (Sandia National Laboratories)**

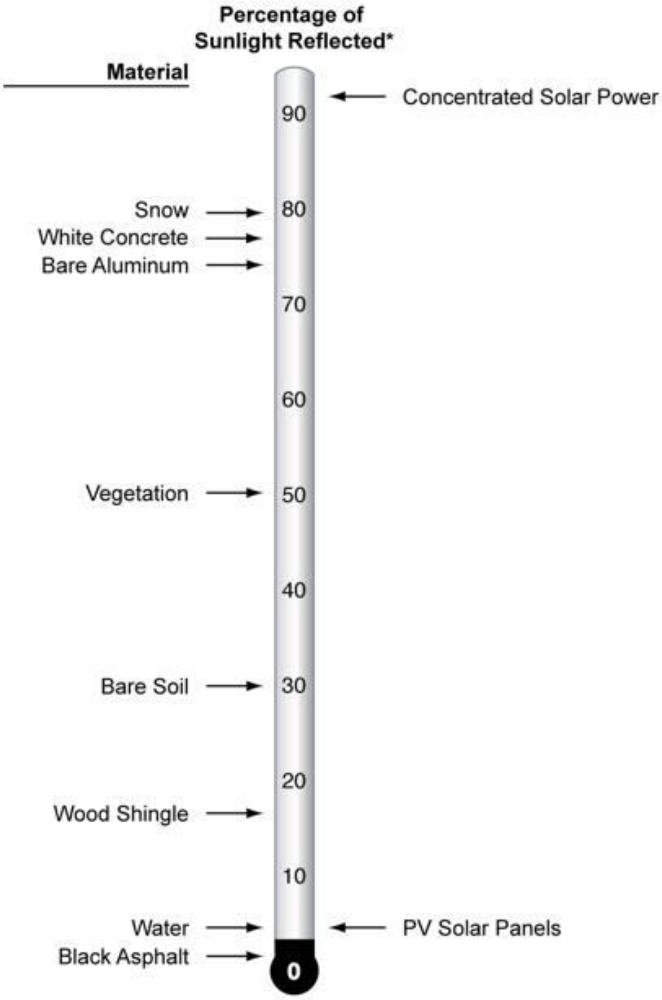


**Figure 28: The percentage of sunlight reflected by CSP facilities in comparison with material of different reflection capabilities. Sunlight is measured as watts per square meter (W/m$^2$). The amount of incoming sunlight is generally considered to be 1000 W/m$^{2.}$ The percentage of sunlight reflected from each surface can be calculated from this baseline i.e. CSP 90+ W/m$^2$. (Source: ACRP, 2011).**

### *6.4.2 Key Mitigation Measures*

The following mitigation measures would be required for each of the two technology options assessed for the proposed CSP facility as summarised in Table 24. The mitigation measures which were identified by the visual impact assessment are also applicable (see Section 6.4.2).

**Table 24: Additional mitigation measures required to address potential impacts on aviation safety**

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
| --- |
| **Solar Power Tower Technology** |
| **<u>Planning, design and operation</u>**<br>The following mitigation measures are based on international requirements and shall be required:<br>• Submit an application to erect a permanent structure within the vicinity of an aerodrome.<br>• The following monitoring plans shall be required: |

**PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES**

- Heliostat positioning plan
  - Identify heliostat movements and positions (including reasonably possible malfunctions) that could result in potential exposure of observers at various locations including in aircraft and motorists to reflected solar radiation from heliostats. The plan should also describe how programmed heliostat operation would avoid potential for human health and safety hazards at locations of observers as attributable to momentary solar radiation exposure greater than the maximum permissible exposure set by health regulations.
  - Include a monitoring component to: (1) obtain field measurements in response to legitimate com plaints; (2) verify that the heliostat positioning plan would avoid the potential for human health and safety hazards including temporary or permanent blindness at locations of observers; and (3) provide requirements and procedures to document, investigate, and resolve legitimate complaints regarding glare.
- A solar power tower luminescence monitoring plan.
  - Provide procedures to conduct periodic monitoring and to document, investigate, and resolve complaints regarding distraction effects to aviation, vehicular, and pedestrian traffic associated with the solar power towers.
  - Evaluate the effects of the intensity of the luminance of light reflected from the solar power tower receivers 90 days after commencement of commercial operations, and after 5 years, as well as after any significant design or operational modification, or after a significant complaint.
  - The plan shall also coordinate monitoring protocols and results with the relevant stakeholders.

- Lighting of the solar power tower shall be required in accordance with the relevant DCA standards.
- Safety markings on the solar power tower will be discussed and finalised with DCA during the planning and design phases.[32]
- The heliostats shall be rotated from stow away position to ready position before sunrise to limit potential inadvertent glare and returned to stow position after sunset.

**Mitigation options to be considered by the DCA**

- Flight procedures can be restricted during certain periods of the day when glare may occur.
- Insert notations in the appropriate Aeronautical Charts, Airport / Facilities Directories, and Notice to Airmen publication to identify potential hazard from glare and thermal turbulence.

**Parabolic Trough Technology**

**Planning and design**

The following mitigation measures are based on international requirements and shall be required:

- Develop and implement a parabolic positioning plan.
- Parabolic designs shall consider using end caps to reduce glare that “spills” from the ends of the trough.
- Submit an application to erect a permanent structure within the vicinity of an aerodrome.

**Operation**

The following mitigation measures are based on international requirements and shall be required:

[32] Internationally accepted design practice is to paint the top 25% of solar power towers with a special white paint to protect the concrete against potential temperature increases as a result of a malfunctioning heliostat. This makes the tower extremely visible when there are no heliostats focusing on the receiver (K. van der Merwe, pers. comm.).

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
| --- |
| • Non-reflective or diffuse materials or coatings (e.g., paint) shall be used for bellows shields located every few meters at joints between heat collecting elements.<br>• The troughs shall be rotated from stow away position to ready position before sunrise to limit potential inadvertent glare and returned to stow position after sunset.<br>• Mirror function shall continuously be monitored by operators and system controllers.<br>• Malfunctioning and non-operational troughs shall automatically be rotated to stow away position.<br>• Specific procedures for documenting, investigating, evaluating, and resolving (if feasible) public complaints about glare shall be developed.<br>**Mitigation options to be considered by the DCA**<br>• Flight procedures can be restricted during certain periods of the day when glare may occur.<br>• Insert notations in the appropriate Aeronautical Charts, Airport / Facilities Directories, and Notice to Airmen publication to identify potential glare and glint hazards. |
| **Applicable Erongo Coal-fired Power Station mitigation measures** |
| In addition to the above, the following mitigation measures from the approved Coal-fired Power Station will be considered for the proposed CSP facility:<br>• The respective infrastructure components should be planned, designed and operated according to relevant best practice guidelines and legislation.<br>• Strict night lighting control should be implemented, including no up-lights on the plant, subject to safety requirements.<br>• Implementation of a dual lighting system (white strobes for daytime use, and red beacons/strobes for night time use) as aviation warning on the solar power tower, in line with safety regulations.<br>• A Stakeholder Liaison Committee, including representatives of the local community, should be formed before construction starts.<br>• The Environmental Management Programme must be complied with during both the construction and operational phases. |

### 6.4.3 Impact Rating

Table 25 and Table 26 assess the significance of the potential impacts on aviation safety (with and without mitigation) as discussed in the above sections. The ratings are based on the discussions with the DCA, international studies and the expert opinion of a CSP specialist, Mr Kobus van der Merwe.

**Table 25: Aviation related Impacts of the proposed CSP facility without mitigation**

| IMPACT DESCRIPTION | TYPE | EXTENT | MAGNITUDE | DURATION | PROBABILITY | CONFIDENCE | REVERSIBILITY | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|---|
| Physical penetration of navigable airspace (solar power tower) | Negative | Local | High | Long term | Definite | Certain | Reversible | **Medium (-)** |
| Physical penetration of navigable airspace (parabolic trough) | Not applicable | | | | | | | |
| Communications interference (for both technology alternatives) | Negative | Local | Low | Long term | Definite | Certain | Reversible | **Low (-)** |
| Visual impacts from glare and glint (solar power tower) | Negative | Local | High | Long term | Definite | Certain | Reversible | **High (-)** |
| Visual impacts from glare and glint (parabolic trough) | Negative | Local | Low | Long term | Definite | Certain | Reversible | **Medium (-)** |
| Turbulence from thermal plumes (for both technology alternatives) | Negative | Site specific | Very low | Long term | Definite | Certain | Reversible | **Very low (-)** |

**Table 26: Aviation related Impacts of the proposed CSP facility with mitigation**

| IMPACT DESCRIPTION | TYPE | EXTENT | MAGNITUDE | DURATION | PROBABILITY | CONFIDENCE | REVERSIBILITY | SIGNIFICANCE |
|---|---|---|---|---|---|---|---|---|
| Physical penetration of navigable airspace (solar power tower) | Negative | Local | Low | Long term | Definite | Certain | Reversible | **Low (-)** |
| Physical penetration of navigable airspace (parabolic trough) | Not applicable | | | | | | | |
| Communications interference (for both technology alternatives) | Negative | Local | Low | Long term | Definite | Certain | Reversible | **Low (-)** |
| Visual impacts from glare and glint (solar power tower) | Negative | Local | Medium | Long term | Definite | Certain | Reversible | **Medium (-)** |
| Visual impacts from glare and glint (parabolic trough) | Negative | Local | Low | Long term | Definite | Certain | Reversible | **Low (-)** |
| Turbulence from thermal plumes (for both technology options) | Negative | Site specific | Very low | Long term | Definite | Certain | Reversible | **Negligible (-)** |

## 6.5 Avifauna

An avifaunal assessment study was carried out by Chris van Rooyen of Chris van Rooyen Consulting in order to assess the impacts of the CSP facility on the avifauna of the study site and the greater area. It sought to identify the baseline characteristics for avifauna in area, determine the anticipated impacts of the proposed facility and to develop practical, cost-effective and auditable management measures to avoid, ameliorate or manage negative biodiversity impacts.

The detailed updated report is attached in full in Annexure E5 of this report, while the main impacts and their mitigation measures are outlined below.

### Policy, legislation and guidelines

There is no legislation pertaining specifically to the impact of solar facilities on avifauna in Namibia. While there are best practice guidelines available which were compiled by Birdlife South Africa in 2012 (Smit 2012), these guidelines are not legally binding. Namibia is however party to the international agreements and conventions listed in Table 27 which are of relevance to avifauna.

**Table 27: International agreements and conventions related to avifauna of which Namibia is party**

| CONVENTION NAME | GEOGRAPHIC SCOPE |
|---|---|
| Convention on Biological Diversity (CBD), Nairobi, 1992 | Global |
| Convention on the International Trade in Endangered Species of Wild Flora and Fauna, (CITES), Washington DC, 1973 | Global |
| Ramsar Convention on Wetlands of International Importance, Ramsar, 1971 | Global |

### Scope of study

An avifaunal study was not undertaken for the Erongo Coal-fired Power Station as the transmission lines did not form part of the project description and avifaunal issues were not identified as significant risks related to the former facility. The focus of the current study was primarily on the potential impacts on priority species such as Namibian Red Data species, Namibian endemics and near-endemics, waterbirds and raptors.

### Arandis baseline conditions

The closest Important Bird Area (IBA), the Namib – Naukluft Park (NA010), which starts approximately 25km to the south-east of study area (Birdlife International 2016) falls outside the zone of influence of this development. A total of 100 species could potentially occur at the development site (Annexure E5), of which 14 are classified as priority species (see Table 1 in Annexure E5).

### *6.5.1 Impact Statement*

The impact of solar installations on avifauna is a new field of study, with only one scientific study published to date (McCrary et al. 1986). Strong reliance was therefore placed on expert opinion and data from existing monitoring programmes at solar facilities in the USA which have recently (2013 – 2015) commenced with avifaunal monitoring. The precautionary principle was applied throughout as the full extent of impacts on avifauna at solar facilities is not presently known.

**Table 28: Potential impacts on avifauna during the construction and operational phases**

| CONSTRICTION PHASE IMPACTS – TEMPORARY DISPLACEMENT DUE TO HABITAT TRANSFORMATION | |
|---|---|
| **Erongo Coal-fired Power Station** | Not assessed during the ESEIA. |
| **CSP** | The construction of the CSP facility and associated infrastructure will result in the radical transformation of the existing natural habitat. The vegetation will be cleared prior to construction commencing. The construction (and de-commissioning) of the CSP facility and associated infrastructure (buildings and access roads) will also result in a significant amount of movement and noise, which will lead to temporary displacement of avifauna from the site. It is highly likely that most priority species listed in **Error! Reference source not found.** above will vacate the area for the duration of these activities |
| **OPERATIONAL PHASE IMPACTS – COLLISIONS WITH THE HELIOSTATS, PARABOLIC TROUGHS OR PVs** | |
| **Erongo Coal-fired Power Station** | Not assessed during the ESEIA. |
| **CSP** | It seems very likely that reflections from solar facilities' infrastructure, particularly large sheets of dark blue photovoltaic panels, may well be attracting birds in flight across the open desert, who mistake the broad reflective surfaces for water – this is called the "lake effect". This could either result in birds colliding directly with the solar panels, or getting stranded and unable to take off again because many aquatic bird species find it very difficult and sometimes impossible to take off from dry land e.g. grebes and cormorants. However, due to limited data it would be premature to make any general conclusions about the influence of the "lake effect" or other factors that contribute to fatality of water-dependent birds.<br><br>Should the CSP site employ solar power tower technology, the centrally located tower-mounted heat exchanger (receiver) will be located at an altitude of between approximately 200 m and 250 m. Given the height of the central receiver, several priority raptor species could potentially be exposed to solar flux[33] if they venture close to the tower, including Southern Pale Chanting Goshawk, Booted Eagle, Greater Kestrel, Rock Kestrel, Black-chested Snake-Eagle, Lanner Falcon and Augur Buzzard. In the case of Lanner Falcon, the species may actually be attracted to the vicinity of the tower to prey on birds which are singed by solar flux resulting in impaired flight ability, making them easy targets to catch e.g. aerial foragers such as swifts and swallows which are preying on insects attracted to the bright receiver.<br><br>The solar power tower might also attract raptors as a convenient perch, as they are normally drawn to high structures in the landscape for this purpose, and in the process they could be exposed to solar flux at nearby standby points. The biggest risk is associated with standby points, i.e. when the heliostats are in stand-by mode and not focusing on the tower receiver (Ho 2015). During standby they are not aimed at the tower receiver, but somewhere in the air above or next to the tower. Fatality of birds can also result from the direct contact of the bird with other project structure(s). This type of fatality has been documented at solar projects of all technology types. |

[33] According to NREL, the solar flux threshold that may have potential harmful effects on birds is 50 kW/m². This can however be reduced by employing randomized heliostat aim-points.

| | |
|---|---|
| **OPERATIONAL PHASE IMPACTS - BURNING DUE TO SOLAR FLUX (ONLY RELEVANT TO CSP CENTRAL RECEIVER TECHNOLOGY)** | |
| **Erongo Coal-fired Power Station** | Not assessed during the ESEIA. |
| **CSP** | Fatality resulting from the burning/singeing effects of exposure to concentrated sunlight. Passing through the area of solar flux may result in: (a) direct fatality; (b) singeing of flight feathers that cause loss of flight ability, leading to impact with other objects; or (c) impairment of flight capability to reduce the ability to forage or avoid predators, resulting in starvation or predation of the individual (Kagan et al. 2014). Solar-flux-related fatality has been observed only at facilities employing solar power tower technologies. |
| **OPERATIONAL PHASE IMPACTS - PERMANENT DISPLACEMENT DUE TO HABITAT TRANSFORMATION** | |
| **Erongo Coal-fired Power Station** | Not assessed during the ESEIA. |
| **CSP** | Once operational, the construction of the heliostats or parabolic troughs will reduce the volume of sunlight reaching the vegetation below, which is likely to impact the vegetation growth and could lead to changes in the ecology. The natural vegetation is likely to persist in the rows between the mirrors, but it will be a fraction of what was available before the construction of the facility. Table 1 in the specialist report (Annexure E5) lists the priority species that could potentially be affected by this impact. Small birds are often capable of surviving in small pockets of suitable habitat, and are therefore generally less affected by habitat fragmentation than larger species. It is, therefore, likely that most of the smaller species will continue to use the habitat available within the solar facility albeit at lower densities (e.g. Gray's Lark). This will however differ from species to species and it may not be true for all of the smaller species. Larger species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are more likely to be displaced entirely from the area of the proposed facility although in the case of some raptors (e.g. Southern Pale Chanting Goshawk, Lanner Falcon, Augur Buzzard and Booted Eagle) the potential availability of carcasses or injured birds due to collisions with the heliostats or parabolic troughs may actually attract them to the area. The significance of the potential displacement impact is difficult to assess at this stage and will only become clear through operational phase surveys. |
| **CUMULATIVE IMPACTS** | |
| **Erongo Coal-fired Power Station** | Not assessed during the ESEIA. |
| **CSP** | The cumulative impacts of the proposed CSP facility on avifauna are considered in light of the impacts identified above and are envisaged to range from *Medium negative* to *insignificant* at a local level, and *Medium-low* to *insignificant* at a regional level. |

### 6.5.2 Key Mitigation Measures

The mitigation measures are recommended to reduce significance of the impacts for the proposed amendment.

**Table 29: Additional mitigation measures required to address potential impacts on avifauna**

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| **<u>Planning, construction and operation</u>**<br>The following recommendations should be considered for the CSP facility:<br>• Construction activity should be restricted to the immediate footprint of the infrastructure.<br>• Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.<br>• Measures to control noise and dust should be applied according to current best practice in the industry.<br>• Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.<br>• Monitoring should be implemented to search the ground between the heliostats of parabolic troughs on a two-weekly basis for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot by specially trained local people under the supervision of the avifaunal specialist. Searches should be conducted randomly or at systematically selected heliostats of troughs to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.<br>• A draft monitoring protocol has been provided by the avifauna specialist for the operational phase. However this protocol must be reviewed and finalised by the avifaunal specialist in consultation with the facility operator and Environmental Control Officer before the commencement of operations. The exact scope and nature of the operational phase monitoring will be informed on an ongoing basis by the result of the monitoring and the EMP must be updated accordingly.<br>• Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panel and mirror design to reduce the illusory characteristics of the heliostats or parabolic troughs. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist.<br>• Monitoring should be implemented to search the ground between the heliostats of parabolic troughs on a two-weekly basis for at least one year to determine the magnitude of collision fatalities. Searches should be done on foot by specially trained local people under the supervision of the avifaunal specialist. Searches should be conducted randomly or at systematically selected heliostats of troughs to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.<br>• The exact protocol to be followed for the operational phase monitoring should be compiled by the avifaunal specialist in consultation with the facility operator and Environmental Control Officer before the commencement of operations. The exact scope and nature of the operational phase monitoring will be informed on an ongoing basis by the result of the monitoring and the EMP will be updated accordingly.<br>• Bird counts should be conducted at least three times per year once the facility has been constructed. The purpose of this would be to establish to what extent displacement of priority species have taken place. The exact time when bird counts should commence, will depend on the construction schedule, and will be agreed upon with the site operator once these timelines have been finalised. As an absolute minimum, bird counts should be undertaken for the first two years of operation, and then repeated again in year 5.<br>• The recommendations of the ecological and botanical specialist studies must be strictly implemented, especially as far as limitation of the construction footprint and rehabilitation of disturbed areas is concerned. |

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
| --- |
| • During standby mode the heliostats don't focus the reflected rays on the tower but randomized aim-points in the air. The plant must be designed that during standby point no more than four heliostats focus on the same spot. This will eliminate the danger to birds flying thru the concentrated rays as they will be exposed to only four "suns". |

### 6.5.3 Impact Rating

Table 30 provides a comparison of the construction and operational phase impact significance pre- and post-mitigation.

**Table 30: Significance of the impacts on avifauna (pre- and post-mitigation)**

| IMPACT DESCRIPTION | PRE-MITIGATION SIGNIFICANCE | POST-MITIGATION SIGNIFICANCE |
| --- | --- | --- |
| Displacement of priority species due to disturbance associated with the construction and decommissioning of the CSP facility and associated infrastructure: Central receiver and parabolic trough | **Low (-)** | **Low (-)** |
| Mortality of priority species avifauna through collisions with the heliostats or parabolic troughs: Central receiver and parabolic trough | **Low (-)** | **Low (-)** |
| Displacement of priority species due to habitat transformation: Central receiver and parabolic trough | **Medium (-)** | **Medium (-)** |
| Mortality of priority avifauna through burning (solar flux): Central receiver only | **Very low (-)** | **Negligible (-)** |

### 6.5.4 Comparison with "no-go" alternative

The no-go alternative will result in the current status quo being maintained as far as the avifauna is concerned. Given the low human population in the region, it can be surmised that the existing anthropogenic impacts on avifauna is relatively low. The no-go option would maintain the ecological integrity of the study area as a whole far as avifauna is concerned.

## 6.6 Hydrology, surface water and soils

The original study has not been revised as it is not anticipated that the proposed CSP facilities would have any additional impacts to what was assessed and would likely be quite similar for the construction phase and to a lesser extent for the operational phase. The original hydrogeology, hydrology, water supply and soils study was undertaken by Andrew Johnstone of GCS (Pty) Ltd and is available in the Final ESEIA for the Erongo Coal-fired Power Station.

### 6.6.1 Impact Statement

Table 31 below provides a summary of the impacts that were identified for the Erongo Coal-fired Power Station, as well as the relevance of these impacts to the proposed CSP facility. According to the ESEIA the significance of potential construction and operational phase impacts are as follow:

- Groundwater: low negative significance with mitigation;
- Surface water: very low negative significance with mitigation; and

- Soil: medium negative significance (mitigation not possible).

Note that no cumulative impacts were identified for groundwater and surface water resources. The potential for groundwater pollution is low and if it does occur it will be limited to the immediate area where no groundwater extraction currently takes place.

**Table 31: Applicability of groundwater, surface water and soils related impacts identified for the Erongo Coal-fired Power Station to the proposed CSP facility**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction and operational phase impacts on groundwater** | | |
| Impact on groundwater of coal stockpiles | √ | |
| Poor quality artificial recharge from the ash storage facility | √ | |
| Poor quality water recharging the groundwater from water treatment facilities | √ | √ |
| Poor quality leachate and runoff from temporary waste storage site | √ | √ |
| Contamination of groundwater from wastewater treatment facility | √ | √ |
| **Construction and operational phase impacts on surface water** | | |
| Reduction in runoff from catchment* | √ | √ |
| Contamination of surface water resources as a result of operations | √ | |
| Potential diversion of stream | √ | √ |
| Construction within floodlines | √ | √ |
| Lack of and/or incorrect implementation of a Stormwater Management System | √ | √ |
| **Construction and operational phase impacts on soil** | | |
| Loss of topsoil on site and soil in drainage channels | √ | √ |

### *6.6.2 Key Mitigation Measures*

**No additional mitigation measures would be required for the proposed CSP facility. However, a number of the mitigation measures identified for the Erongo Coal-fired Power Station would no longer be required as summarised in**

Table 32.

**Table 32: Additional mitigation measures required to address potential visual impacts**

**PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES**

**Additional mitigation measures**

No additional mitigation measures are required.

**Mitigation measures not applicable to the proposed CSP facility**

***Groundwater:***

- Ensure that the coal stockpile is designed to meet international best practice standards to ensure no contamination of ground water. Containment of leachate is required, with drainage channels to collect leachate for treatment and to reduce the vertical migration into the underlying soil and groundwater.
- Use the floodline delineation to inform final positioning of the ash storage facility.
- Employ dry ash storage, thereby reducing the amount of water in the ash facilities and the chances of polluting the groundwater during recharge.
- Line facilities where leachate production is possible, such as the ash storage facility, water storage and treatment facilities, with compacted clay, asphalt or synthetic liners to prevent any vertical migration into the underlying soil and groundwater.
- Create runoff separation controls such as berms and furrows around ash storage facilities and waste storage areas to separate clean and contaminated run-off. Poor quality runoff from the plant area must be diverted into a lined recovery dam. The runoff controls must allow clean water to drain around the site without becoming contaminated. These controls must be installed during the construction phase and maintenance of these controls must be implemented throughout operation. Ensure that the gradients are sufficient to prevent the unwanted accumulation of surface water and the potential recharge of groundwater from this.
- Contain and re-use leachates from ash storage facility and treatment plants.

**Proposed changes to approved mitigation measures**

**From:** ***Groundwater:***

- Remove all infrastructure (except ash storage facility) from site during decommissioning and rehabilitate area as per the rehabilitation plan to be compiled, unless there is an identified alternative use for infrastructure

***Surface water:***

- Map the relevant floodlines for every watercourse and attempt, as far as possible, to locate all infrastructure out of these floodlines. Should this not be possible, design must accommodate the potential for flash floods. The final position of the ash storage facility will be determined after the site survey and the floodline delineation. A stream diversion could be created, which would be costly and should only be considered if no other options are available. It is recommended, at this stage, that alternative locations for the ash storage site must be investigated, which will mitigate the risk.

**To:** ***Groundwater:***

- Remove all infrastructure from the site during decommissioning and rehabilitate area as per the rehabilitation plan to be compiled, unless there is an identified alternative use for infrastructure.

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| ***Surface water:*** <br>• Map the relevant floodlines for every watercourse and attempt, as far as possible, to locate all infrastructure out of these floodlines. Should this not be possible, design must accommodate the potential for flash floods. |

### 6.6.3 Impact Rating

The overall impact of CSP technology would have a smaller impact on groundwater, surface water and soils than the Erongo Coal-fired Power Station since not all of the original impacts are applicable (as shown in Table 33. It is however anticipated that the applicable potential impacts would be quite similar for the construction phase and to a lesser extent for the operational phase. The impact ratings (with mitigation) therefore remains unchanged.

**Table 33: Comparison of the significance of potential impacts on groundwater, surface water and soil with mitigation**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction and operational phase impacts on groundwater** | | |
| Impact on groundwater of coal stockpiles | **Low (-)** | **-** |
| Poor quality artificial recharge from the ash storage facility | **Low (-)** | **-** |
| Poor quality water recharging the groundwater from water treatment facilities | **Low (-)** | **Low (-)** |
| Poor quality leachate and runoff from temporary waste storage site | **Low (-)** | **Low (-)** |
| Contamination of groundwater from wastewater treatment facility | **Low (-)** | **Low (-)** |
| **Construction and operational phase impacts on surface water** | | |
| Reduction in runoff from catchment* | **Very low (-)** | **Very low (-)** |
| Contamination of surface water resources as a result of operations | **Very low (-)** | **Very low (-)** |
| Potential diversion of stream | **Very low (-)** | **Very low (-)** |
| Construction within floodlines | **Very low (-)** | **Very low (-)** |
| Lack of and/or incorrect implementation of a Stormwater Management System | **Very low (-)** | **Very low (-)** |
| **Construction and operational phase impacts on soil** | | |
| Loss of topsoil on site and soil in drainage channels* | **Medium (-)** | **Medium (-)** |

*Mitigation not possible

## 6.7 Biodiversity

A biodiversity assessment study was carried out by John Irish of Biodata Consultancy CC in 2011 in order to assess the impacts of the Erongo Coal-fired Power Station on the biodiversity of the study site and the greater area. It sought to identify the baseline biodiversity of the area that may be affected, determine the anticipated impacts of the proposed facility and to develop practical, cost-effective and auditable management measures to avoid, ameliorate or manage negative biodiversity impacts.

John Irish was again appointed to assess the impacts of CSP technology at the site and to prepare input into the Amendment Report. The detailed updated report is attached in full in Annexure E1 of this report, while the main impacts and their mitigation measures are outlined below.

Both the original and amendment studies comply with the relevant Namibian legislation and take note of relevant international best-practice principles and performance standards such as the Equator Principles and those advocated by the IFC.

### *6.7.1 Impact Statement*

A technology change to solar power is generally considered more environmentally friendly than the previously planned coal-fired power station on the same site, and avoids many of the environmental risks of the latter related to potential air and water pollution. However, the environmental sensitivity of the Central Namib Desert remains unchanged from the previous assessment and any development on this site, however 'green' the technology may be, requires careful management to keep damage to substrates and endemic biodiversity at acceptable levels so that thresholds of disturbance are not reached beyond which biodiversity and ecological functioning is irreversibly damaged.

However, three changes to or additional impacts were identified, as detailed below. Note that the cumulative impacts assessed for the Erongo Coal-fired Power Station remains applicable to the proposed CSP facility.

**Table 34: Potential impacts on biodiversity during the construction and operational phase of the proposed CSP facility**

| CONSTRUCTION PHASE IMPACTS – HABITAT LOSS IN FOOTPRINT AREA | |
|---|---|
| **Erongo Coal-fired Power Station** | Currently occurring habitats within the footprint of the development will be modified over time into built structures, paved or bare ground, coal stockpiles or ash storage sites. The newly created environment will not be able to support life forms currently occurring in the area, and will not contribute to the ecological functioning of the surroundings either. This will result in a reduction of the bioclimatic envelope and habitat by 23% (loss of 6.5 $km^2$ of a total of $34km^2$ habitat) for the 800 MW (650 ha) power station, which will have a direct impact on endemic Central Namib invertebrates with restricted ranges. The footprint size for the 300 MW (400 ha) power station covers approximately $3.6km^2$, which will have a slightly reduced impact on biodiversity[34]. |
| **CSP** | The impact is as described above, however, the change in the footprint of a coal-fired power station is expected to reduce the global distribution range size of any range-restricted endemic invertebrate in the area by on average 32%, which was already higher than the generally acceptable limit of 25% of total habitat loss. If the entire current project area is used (1370 ha), combined with substrate destructive technology or construction methods, the percentage of range loss would increase on average to 54%, which virtually guarantees some extinction. However if the receptor fields are built to prevent substrate destruction, as, the direct habitat loss will be restricted to supporting infrastructure only, and the percentage of range loss will probably be less than it was for a coal-fired station. However it will only be possible to calculate the magnitude of the expected change once actual infrastructure footprints and their sizes are available. |

[34] The relationship between area and bioclimatic envelope is not directly linear and thus the percentage cannot be calculated as a direct percentage of area lost per envelope size.

| CONSTRUCTION PHASE IMPACTS ON PROTECTED SPECIES *ACACIA ERIOLOBA* | |
|---|---|
| **Erongo Coal-fired Power Station** | Species does not occur on footprint area and was therefore not an impact for the coal technology option. |
| **CSP** | The enlarged project area necessitated the consideration of an additional plant species with legal status. *Acacia erioloba*, Camelthorn, is a Protected Tree under regulations in terms of the Forest Act 12 of 2001, currently awaiting final publication. The principal occurrence of *Acacia erioloba* in the wider vicinity is along the main watercourse that crosses the project area, but mainly upstream of the project area. The species did not occur in areas considered in the previous study considered areas, but a few individuals reach as far as the eastern border of the study area (proposed site).<br><br>In the desert environment, trees are important as sources of food, shelter and structural niche diversity. Removing a tree takes away the livelihood of an entire interdependent community of animals. Desert trees take centuries to reach the size where they can provide these ecosystem services. They cannot be replaced within human timescales. Larger plants on the site have already been there for considerably longer than the projected lifespan of the proposed project (J. Irish, pers. comm.). |
| **CONSTRUCTION AND OPERATIONAL PHASE IMPACTS ON WATERCOURSE – FLASH FLOODING** | |
| **Erongo Coal-fired Power Station** | The removal of vegetation cover and the alteration of natural drainage patterns may increase the risk of flash floods. There is also a pollution threat associated with flooding that could potentially spread pollutants downstream from the source, affecting biophysical resources off-site. Where developments alter drainage patterns, the new flow lines may induce erosion, thereby affecting biodiversity by altering downstream habitats through siltation. |
| **CSP** | Because the footprint of the CSP project is larger compared to that of the coal-fired power project, the upstream catchment area that can affect the CSP project is also relatively larger. A larger upstream catchment increases the source area for seasonal flash floods, compared to that for the coal-fired project. The design of the CSP project should accommodate the potential for relatively more intense, albeit highly irregular, flash floods compared to the previous project. This may become an ecological issue if flood attenuation measures in the project area disrupt natural surface or groundwater flow to the extent that downstream water points are adversely affected, or if there is a pollution event that replicates downstream. Preservation of meagre water resources is of crucial importance to the survival of desert vertebrates. Seep 1, less than a kilometre from the project area, is at highest risk because all inflow into the seep passes through the project area. The other three, more distant, seeps are less at risk because of the progressively smaller proportion of their total inflow that passes through the project area. |

### *6.7.2 Key Mitigation Measures*

Three additional mitigation measures are recommended to reduce significance of the impacts for the proposed amendment.

**Table 35: Additional mitigation measures required to address potential impacts on biodiversity**

| AMENDMENT TO MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| ***Planning, design, construction and operation*** <br>• The site must be re-evaluated once the layout design and footprints are available to verify the results of the biodiversity assessment. <br>• Limit habitat destructive impact during the construction of the receptor fields by protecting the integrity of the topography and vegetation on site by limiting vehicular movement on site during the construction phase to once-off events using only rubber tired vehicles, and having workers move about on foot only. <br>• Habitat loss can be minimised by building receptor fields on the existing surface, with no groundworks or levelling of ground. <br>• Preserve protected *Acacia erioloba* trees[35]. Given the high value, slow growth and irreplaceability of these and other trees in the desert (carbon-dated to ages of 600 years and more – J. Kinahan, pers. comm.), it is recommended that this principle of preservation be extended to all trees in the area with a trunk diameter of more than 20 cm at a height of 1 m above the ground, irrespective of species. <br>• Allow for unimpeded and pollution free storm water flow. Where drainage needs to be re-routed around supporting infrastructure, do so in low gradient, erosion preventive ways. |

### 6.7.3 Impact Rating

Table 36 provides a comparison of the construction and operational phase impact significance after mitigation of the Erongo Coal-fired Power Station against those of the proposed CSP facility (with mitigation). As can be seen, the overall significance if the identified impacts remains unchanged.

**Table 36: Significance of the construction and operational phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction Phase** | | |
| Direct habitat loss through infrastructure development | High (-) | High (-) |
| Animal collisions with vehicles | Very low (-) | Very low (-) |
| Impacts on *Aloe asperifolia* | Neutral | Neutral |
| Impacts on *Acacia erioloba* trees | - | Very Low |
| Alien introductions through new habitat creation | Low (-) | Low (-) |
| Potential human-wildlife conflict | Neutral | Neutral |
| Indirect habitat loss through behaviour alteration as a result of noise | Neutral | - |

[35] Please note that according to the specialist it is highly unlikely that many trees will be affected on site given the sparse occurrence of such trees and the fact that they are located on the border of the site. It should thus be possible to accommodate the few individuals that may possibly be encountered.

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Operational Phase** | | |
| Indirect habitat loss through habitat alteration by fugitive dust emissions | Medium (-) | - |
| Indirect habitat loss through habitat alteration by stack emissions | Low (-) | - |
| Indirect habitat loss through behaviour alteration as a result of light emissions | Low (-) | Low (-) |
| Animal collisions with vehicles | Very low (-) | Very low (-) |
| Flash floods | Very low (-) | Very low (-) |
| Potential human-wildlife conflict | Neutral | Neutral |
| Indirect habitat loss through behaviour alteration as a result of noise | Neutral | - |

## 6.8 Greenhouse gasses

The original study has not been revised as the proposed CSP facility does not rely on fossil fuels and would therefore not release greenhouse gases (GHG) during operation.

### *6.8.1 Impact Statement*

A technology change to solar power is generally considered more environmentally friendly than the previously planned coal-fired power station on the same site, specifically relating to GHG as CSP is renewable energy with no related operational GHG released.

**Table 37: Potential impacts on GHG during the operational phase of the proposed CSP facility**

| OPERATION PHASE IMPACTS – GHG EMISSIONS | |
|---|---|
| **Erongo Coal-fired Power Station** | ***The increased usage of non-renewable resources (coal and diesel):*** A 300 MW plant would use 1.1 metric tonne (Mt) of coal and 18,100 tonne of diesel per year, and an 800 MW plant 2.9 Mt of coal and 47,300 tonne of diesel per year. This is a High Negative significance rating for coal, mitigated to Medium negative and a Medium negative rating for diesel, mitigated to Very Low negative.<br><br>***An increase in national GHG emissions:*** Total GHG emissions from this project amount to 2.58 Mt $CO_2$ emissions/year (300 MW plant), which is a significant contribution to the current national emissions from the energy sector estimated at 4.57 Mt $CO_2$ emissions/year. An 800 MW plant would contribute 6.87 Mt $CO_2$ emissions/year (this would more than double the current energy sector GHG emissions). This is a High Negative significance rating, mitigated to Medium negative. In terms of the global context, however, this is not significant(less than 1%). The global $CO_2$ emissions for 2009 equalled 30,313 million tons/year, while the African levels equalled 1,119 million tons/year. |
| **CSP** | CSP technology make use of a renewable energy source (i.e. solar energy) and does not release GHG emissions during operation. |

### 6.8.2 Key Mitigation Measures

None of the original mitigation measures for the Erongo Coal-fired Power Station is applicable to the proposed CSP facility as shown in Table 38 below.

**Table 38: Mitigation measures not applicable to the proposed CSP facility**

| AMENDMENT TO MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| No additional mitigation measures are required. |
| **Mitigation measures not applicable to the proposed CSP facility** |
| • The development of a plant energy management plan (possibly under the ISO 50 001 standard) is recommended for this operation to monitor efficiency in machinery and equipment (detailed in the EMP).<br>• Reflect any energy efficiency initiative with a GHG emission impact in the GHG Management Plan and hereby in a transparent way communicate the operation's assistance to the group's overall emission reduction target.<br>• Energy management system implementation in plant and use of highest possible efficiency vehicles and equipment technologies, including the following:<br>  ○ All motor sizes for ancillary equipment should be designed to actually match the duty of the machine being driven to maximise efficiency and reduce emissions.<br>  ○ Plant equipment, vehicles and locomotives with the lowest possible emissions rating should be acquired, where practical.<br>  ○ Thermal/electrical energy efficiency measures to be applied at the plant.<br>  ○ Capacity building and awareness raising of staff in terms of energy efficient practices.<br>  ○ Ensure use of high efficiency lighting and effective occupancy control, while maximising use of natural lighting.<br>• The use of wood biomass is to be promoted to facilitate renewable fuel use. However this must be carried out in a sustainable manner. Where biomass is sourced from initiatives to clear invader species in Namibia, such initiatives must be verified as being managed on a sustainable basis (i.e. invader species only removed where they are a legitimate problem). Where biomass is sourced from plantation stocks, these must be certified to indicate they are properly managed and that removed woody plants are replaced by new woody plants to ensure that there is a benefit in terms of GHG emissions. |

### 6.8.3 Impact Rating

Table 39 provides the operational impact significance after mitigation of the proposed coal-fired power facility against that of the CSP facility. Note that this impact is only applicable to the operational phase.

**Table 39: Significance of the operational phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Operational Phase** | | |
| Increased use of fossil fuels (coal) | Medium (-) | N/A |
| Increased use of fossil fuels (diesel) | Very low (-) | N/A |

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Operational Phase** | | |
| Increase in National GHG Emissions | Medium (-) | Insignificant |

## 6.9 Climate Change

According to the IFC's Guidance Notes on Performance Standards on Environmental and Social Sustainability (2012) "*changing weather patterns due to climate change, including climate variability and extremes, may affect projects in a variety of ways…"* The document further states that *"a project's vulnerability to climate change and its potential to increase the vulnerability of ecosystems and communities to climate change should dictate the extent of climate change considerations in the risks and impacts identification process."*

Based on the above considerations, a desktop climate risk screening was undertaken by Aurecon to assess potential risks that climate change might have on the proposed CSP facility and to develop effective resilience strategies to ensure that the facility remains efficient.

### *6.9.1 Risk Statement*

Climate change will have a significant impact on the entire energy sector, internationally and within Namibia. While a large body of information exists which links climate change and specific energy technologies, specific project level experiences are less well documented.

For the Arandis site the most severe impacts will likely be related to increased temperatures, followed by water security, impacts related to fluctuating winds and subsequent dust deposits. The likelihood of future impacts being experienced due to the presence of fog cannot be projected with a significant degree of confidence, but is worth mentioning since the site is located within the fog belt.

In recent years attention has been focussed on mitigating the footprint of energy production, while insufficient attention has been paid to adapting the energy sector and critical infrastructure to projected climate change. The long lead times and operating lives of energy sector investments require these investments to fully account for climate change and the implementation of cost-effective strategies to address their risk exposure. CSP and PV facilities are no different with potential timeframes upwards of 25 years. This provides strong motivation for assessing climate change risk in terms of impacts on infrastructure, technical and economic viability of investments and the identification of response options to improve resilience.

The climate analysis and risk screening aims to provide a greater understanding of the climate change risks faced by the proposed facility at Arandis and how these may impact infrastructure investments and the project's technical and economic viability. These potential risks are summarised in Table 40 for CSP and PV technology. For the full assessment, please refer to Annexure E6.

**Table 40: Key climate impacts on CSP and PV technology**

| PROJECTED CLIMATE VARIABLE | COMPONENTS AT RISK | POTENTIAL KEY IMPACT |
|---|---|---|
| **CSP Technology** | | |
| **Increased Temperatures** | • Cooling System (Dry) | • Dry cooling systems will experience reduced efficiency during high temperature impacting on output. |
| **Reduced precipitation** | • Boiler/Turbine | • If water is required for steam, reduced water availability will result in reduced output. |
| **Wind** | • Mirrors/ concentrators<br>• Tracking system/ motors<br>• Support structures | • Vulnerable to damage in high and fluctuating winds.<br>• Increased potential for dust deposit and surface erosion with implications for output and water use. |
| **PV technology** | | |
| **Increased Temperatures** | • Solar PV array<br>• Control system, inverters and cables | • Reduced cell efficiency and energy output.<br>• Reduced capacity of underground conductors in high ambient temperature.<br>• Increases in soil temperature. |
| **Wind/Dust** | • Solar PV array<br>• Control system, inverters and cables<br>• Mounting structure | • Increased efficiency and output with cooling effect of wind.<br>• Deposits on panels and lower output if air is gritty/dusty.<br>• Degradation of module surfaces. |
| **Cloud cover/Fog** | • Solar PV array<br>• Control system, inverters and cables | • Reduced efficiency/output.<br>• Fluctuations in cloud and fog may result in a reduced efficiency thus causing inconsistent energy supply. |

### *6.9.2 Key Recommendations*

Investment decisions in the energy sector have long term implications. CSP and PV facilities are no different with potential life spans of upwards of 25 years for PV and 40 years for CSP technology. This provides strong motivation for assessing climate change risk in terms of impacts on infrastructure, technical and economic viability of investments and the identification of response options to improve resilience. Table 41 provides soft engineering and non-engineering response options to counteracting uncertainties related to climate change.

**Table 41: Soft engineering and non-engineering response options**

| ENGINEERING OPTIONS | RECOMMENDATION |
|---|---|
| **Soft Engineering** | |
| **More robust design specifications** | • Design structures able to withstand more extreme conditions: higher wind or water velocity, higher air and/or water temperatures. |

| ENGINEERING OPTIONS | RECOMMENDATION |
|---|---|
| | • Design for improved resilience and reduced redundancy of control systems and information and communications technology (ICT) components. |
| **Relocate or retrofit existing Infrastructure** | • Improve existing infrastructure's ability to withstand more extreme conditions.<br>• Relocation and decentralisation may reduce the presence or need for large facilities in high-risk areas.<br>• Ensure improved resilience and reduced redundancy of control systems and information and communications technology (ICT) components. |
| **Review and retrofitted cooling systems** | • Implementation of dry cooling in water scarce areas.<br>• Waterproofed facilities where increased frequency of flooding is expected.<br>• Improved resilience of substations and transformers. |
| **Consider designs that improve passive airflow beneath mounting structures for PV systems** | • Reduced panel temperature and increased power output. |
| **Application heat-resistant cells, modules, and components** | • Reduced physical vulnerability to high temperatures.<br>• Reduced loss of output related to increased temperatures. |
| **Micro-inverters for each panel** | • Improved output and grid stability where cloud cover or fog can cause rapid fluctuations in output. |
| **Non-engineering** | |
| **More robust operational and maintenance procedures** | • Improved resilience of critical components and reduced operational interruptions. |
| **Coordinated land use planning** | • Avoid development of future power infrastructure in vulnerable areas. |
| **Improve forecasting of demand changes and supply and demand** | • Balance supply and demand with the impact of climate change on outputs. |
| **Set up rapid emergency repair teams** | • Rapid repair of damaged infrastructure to limit impact on operations. |

In addition to the above, the following key mitigation measures for the Erongo Coal-fired Power Station remain applicable:

- Energy management system implementation in plant and use of highest possible efficiency vehicles and equipment technologies, including the following:
  - All motor sizes for ancillary equipment should be designed to actually match the duty of the machine being driven to maximise efficiency and reduce emissions.
  - Plant equipment and vehicles with the lowest possible emissions rating should be acquired, where practical.
  - Thermal/ electrical energy efficiency measures to be applied at the plant.

- Build capacity building and raise awareness of staff in terms of energy efficient practices.
- Ensure use of high efficiency lighting and effective occupancy control, while maximising use of natural lighting.

## 6.10 Air Quality

An air quality assessment study was carried out by Airshed Planning Professionals (Pty) Ltd in 2011 in order to assess the impacts of the Erongo Coal-fired Power Station on air quality of the study site and the greater area. It sought to identify the baseline air quality levels in the area, determine the anticipated impacts of the proposed facility and to develop practical, cost-effective and auditable management measures to avoid, ameliorate or manage negative impacts on air quality.

Airshed was again appointed to assess the impacts of CSP technology at the site and to prepare input into the Amendment Report. The detailed updated report is attached in full in Annexure E3 of this report, while the main impacts and their mitigation measures are outlined below.

Both the original and amendment studies comply with the relevant Namibian legislation and take note of relevant international best-practice principles and performance standards such as the Equator Principles and those advocated by the IFC.

### *6.10.1 Impact Statement*

The nature of activities for the construction phase are similar for both the Erongo Coal-fired Power Station and the CSP technologies. There is a possibility for elevated off-site dust fallout rates and $PM_{10}$ and $PM_{2.5}$ concentrations during the construction phase, but it is unlikely to affect the closest residential area, located more than 7 km away. Note that the potential dust fallout from the CSP facility is considered to be more of a nuisance impact than of a health related impact.

The significance of impacts related to emissions (gaseous and particulate emissions) for the Coal-Fired Power Station for the construction phase was found to be of *Low negative* to *Very low negative*, with mitigation. Because of the similarity in predicted construction phase impacts between the CSP technologies proposed and that of the Coal-fired power station the impact is expected to remain *Low negative* to *Very low negative*.

From an air quality perspective during the operational phase, the proposed CSP facility is considered insignificant and preferred to the Erongo Coal-fired Power Station due to the insignificantly low predicted impacts on the receiving environment and human health. The Erongo Coal-fired Power Station has the potential for significant impacts on human health in the surrounding area over the duration of the project life.

No cumulative impacts were identified for the proposed CSP facility due to the insignificantly low predicted impacts.

Changes to operational impacts were identified, as detailed below.

**Table 42: Changes to operational phase impacts**

| OPERATIONAL PHASE IMPACTS PARTICULATE AND GASEOUS EMISSION AND HUMAN HEALTH | |
|---|---|
| **Erongo Coal-fired Power Station** | Particulate and gaseous emissions can impact negatively on human health in the surrounding communities. The main source of $SO_2$ and $NO_2$ emissions at the proposed Erongo Coal-fired Power Station will be from the boilers that contribute more than 99% of the overall emissions that are released from the stacks. Fugitive particulate matter emissions from handling activities and wind-blown dust |

| OPERATIONAL PHASE IMPACTS PARTICULATE AND GASEOUS EMISSION AND HUMAN HEALTH | |
|---|---|
| | were regarded as significant and could have a high negative impact to ambient air quality in the vicinity of the project. Fugitive dust sources include materials transfer points of limestone, coal and ash. Crushing of limestone and coal will also be significant source if uncontrolled. Vehicle entrainment on the paved and unpaved roads are further significant sources of dust generation together with the potential for wind erosion from the coal stockpiles and ash storage facility. |
| **CSP** | Emissions to air associated with the operational phase would only result from maintenance vehicles. These are regarded as insignificant. Almost no direct GHG emissions are expected during the operational phase. |

### *6.10.2 Key Mitigation Measures*

The same mitigation measures must be applied for the construction phase for both the Erongo Coal-fired Power Station and the CSP facility. With respect to the design and construction phases, most of the mitigation measures for air quality for the Erongo Coal-fired Power Station related to managing gaseous emissions and particulate matter harmful to human health. This is not a concern for the CSP technology and many of the mitigation measures are no longer relevant for the latter, as indicated below. No additional design or operational phase mitigation measures were identified for the CSP facility.

**Table 43: Additional mitigation measures required to address potential impacts on air quality**

| AMENDMENT TO MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| No additional mitigation measures are required. |
| **Mitigation measures not applicable to the proposed CSP facility** |
| • Install Electrostatic Precipitators or Fabric Filter Plants to reduce the particulate emissions, Circulating fluidised bed boilers for desulphurisation to reduce $SO_2$ emissions and use low nitrogen oxides ($NO_x$) burners to minimise the $NO_2$ emissions.<br>• Maintain a buffer zone of at least 300 m wide between the power plant and nearest community. This is not an issue in this case as the nearest community is located about 5.5 km away.<br>• Increase the stack height to a minimum of 100 m to ensure that the potential ground level concentrations meet the respective guidelines. Specific recommendations on the control efficiency for $SO_2$ and related stack heights are:<br>o Limit $SO_2$ emissions to 200 mg/m³ if a 50 m stack height is considered.<br>o 400 mg/m³ $SO_2$ emission limit if a minimum stack height of 100 m is considered.<br>• Fugitive dust releases from on-site roads, the ash storage facility and the coal stockpiles are the main sources responsible for exceedances of PM10, PM2.5 and dust fallout guidelines off-site when no mitigation is in place. Specific control efficiencies proposed include:<br>o Dust control of the roads to the ash storage facilities through the regular application of water in combination with chemicals (or salt as an alternative). A minimum control efficiency of 75% should be achieved throughout.<br>o Dust control efficiency of 85% on the ash storage facilities through the continuous rehabilitation of the areas not actively worked, through rock cladding or any other binding material that will ensure the wind erosion potential of the ash storage facilities is minimised. |

| AMENDMENT TO MITIGATION MEASURES |
|---|
| ○ Water spray systems at and around the coal storage piles should reduce the potential for windblown dust by at least 50%. Windbreaks would have an additional 30% control efficiency (NPI, 2012). If covered, the potential for windblown dust would be reduced to negligible levels.<br>• Crushing of limestone and coal will be designed as a closed system, which can result in dust control efficiencies as high as 100% (NPI, 2012). |

### 6.10.3 Impact Rating

Table 44 provides a comparison of the operation phase impact significance after mitigation of the Erongo Coal-fired Power Station against those of the proposed CSP facility (with mitigation).

**Table 44: Significance of the operational phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Operational Phase** | | |
| $SO_2$ (200 mg/Nm$^3$) | **Low (-)** | - |
| $SO_2$ (400 mg/Nm$^3$) | **Low (-)** | - |
| $SO_2$ (800 mg/Nm$^3$) | **Medium (-)** | - |
| $NO_2$ Health Impacts | **Low (-)** | - |
| $PM_{10}$ Health Impacts | **Medium (-)** | - |
| $PM_{2.5}$ Health Impacts | **Medium (-)** | - |
| Dust fallout (nuisance) | **Low (-)** | - |
| Gaseous and particulate emissions | - | **Very low (-)** |

## 6.11 Noise

The original study has not been revised as it is not anticipated that the proposed CSP facilities would have any additional noise impacts which would likely be quite similar for the construction phase. Impacts during the operational phase is however expected to be of lower significance. The original noise assessment study of the coal-fired power station was carried out by Nicolette Krause of Airshed Planning Professionals (Pty) Ltd.

### 6.11.1 Impact Statement

Table 45 below provides a summary of the impacts that were identified for the Erongo Coal-fired Power Station, as well as the relevance of these impacts to the proposed CSP facility. In terms of the CSP facility, the potential noise impacts relate to the construction activities, the electrical substation, truck-mounted washing systems, ancillary works such as the water purification works and waste water treatment facility and traffic.

Note that cumulative impacts associated with noise were not separately assessed as all noise impacts are considered cumulative to the baseline noise level.

**Table 45: Applicability of noise related impacts identified for the Erongo Coal-fired Power Station to the proposed CSP facility**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction Phase** | | |
| Increase in noise levels from construction on site | √ | √ |
| Increase in B2 daytime noise levels | √ | √ |
| **Operational Phase** | | |
| On-site noise levels | √ | √ |
| Increase in B2 noise levels | √ | ~~√~~ |
| Increase in rail noise | √ | |
| Noise impacts at Arandis | √ | |

### *6.11.2 Key Mitigation Measures*

No additional mitigation measures would be required for the proposed CSP facility. However, a number of the mitigation measures identified for the Erongo Coal-fired Power Station would no longer be required as summarised in Table 46.

**Table 46: Additional mitigation measures required to address potential noise impacts**

| PROPOSED AMENDMENTS TO AUTHORISED MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| No additional mitigation measures are required. |
| **Mitigation measures not applicable to the proposed CSP facility** |
| • Vibrating screens and crushers are known to be noisy and good design philosophies should be followed for equipment of this nature. Such equipment must be installed on vibration isolating mountings.<br>• Enclosing the tipper discharge and lowering the conveyor drop height may reduce noise emissions. Mechanical and electrical design also influences the amount of noise from stacking and reclaiming operations.<br>• A noise management plan should be compiled and implemented through the life cycle of the power plant. Ambient noise measurements should be conducted during the construction and operational phases (at a fixed point between the proposed site and Arandis, on the boundary of proposed operations (in the main wind directions) as well as along the railway line and B2 during the day and night) to assess and confirm the project's noise impact area. Periodical noise measurements can also serve to assess the efficiency of implemented management and mitigation measures aimed at reducing noise impacts. Day and night-time sound pressure levels as well as 1/3 octave band frequency spectra should be recorded. |

### *6.11.3 Impact Rating*

Table 47 provides the construction and operational impact significance after mitigation of the proposed coal-fired power facility.

**Table 47: Significance of the construction and operational phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| Construction phase | **Low (-)** | **Low (-)** |
| Operational phase | **Very low (-)** | **Very low (-)** |

## 6.12 Traffic

The original study has not been revised as it is not anticipated the proposed CSP facility would have any additional traffic impacts. The original traffic impact assessment was undertaken by Theo Potgieter of Burmeister and Partners (Pty) Ltd.

### *6.12.1 Impact Statement*

Impact identified for Erongo Coal-fired Power Station relate to a new access road and two existing intersections: (1) the B2-D1911 intersection (referred to as the B2 intersection), and (2) the intersection of the D1911 with the Rössing – Arandis road (referred to as the D1911 intersection). During the construction phase, the volume of vehicles accessing the site would be similar to what was assessed for the Erongo Coal-fired Power Station. However, during the operational phase fewer vehicles would be required.

The potential impact of glint and glare (see Section 6.5) on road users is not considered to be significant. Based on similar projects in South Africa, it is expected that possible glare from the parabolic troughs would be less than the glint from the sun reflecting on a passing B2 user's window or light reflecting on side mirrors when driving away from the setting or rising sun. Furthermore, the heliostats required for the solar power tower technology are on high (5 m) steel structures and the only possible glint towards the B2 would be in the early morning and late afternoon. The heliostat field would block most of the glint from other heliostats but any glint that may escape the proposed CSP facility towards the south would be dimmed by the wind barrier around the proposed CSP facility. Also, misaligned heliostats missing the receiver would always reflect the sunlight upwards (K. van der Merwe, pers. comm.). For more information on the potential impact of glint and glare on B2 users, please refer to Comment 1.1 in the Comments and Response Report included in Annexure C6).

### *6.12.2 Key Mitigation Measures*

No additional mitigation measures would be required and none of the approved mitigation measure are not applicable. For more information on the approved mitigation measures, please refer to Section 9.

### *6.12.3 Impact Rating*

Table 48 provides the construction and operational impact significance after mitigation of the proposed coal-fired power facility.

**Table 48: Significance of the construction and operational phase impacts**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction Phase** | | |
| Construction of access - B2 Intersection at Arandis | **Low (-)** | **Low (-)** |
| **Operational Phase** | | |
| Arandis / B2 Intersection | **Low (-)** | **Very low (-)** |
| D1911 Intersection | **Very low (-)** | **Very low (-)** |

## 6.13 Archaeology and heritage

The original assessment, carried out by John Kinahan of Quaternary Research Services, has not been revised as it originally considered a much wider footprint area than the approved Erongo Coal-fired Power Station footprint. The assessment involved a thorough review of available literature as well as a detailed field survey of the site, including a series of foot traverses.

### *6.13.1 Impact Statement*

The archaeological sites identified by the specialist are predominantly seed diggings. Historical remains associated with the site include items of minor significance related to the railway and possibly to military action along the railway during the 1915 South African invasion. A Commonwealth War Grave site was however identified at Trekkopje, located outside the limits of the approved project site, northeast of the railway which forms the boundary for the proposed CSP site. Based on this review, the entire impact statement for the Erongo Coal-fired Power Station remains applicable:

- Given the low significance of the artefacts identified, the impacts of the proposed project on the archaeological artefacts are uniformly low.
- The potential erosion of gullies as a result of increased surface runoff directly attributable to the construction of the power plant may have a negative effect on archaeology and heritage resources beyond the immediate footprint of the proposed power plant.

The specialist assessment concluded that none of the recorded archaeological are significant in the sense envisaged by the National Heritage Act (27 of 2004) Part IV Sections 24 to 27 which make provision for inclusion in the Namibian Heritage Register of protected sites. However, since a layout plan is not available, it would be important to verify the above impact statement once the final design layout is available to ensure that no additional measures are required to manage negative impacts on individual archaeological and heritage resources.

### *6.13.2 Key Mitigation Measures*

One additional mitigation measure has been identified to ensure that the impact on archaeological and heritage resources remains low. This mitigation measure is provided in Table 49.

**Table 49: Additional mitigation measures required to address potential impacts on archaeological and heritage resources**

| AMENDMENT TO MITIGATION MEASURES |
|---|
| **Additional mitigation measures** |
| **Planning and construction** |
| • Once the layout design and footprints are available they must be verified against the findings of the original archaeological assessment to determine if any heritage resources are impacted in order to ensure appropriate mitigation can be put in place before construction commences. |

### *6.13.3 Impact Rating*

Table 50 provides the construction and operational impact significance after mitigation of the proposed coal-fired power facility.

**Table 50: Significance of the construction and operational phase impacts (with mitigation)**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| **Construction Phase** | | |
| Direct loss of heritage resources through infrastructure development | **Low (-)** | **Low (-)** |
| Sheet and gully erosion | **Low (-)** | **Low (-)** |

## 6.14 Health

The potential for health risks related to respiratory diseases, radiation and odour was identified during the operation of the Erongo Coal-fired Power Station, resulting from the combustion of coal. Since the proposed CSP facility is renewable in nature and does not rely on fossil fuels these risks are no longer applicable.

The three potential health impacts identified for the Erongo Coal-fired Power Station are not considered to be applicable to the proposed CSP facility. According to the air quality assessment (see Section 6.11), particular matter (that can cause respiratory diseases) would be more of a nuisance than a health impact, especially since there would be no $SO_2$ or $NO_2$ emissions.

However, the CSP facility could potentially have implications on human health in terms of the position of the heliostats. Heliostat movements and positions (including reasonably possible malfunctions) could result in potential exposure of observers to glint and/or glare at various locations. This includes exposure of motorists to reflected solar radiation from malfunctioning heliostats which may impair their line of sight, potentially resulting in an accident. A heliostat positioning plan as per the recommendations in Section 7.5.2 must therefore be compiled.

With regards to the molten salt, both $NaNO_3$ and $KNO_3$ are non-toxic according to the Material Safety Data Sheets. These compounds can however be irritants if they come into contact with skin, eyes or if inhaled, but are not considered to be a health threat to humans or the environment[36].

**Table 51: Potential impacts on health during the operational phase of the proposed CSP facility**

| IMPACT DESCRIPTION | COAL-FIRED POWER STATION | CSP |
|---|---|---|
| Respiratory disease due to dust fallout and exposure to $SO_2$ and $NO_2$ | √ | |
| Radiation due to mineral compounds concentrated in fly ash | √ | |
| Odour from $SO_2$ | √ | |
| Impaired vision due to glint and/or glare from heliostats (without implementing a heliostat positioning plan) | | √ |

[36] Source: http://www.sciencelab.com/msds.php?msdsId=9927271 and http://www.sciencelab.com/msds.php?msdsId=9927232

# 7 CHANGES TO RISK ASSESSMENT

*This section summarises the risks that were identified for the Erongo Coal-fired Power Station in terms of the ISO 31000 requirements and their applicability to the proposed CSP facility.*

## 7.1 Introduction

A risk assessment and risk management study was executed for the Erongo Coal-fired Power Station by Aurecon's Risk Specialist Team to identify hazards and assessing the associated risks as they apply to the total operational power generation lifecycle in terms of the ISO 31000 (ISO, 2009) requirements. The methodology employed used best practice standards in terms of the National Occupational Safety Association (NOSA) Integrated Five Star System. This is aligned with standards endorsed by ISO and the British Standards Institute (BSI) listed below:

- ISO 31000: 2009: Risk Management – Principles and Guidelines
- ISO 14001: 2004: Environmental Management Systems[37]
- BSI OHSAS 18001: 2007: Occupational Health and Safety Assessment Series.

Since 2012, the Standards have however been updated which implies that the risk assessment is outdated and will need to be revised once the final design for the proposed CSP facility is available. Furthermore, due to the change in technology, only 13 of the 29 risks that were identified would still be applicable to the proposed CSP facility as discussed in Section 7.2.

*Note that a desktop climate risk screening was undertaken to assess potential risks that climate change might have on the proposed CSP facility and to identify effective resilience strategies. This assessment does however not identify risks in terms of the above listed standards and should be considered as completely separate. Please refer to Section 6.9 of this Amendment Report for more information on the outcome of the climate change risk screening.*

## 7.2 Applicable risks identified for the Erongo Coal-fired Power Station

Annexure G2 lists all the risks that were identified for Erongo Coal-fired Power Station and also indicates the ones that could be applicable to the proposed CSP facility. This will however need to be verified once the design has been finalised. The location of these risk scenarios are also illustrated and described in Annexure G2.

[37] Please note that ISO 14001: 2004 has been revised with ISO 14001:2015.

# 8 OVERALL SIGNIFICANCE

*This section identifies the significant impacts associated with the proposed CSP facility (assuming the mitigation measures proposed have been implemented). The intention is to provide an integrated overview of the impact significance predicted.*

A large number of negative impacts were identified for the Erongo Coal-fired Power Station as well as numerous highly significant positive impacts related to the socio-economic considerations at local, regional and national levels.

Most of these impacts remain applicable to proposed CSP facility, but many at a less significant scale with regards to the negative impacts. Impacts associated with the alternative of hybridising the CSP facility with PV technology does not affect the significance ratings and are therefore not discussed separately.

Highly significant negative impacts that remain unchanged relate to the loss of a restricted and sensitive habitat as a direct result of infrastructure development. This is a negative impact that is especially significant in light of the high levels of endemism and small bioclimatic envelopes in the Central Namib Desert, which can result in species extinction, especially for invertebrate species. There is no mitigation possible for this impact. The narrow range and the restricted distribution of the habitat affected means that direct trade-offs to conserve similar habitats elsewhere are not possible. This habitat loss is irreversible as desert environments are notoriously sensitive and slow to recover, and not much is known about rehabilitation of disturbed environments in the desert. Furthermore, since the footprint of the proposed CSP facility would be larger compared to that of the Erongo Coal-fired Power Station, the upstream catchment area that can affect the proposed CSP facility is also relatively larger. A larger upstream catchment increases the source area for seasonal flash floods, compared to that for the coal-fired project. The design of the CSP facility must accommodate the potential for relatively more intense, albeit highly irregular, flash floods compared to the previous project. This may become an ecological issue if flood attenuation measures in the project area disrupt natural surface or groundwater flow to the extent that downstream water points are adversely affected, or if there is a pollution event that replicates downstream.

Impacts specific to the CSP facility include the operational impact on aviation safety which is specifically associated with glint and glare from the heliostats (for the solar power tower CSP technology alternative) and has the potential to be of medium significance (with mitigation) as it could temporarily blind pilots, as well as operators of hot air balloons. However, tourism related flights (aeroplane and hot air balloons) are generally restricted to the area between Swakopmund and Walvis Bay and Sossusvlei and should therefore not be affected significantly. In order to mitigate potential risks, it was agreed with the DCA that an application to erect a permanent structure within the vicinity of an aerodrome will be submitted which would result in this area being designated as a restricted flight zone.

The potential impact on visual receptors was also considered to be high for the Erongo Coal-fired Power Station as well as the solar power tower technology alternative, but of low significance for the parabolic trough technology alternative. The higher significance rating for the solar power tower technology alternative is due to it being highly visible from a number of viewpoints which could potentially have implications for tourism. However, with regards to the impact on sense of place, the area is generally associated with historic mining activities and thus the perception exists that larger landscape modifications are acceptable for travellers on the B2 National Road. Since the visual impact is directly related to the presence of the CSP facility, it can be reversed with removal of infrastructure. However, the CSP facility may lead to other development in the vicinity, which will change the sense of place over the long term.

Construction of infrastructure in the drainage channels with alluvial soil banks is still considered to be of medium significance as it will result in the loss of a very restricted resource in this desert environment. Most vegetation that occurs in the area is associated with such soil banks and the limited topsoil that occurs on site. While the areas on-site that may be affected are relatively small, the removal of this soil also has potential off-site impacts as it is part of a greater system where areas downstream of the catchment receive soil in the form of silt following flooding episodes.

Another impact that is specifically applicable to the proposed CSP facility relates to avifauna. This impact is considered to be of medium significance and could potentially be lower, but this can only be confirmed once the facility is operational and monitoring results have been interrogated. Of specific concern is the displacement of priority bird species due to habitat transformation (the heliostats or parabolic troughs will reduce the volume of sunlight reaching the vegetation below, which is likely to impact the vegetation growth and could lead to changes in the ecology). The natural vegetation is likely to persist in the rows between the mirrors, but it will be a fraction of what was available before the construction of the facility. Small birds are often capable of surviving in small pockets of suitable habitat, and are therefore generally less affected by habitat fragmentation than larger species. It is therefore likely that most of the smaller species will continue to use the habitat available within the solar facility (following the construction phase) albeit at lower densities (e.g. Gray's Lark). This will however differ from species to species and it may not be true for all of the smaller species. Larger species which require contiguous, un-fragmented tracts of suitable habitat (e.g. large raptors, korhaans and bustards) are more likely to be displaced entirely from the area of the proposed facility although in the case of some raptors (e.g. Southern Pale Chanting Goshawk, Lanner Falcon, Augur Buzzard and Booted Eagle) the potential availability of carcasses or injured birds due to collisions with the heliostats or parabolic troughs may actually attract them to the area.

Negative impacts that would not be applicable to the CSP facility relate to air quality and the predicted increase in national GHG emissions due to the use of a fossil fuel (coal). As a result, the potential health impacts that were associated with emissions from the Erongo Coal-fired Power Station are also no longer applicable. However, the solar power tower technology could potentially have implications on human health created by glint and/or glare. This depends on the heliostat movements and positions (including possible malfunctions) that could result in potential exposure of observers at various locations to glint and/or glare, specifically motorists, who may be distracted or the view impaired by reflected solar radiation from the heliostats which could result in an accident. A heliostat positioning plan has therefore been recommended to manage this risk.

As mentioned earlier, the significance of positive impacts remain the same and are all related to socio-economic considerations. The most important of these is national energy security and a reliable source of electricity to drive economic development in Namibia. This will allow Namibia to meet certain of its commitments in terms of Vision 2030, COP21 and the Millennium Goals, as related to facilitating development in Namibia and improving the quality of life for its people. The construction of a CSP facility in the Erongo Region, and specifically near Arandis will allow opportunities for diversification and growth of the local economy, including the possibility for educational tours to the CSP facility. There are also numerous opportunities for NamPower to contribute positively to the community through its Corporate Social Investment programme. While there are more limited job creation opportunities for locals related to the operational phase, these are none-the-less significant bearing in mind the high unemployment rates in Arandis. There is an even greater opportunity for employment of unskilled labour during the construction phase, albeit for a limited period. In addition, opportunities exist for skills development for those in the area, potentially increasing the ability for individuals to seek employment in the future.

Table 52 and Table 53 summarise the potential impacts that were identified for the Erongo Coal-fired Power Station and the proposed CSP facility.

**Table 52: Medium and high significance impacts associated with the Erongo Coal-fired Power Station and proposed CSP facility**

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Construction** | | | |
| ***Socio-Economic*** | Job creation | **High (+)** | **High (+)** |
| ***Biodiversity*** | Direct habitat loss through infrastructure development | **High (-)** | **High (-)** |
| ***Socio-Economic*** | Multiplier effects on local economy | **Medium (+)** | **Medium (+)** |
| | Increased social pathologies | **Medium (-)** | **Medium (-)** |
| **Operational** | | | |
| ***Socio-Economic*** | Increased availability of electricity | **High (+)** | **High (+)** |
| | Diversification & growth of local economy | **High (+)** | **High (+)** |
| | Opportunities resulting from Corporate Social Investment into community | **High (+)** | **High (+)** |
| | Job creation | **High (+)** | **High (+)** |
| ***Biodiversity*** | Permanent habitat loss through infrastructure development, resulting from construction of the facility | **High (-)** | **High (-)** |
| ***Visual*** | Visibility of plant & of stack/ tower (solar power tower) | **High (-)** | **High (-)** |
| ***Greenhouse Gases*** | Increased use of fossil fuels (coal) | **Medium (-)** | **None** |
| | Increase in National GHG Emissions | **Medium (-)** | **None** |
| ***Socio-Economic*** | Impacts on Tourism | **Medium (-)** | **Low (-)** |
| ***Aviation safety*** | Visual impacts from glare and glint (solar power tower) | **None** | **High (-)** |
| ***Avifauna*** | Displacement of priority species due to habitat transformation | **Not assessed** | **Medium (-)** |

**Table 53: Low, very low and neutral significance impacts associated with the Erongo Coal-fired Power Station and proposed CSP facility**

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Construction** | | | |
| ***Biodiversity*** | Introduction of species alien or not native to the site resulting from new habitat creation (Construction but mainly Operational) | Low (-) | Low (-) |
| ***Heritage*** | Direct loss of heritage resources through infrastructure development | Low (-) | Low (-) |
| ***Socio-Economic*** | Construction-related health safety, and aesthetic impacts | Low (-) | Low (-) |
| | Negative impacts related to a construction camp | Low (-) | Low (-) |
| | Population influx | Low (-) | Low (-) |
| ***Noise*** | Noise from construction activities | Low (-) | Low (-) |
| ***Biodiversity*** | Animal collisions with vehicles | Very low (-) | Very low (-) |
| | Impact on *Acacia erioloba* trees | Not applicable | Very Low (-) |
| ***Socio-Economic*** | Disruption of daily movement patterns | Very low (-) | Very low (-) |
| ***Surface Water*** | Lack of and/or incorrect implementation of a Stormwater Management System | Very low (-) | Very low (-) |
| | Construction within floodlines and potential diversion of stream | Very low (-) | Very low (-) |
| | Reduction in runoff from catchment | Very low (-) | Very low (-) |
| ***Biodiversity*** | Impacts on *Aloe asperifolia* | Neutral | Neutral |
| | Potential human-wildlife conflict (also Operational) | Neutral | Neutral |
| | Indirect habitat loss through behaviour alteration as a result of noise (Construction but mainly Operational) | Neutral | Neutral |
| **Operational** | | | |
| **Air Quality** | Dust fallout (nuisance) | Low (-) | Very low (-) |
| | $NO_2$ Health Impacts | Low (-) | |
| | $SO_2$ (associated with a 200 and 400mg/Nm$^3$ emission limit scenario) | Low (-) | |
| **Biodiversity** | Indirect habitat loss through behaviour alteration as a result of light emissions | Low (-) | Low (-) |
| | Indirect habitat loss through habitat alteration from stack emissions | Low (-) | Not applicable |
| | Introduction of species alien or not native to the site resulting from new habitat creation | Low (-) | Low (-) |

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Groundwater** | Contamination of groundwater from wastewater treatment facility | **Low (-)** | **Low (-)** |
| **Groundwater** | Poor quality artificial recharge from the ash storage facility, the temporary waste storage site, the coal stockpile, the water treatment facilities and the sewage plant (for CSP: excluding the ash storage facility and coal stockpile) | **Low (-)** | **Low (-)** |
| **Heritage** | Loss of heritage resources resulting from sheet and gully erosion | **Low (-)** | **Low (-)** |
| **Noise** | Noise from operations | **Low (-)** | **Very Low (-)** |
| **Socio-Economic** | Operational safety and physical intrusion impacts | **Low (-)** | **Very low (-)** |
| **Traffic** | Level of service at B2 Intersection | **Low (-)** | **Low (-)** |
| **Visual** | Visibility of access road, ash storage facility, coal stockpile and the railway (for CSP: only visibility of access road) | **Low (-)** | **Low (-)** |
| **Biodiversity** | Animal collisions with vehicles | **Very low (-)** | **Very low (-)** |
| | Biodiversity impacts downstream resulting from contaminated water following flash floods | **Very low (-)** | **Very low (-)** |
| **Greenhouse Gases** | Increased use of fossil fuels (diesel) | **Very low (-)** | **None** |
| **Socio-Economic** | Disruption of daily movement patterns | **Very low (-)** | **Very low (-)** |
| **Surface Water** | Lack of and/or incorrect implementation of a Stormwater Management System | **Very low (-)** | **Very low (-)** |
| | Infrastructure in floodlines and potential diversion of stream | **Very low (-)** | **Very low (-)** |
| | Contamination of surface water resources as a contaminated water from operations | **Very low (-)** | **Very low (-)** |
| | Reduction in runoff from catchment | **Very low (-)** | **Very low (-)** |
| **Traffic** | Levels of service at D1911 Intersection | **Very low (-)** | **Very low (-)** |
| **Biodiversity** | Indirect habitat loss through behaviour alteration as a result of noise | **Neutral** | **None** |
| | Potential human-wildlife conflict | **Neutral** | **Neutral** |
| **Aviation safety** | Physical penetration of navigable airspace (solar power tower) | **Not assessed** | **Low (-)** |
| | Visual impacts from glare and glint (parabolic trough) | **Not assessed** | **Low (-)** |
| | Communications interference | **Not assessed** | **Low (-)** |

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Avifauna** | Displacement of priority species due to disturbance associated with the construction and decommissioning of the CSP facility and associated infrastructure | **Not assessed** | **Low (-)** |
| | Mortality of priority species avifauna through collisions with the heliostats or parabolic troughs | **Not applicable** | **Low (-)** |
| **Aviation safety** | Turbulence from thermal plumes | **Not assessed** | **Negligible (-)** |
| **Avifauna** | Mortality of priority avifauna through burning (solar flux) | **Not applicable** | **Negligible (-)** |

# 9 RECOMMENDATIONS

*The purpose of this chapter is to summarise the recommendations arising from the various revised specialist studies as related particularly to design and pre-construction activities, prior to the implementation of the Construction and Operational Phase EMPs.*

The specialists have made a number of recommendations to mitigate or enhance the significance of certain impacts and to manage residual impacts anticipated to occur through the development of the proposed CSP project. These are detailed in the specific specialist reports which are summarised in Section 6 and included in Annexure E. The recommendations to manage the residual impacts related to the Construction and Operational phases are included in the EMPs (Annexure D).

Recommendations (as discussed in Section 6) relating to the design/pre-construction, construction and operation phases for the CSP technology option are outlined below. Note that relevant mitigation measures from the Erongo Coal-fired Power Station are also included.

## 9.1 Design phase and pre-construction recommendations

The following measures must be implemented as part of the detailed design phase, and/or prior to commencement of any construction phase activities. Most of the recommendations have been highlighted as key mitigation measures in the various specialist reports summarised in Section 6.

### *9.1.1 Biodiversity mitigation measures*

- Intensive biodiversity sampling for plants, invertebrates and reptiles in areas to be covered by infrastructure footprints is recommended. This should occur prior to construction starting and the material should be deposited in a reputable biosystematics collection for dissemination and study. This will also allow for providing a permanent record of pre-development biodiversity against which post-decommissioning rehabilitation can be measured.

### *9.1.2 Visual mitigation measures*

- Consider setting up a renewable energy demonstration centre which could be used as a tourist attraction.
- Consider introducing an architectural design element into the tower structures as was the case in the PS10 project at the Solucar Platform in the Spanish province of Seville depicted in the Visual specialist report.

### *9.1.3 Noise mitigation measures*

- Implement standard industry noise reduction aspects during the planning and design stages of the project such as the enclosure of major sources of noise, such as compressor or pump systems.

### 9.1.4 Groundwater, surface water and soils mitigation measures

***Surface water:***

- Compile an appropriate stormwater management system to cover the phases from pre-construction to post-decommissioning (or until no further risk of surface water contamination exists). The stormwater management plan should be in place before construction activities are commenced and should remain in place after decommissioning of the power plant, or until there is no further risk of surface water contamination.
- Map the relevant floodlines for every watercourse and attempt, as far as possible, to locate all infrastructure out of these floodlines. Should this not be possible, design must accommodate the potential for flash floods. The final position of the ash storage facility will be determined after the site survey and the floodline delineation. A stream diversion could be created, which would be costly and should only be considered if no other options are available.
- Design the respective infrastructure components according to relevant best practice guidelines and legislation.

### 9.1.5 Climate change response options

***Engineering options:***

- More robust design specifications:
  - Structures able to withstand more extreme conditions: higher wind or water velocity, higher air and/or water temperatures.
  - Improved resilience and reduced redundancy of control systems and information and communications technology (ICT) components.
- Relocate or retrofit existing Infrastructure:
  - Improved existing infrastructure's ability to withstand more extreme conditions.
  - Relocation and decentralisation may reduce the presence or need for large facilities in high-risk areas.
  - Improved resilience and reduced redundancy of control systems and information and communications technology (ICT) components.
- Review and retrofitted cooling systems:
  - Implementation of dry cooling in water scarce areas.
  - Waterproofed facilities where increased frequency of flooding is expected.
  - Improved resilience of substations and transformers.
- Consider designs that improve passive airflow beneath mounting structures for PV systems:
  - Reduced panel temperature and increased power output.
- Apply heat-resistant cells, modules, and components:
  - Reduced physical vulnerability to high temperatures.
  - Reduced loss of output related to increased temperatures.
  - Micro-inverters for each panel
  - Improved output and grid stability where cloud cover or fog can cause rapid fluctuations in output (thus causing inconsistent energy supply).

***Non-engineering options:***

- More robust operational and maintenance procedures:
  - Improved resilience of critical components and reduced operational interruptions.
- Coordinated land use planning:
  - Avoid development of future power infrastructure in vulnerable areas (e.g. watercourses).
- Improve forecasting of demand changes and supply and demand:
  - Balance supply and demand with the impact of climate change on outputs.
- Set up rapid emergency repair teams:
  - Rapid repair of damaged infrastructure to limit impact on operations.

### *9.1.6 Aviation mitigation measures*

- Use non-reflective or diffuse materials or coatings (e.g., paint) for bellows shields located every few meters at joints between heat collecting elements.
- Rotate units from stow away position to ready position before sunrise to limit potential inadvertent glare and returned to stow position after sunset.
- Consider using end caps to reduce glare that "spills" from the ends of the trough in parabolic designs.
- Flight procedures can be restricted during certain periods of the day when glare may occur.
- Comply with zoning ordinances put into place to limit glare-producing structures in airport influence zones.
- Insert notations in the appropriate Aeronautical Charts, Airport/ Facilities Directories, and Notice to Airmen publication to identify potential hazard from glare and thermal turbulence.
- Ensure mirror function is continuously monitored by operators and system controllers.
- Develop procedures to move mirrors east to avoid glare as the system is designed to automatically turn a malfunctioning mirror east so there is no reflection from the sun as it moves west.
- Develop specific procedures for documenting, investigating, evaluating, and resolving (if feasible) public complaints about glare.
- Develop and implement a parabolic positioning plan.

**Additional for solar power tower CSP facilities:**

- Submit an application to erect a permanent structure i.e. CSP solar power tower within the vicinity of an aerodrome.
- The following monitoring plans shall be required:
  - Heliostat positioning plan
    - Identify heliostat movements and positions (including reasonably possible malfunctions) that could result in potential exposure of observers at various locations including in aircraft and motorists to reflected solar radiation from heliostats. The plan should also describe how programmed heliostat operation would avoid potential for human health and safety hazards at locations of observers as attributable to momentary solar

radiation exposure greater than the maximum permissible exposure set by health regulations.

- Include a monitoring component to: (1) obtain field measurements in response to legitimate com plaints; (2) verify that the heliostat positioning plan would avoid the potential for human health and safety hazards including temporary or permanent blindness at locations of observers; and (3) provide requirements and procedures to document, investigate, and resolve legitimate complaints regarding glare.

o A solar power tower luminescence monitoring plan

- Provide procedures to conduct periodic monitoring and to document, investigate, and resolve complaints regarding distraction effects to aviation, vehicular, and pedestrian traffic associated with the solar power towers.
- Evaluate the effects of the intensity of the luminance of light reflected from the solar power tower receivers 90 days after commencement of commercial operations, and after 5 years, as well as after any significant design or operational modification, or after a significant complaint.
- The plan shall also coordinate monitor protocols and results with the relevant stakeholders.

- Lighting of the power tower shall be required in accordance with the relevant DCA standards.

## 9.2 Construction phase recommendations

### *9.2.1 Biodiversity mitigation measures*

Some of the recommendations that have been made to reduce the significance of identified impacts include:

- Limit footprint of supporting infrastructure to smallest practical size.
- Limit habitat destructive impact of construction of receptor fields by protecting the integrity of the topography and vegetation on site, limiting vehicular movement on site to once-off events using only rubber tired vehicles, and having workers move about on foot only.
- Use yellow external lighting where practical and safe to reduce interference with insect behaviour patterns.
- Do not have open water sources on site accessible to animals (including invertebrates).
- Manage on-site rubbish to be inaccessible to animals, and dispose of rubbish at an established and approved off-site disposal facility.
- Eradicate alien plant introductions, should they occur.
- Avoid Protected *Aloe asperifolia* plant populations completely, work around isolated plants as required, and transplant any individuals within the site only that cannot be so accommodated, utilising them for decorative effect
- Preserve Protected *Acacia erioloba* trees. Given the high value, slow growth and irreplacibility of these and other trees in the desert, it is recommended that this principle of preservation be extended to all trees in the area with a trunk diameter of more than 20 cm at a height of 1 m above the ground, irrespective of species.
- Allow for unimpeded and pollution free storm water flow. Where drainage needs to be re-routed around supporting infrastructure, do so in low gradient, erosion preventive ways.
- Impose a maximum speed limit of 60 km/h on the site and branch road off the B2.

### 9.2.2 Visual mitigation measures

- Dust control measures to be implemented during construction.
- To ensure colour mitigation of plant, a desert grey-brown colour should be used for those structures that have painted walls. Sheet metal covered structures should be a mid-grey colour (and not yellow which is more reflective and increases colour contrast).
- Safety markings on the solar power tower will be discussed and finalised with DCA during the planning and design phases.[38]
- Flat or slightly curving roof for power plant should be considered if possible.
- Strict lighting control without reducing security as recommended in the attached light management guidelines.

### 9.2.3 Socio-economic mitigation measures

- Unauthorised access to the construction site must be prevented through appropriate fencing and security.
- Implement adequate rehabilitation measures when the construction period has ended to return the landscape and other changes to at least its original state.
- Community education:
  - It is recommended that a community awareness campaign be implemented in the Arandis community to sensitise the community members to traffic and other construction-related safety risks.
  - Activities undertaken as part of the awareness campaign and the education/ communication programme should be recorded and reflected in a formal progress report compiled on a quarterly basis.
  - Mechanisms must be established to ensure that problems are dealt with promptly. In this regard, it is recommended that a team of community liaison officers (CLOs) be appointed from all affected communities. The CLOs should be local residents, as they will serve as points of contact between the community and the environmental control officers (ECOs) responsible for monitoring construction activities.
  - Feedback sessions should be arranged with community leaders and ECOs to assess the impact of this programme in terms of knowledge, attitudes and behaviour.
- Communities' negative experience of the nuisance impact of construction activities can be further mitigated through ensuring awareness of the benefits derived from local job creation on the project and by clear communication of the long-term positive impacts that the intended project will have.
- The recruitment policy used to employ people on the project must be fair and transparent.
- The intention of giving preferential employment to locals must be clearly communicated, so as to discourage an influx of job-seekers from other areas.
- Involve local community structures (e.g. Spitzkoppen community representatives, Arandis Sustainable Development Project, Spitzkoppen Community Development Association and Arandis Town Council) to assist in communicating the intention of NamPower to give preference

[38] Internationally accepted design practice is to paint the top 25% of solar power towers with a special white paint to protect the concrete against potential temperature increases as a result of a malfunctioning heliostat. This makes the tower extremely visible when there are no heliostats focusing on the receiver.

to local labour, and also to assist by developing a skills database and residents status for the labour pool in their community.

- In order to mitigate the effects of increased pressure on local services and infrastructure, it is recommended that:
  - NamPower or the appointed construction contractor should provide the Arandis Town Council with information on the number of jobs that will be created, so that potential changes in influx trends can be planned for.
  - Services for the construction camp be sourced from the Arandis Town Council. The latter must be informed well in advance of the anticipated timeframe and of the nature of services that will be required.
- Implement measures to combat HIV/ AIDS and other social ills:
  - Implement HIV/ AIDS, alcohol abuse, drug abuse, and domestic violence prevention and awareness campaigns in the communities.
  - NamPower should ensure the health of its employees and their dependants by adopting rigorous health programmes, which should, at a minimum, include programmes to combat HIV/ AIDS and TB.
  - The contractor should make HIV/ AIDS and STD awareness and prevention programmes a condition of contract for all suppliers and sub-contractors.
  - The contractor should provide an adequate supply of free condoms to all workers. Condoms should be located in the bathrooms and other communal areas on the construction site.
  - A voluntary counselling and testing (VCT) programme should be introduced during the construction phase and continued during operations. This can be undertaken in conjunction with the existing VCT programmes of NamPower. The NamPower Wellness Section should set the standard for this programme.
  - The contractor should undertake a HIV/AIDS and STD prevalence survey amongst all workers on a regular basis. It will involve a voluntary test available to 100% of the workforce. The results of the survey will help to determine the HIV/ AIDS and STD strategy. When and if statistically representative results are obtained the results of the survey should be made available to management and workers at the same time. Results should be presented in statistical terms so as to ensure confidentiality. As above the NamPower Wellness Section should set the standard for this programme.
  - NamPower should align awareness campaigns with those of other organisations in the area (i.e. Rössing Foundation and Arandis Town Council). These campaigns should use various common-practice methodologies in order to ensure social and cultural sensitivity.
  - Access at the construction site and camp should be controlled to prevent sex workers from either visiting and/or loitering at or near these locations.
  - Provision of sufficient entertainment facilities in construction camps (e.g. lounge with TV, pool Cease table, access to local soccer fields etc.).

### Measures to address crime

- Stop construction activities before nightfall, if possible.
- Construction workers should be clearly identifiable by wearing proper construction uniforms displaying the logo of the construction company. Construction workers could also be issued with identification tags.

- The appointed contractor should establish clear rules and regulations for access to the construction site and offices to control loitering. Consultation should occur with the local Namibian police branch to establish standard operating procedures for the control and/or removal of loiterers.
- Liaison structures are to be established with local police to monitor social changes during the construction phase. Liaison should also be established with existing crime control organisations, such as the local Arandis Community Policing Forum – 'Crime stoppers'.

### Measures to be implemented prior to the establishment of the construction camp

- The local police force should be assisted in establishing communication channels with the camp's management in order to contact the person in charge when any inappropriate behaviour occurs.
- Collaboration between the local police force, community stakeholders and the camp's management should be put in place before the utilisation of the construction camp commences. This will allow the parties involved to agree on a set of ground rules by which the camp should be managed.
- Suitable arrangements must be made for ablutions (washing and sanitation facilities), sleeping and cooking. The Design Engineer will determine the standards and location of such facilities.
- The camp should be fully enclosed by security fencing and be security-patrolled. As far as possible only workers must be allowed admittance to the camp.
- Sufficient entertainment facilities should be included in the construction camp. Entertainment facilities could comprise a lounge with a pool table, television, vending machines for soft drinks, and soccer fields. If entertainment facilities cannot be included in the camp layout, attendance of alternative entertainment facilities must be encouraged.

### With regards to the fire hazard related to construction camp

- A fire safety and firefighting strategy should be included in the Safety, Health and Environment (SHE) Plan, which should describe action to be taken in case of a fire starting on site or at a construction camp.
- Regulations be stipulated in the EMP regarding where, how, for what reasons, etc. fires can be made. The EMP should also stipulate emergency procedures that workers should follow in case of a fire breaking out.
- Construction workers should be trained in the use of firefighting equipment available on site.

### Poaching and theft by construction/ maintenance workers

- Mitigation measures are discussed under the more general heading of crime.

### For impacts related to littering and ablutions

- Sufficient portable chemical toilets should be provided on site.
- Refuse on site should be discarded in sealed bins and/ or covered skips. Refuse should be removed from the site on regular intervals (at least once a week) and disposed of at an approved waste disposal site.
- Rules of conduct stipulated in the EMP with regard to the use of sanitation facilities, water and management of waste by construction workers must be strictly enforced. The construction camp and site must be monitored by an ECO on a regular basis to ensure adherence to these requirements.

**Informal/ illegal occupation of vacated construction camps**

- Measures include ensuring the camp is demolished once construction is completed and the construction camp vacated to avoid settling of informal residents. Alternatively, if the camp is to be made available for use by other contractors on other projects, it should be "mothballed" until the new occupants take up residence.

### 9.2.4 Avifauna mitigation measures

- Construction activity should be restricted to the immediate footprint of the infrastructure.
- Access to the remainder of the site should be strictly controlled to prevent unnecessary disturbance of priority species.
- Measures to control noise and dust should be applied according to current best practice in the industry.
- Maximum use should be made of existing access roads and the construction of new roads should be kept to a minimum.

### 9.2.5 Air quality mitigation measures

- Sprays water at areas to be cleared for dust suppression. Moist exposed surfaces will reduce the potential for dust generation.
- Ensure travel distances between construction areas are kept to a minimum.
- Water sprays on all roads before grading.
- Dust fallout bucket to be placed next to the main on-site construction road with monthly dust fallout rates not exceeding 1 200 mg/m²/day, not to be exceeded more than two consecutive months, or three times per year.

### 9.2.6 Noise mitigation measures

- All diesel-powered equipment must be regularly maintained and kept at a high level of maintenance. This must include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as trigger for withdrawing it for maintenance.
- To minimise noise generation, vendors should be required to guarantee acceptable equipment design noise levels, for example of generators, transformers, etc. In total, the noise levels from the plant must not result in an increase of more than 3dBA on the outskirts of Arandis (relative to current noise levels to be determined as the baseline).
- During the planning and design stages of the project any possible noise related aspects should always be kept in mind. The enclosure of major sources of noise, such as compressor or pump systems, must be included in the design process.
- Vibrating screens and crushers are known to be noisy and good design philosophies should be followed for equipment of this nature. Such equipment must be installed on vibration isolating mountings.
- Enclosing the tipper discharge and lowering the conveyor drop height may reduce noise emissions. Mechanical and electrical design also influences the amount of noise from stacking and reclaiming operations.
- Project traffic routing through community areas should be reduced wherever possible.
- A mechanism to record and respond to noise complaints must be developed.

### 9.2.7 Groundwater, surface water and soils mitigation measures

- Remove all infrastructure from site during decommissioning and rehabilitate area as per the rehabilitation plan to be compiled, unless there is an identified alternative use for
- Compile a Waste Management Plan for all waste (hazardous and domestic) to include recycling, waste minimisation and on-site treatment where safe and possible, as part of the EMP to manage waste on site.
- Ensure appropriate storage of topsoil from site for use during rehabilitation of areas disturbed during construction (as relevant in a desert environment).

### 9.2.8 Traffic mitigation measures

- The establishment of a temporary, direct road between Arandis and the power station site would reduce pressure on the intersections during the construction phase.
- Route construction traffic from Walvis Bay on the D1984.
- The existing road network can cope with the projected increase in traffic volumes associated with a 300 MW facility without resulting in a drop in the level of service, hence no mitigation is required.
- Safe travelling speeds must be determined for access routes close to populated areas, and measures implemented to ensure that these restrictions are enforced. Such measures may include monitoring vehicle speeds, erecting speed limit signs and installing speed humps.
- Roads must be adequately maintained to prevent deterioration of road surfaces due to heavy vehicle traffic.
- Junctions of access roads and public roads must be regulated at all times, with construction vehicles yielding to oncoming traffic (e.g. the B2 road junction with the access road to the project site).
- Where possible, construction traffic should make use of alternative access routes not involving public roads.

### 9.2.9 Archaeology and heritage mitigation measures

- Liaison with the National Heritage Council for a clearance certificate should be initiated prior to the onset of construction.
- All sites must be documented prior to their destruction.
- Proper instructions must be issued to contractors on site with regards to the dealing with any archaeological artefacts found in order that these can be reported to the National Heritage Council and not be disturbed.

## 9.3 Operational phase recommendations

### 9.3.1 Biodiversity mitigation measures

- Use yellow external lighting where practical and safe to reduce interference with insect behaviour patterns.
- Do not have open water sources on site accessible to animals (including invertebrates).
- Manage on-site rubbish to be inaccessible to animals, and dispose of rubbish at an established and approved off-site disposal facility.
- Eradicate alien plant introductions, should they occur.
- Impose a maximum speed limit of 60 km/h on the site and branch road off the B2.

### 9.3.2 Visual mitigation measures

- Use yellow external lighting where practical and safe to reduce interference with insect behaviour patterns.
- Do not have open water sources on site accessible to animals (including invertebrates).
- Manage on-site rubbish to be inaccessible to animals, and dispose of rubbish at an established and approved off-site disposal facility.
- Eradicate alien plant introductions, should they occur.
- Impose a maximum speed limit of 60 km/h on the site and branch road off the B2.

### 9.3.3 Socio-economic mitigation measures

- The project should engage with the NamPower Foundation prior to construction starting in order to have a "game plan" on the table which can be implemented as soon as construction starts.
- The details of NamPower's CSI programme in the local area should be designed in consultation with community representatives in order to ensure that the actual needs of the beneficiary community are met.
- Where possible, this initiative should be in collaboration with other existing or planned infrastructure or development initiatives by NGOs, mines (e.g. the Rössing Foundation) and the Arandis Town Council.
- NamPower should support or endorse existing development programmes and projects. One such programme is the Arandis Sustainable Development Project which aims to empower youth to become competent and semi-skilled artisans.
- In terms of assisting the Spitzkoppen community in identifying their needs as a guideline for NamPower's CSI initiatives in that area, it is recommended that:
  - A consultative meeting be held between NamPower and the Spitzkoppen Community Development Association. The meeting should be led by an experienced facilitator.
  - During this meeting, the members of the Spitzkoppen Community Development Association should be presented with a framework for identifying and ranking their community's needs - a possible basis to develop such a framework is based on psychologist Abraham Maslow's Hierarchy of Needs, which classifies human needs into five categories.
- Skills transfer should be encouraged by identifying people with the potential and the capacity to learn the skills required to qualify for opportunities at the operational plant.
- On-site or in-job training should be encouraged and should form part of the policies of NamPower, if it is not already included in their policy.
- Support the development of SMMEs and the empowerment of women.
- Unauthorised access to the proposed CSP facility site must be prevented through appropriate fencing and security.
- The proposed CSP facility should be adequately maintained and operated during its lifetime so as to minimise the risk of personnel being injured as result of failed machinery etc.
- Rigorous operational health and safety programmes should be implemented.
- In mitigation of this impact it may be possible to create new tourist attractions (e.g. power plant tours) and alternative viewpoints from the Moon Landscapes and Welwitschia Plains, so that there would be no net loss in terms of tourism and recreation opportunities. There will also be opportunities for significantly increased business and workshop based tourism.

- If ballooning operating activities are significantly affected by the project, corporate/ industrial tourism clients could be channelled towards the affected operator.
- Refer to mitigation measures in the Visual impact assessment.

### 9.3.4 Avifauna mitigation measures

- Bird counts should be implemented once the CSP facility has been constructed. The purpose of this would be to establish to what extent displacement of priority species have taken place.
- As an absolute minimum, bird counts should be undertaken for the first two years of operation, and then repeated again in year 5, to account for inter annual variations which can be significant in this arid region.
- In tandem with the bird counts, carcass searches by specially trained local people should be implemented under the supervision of the avifaunal specialist to search the ground between heliostats and parabolic troughs on a two-weekly basis to determine the magnitude of collision fatalities. Searches should be done on foot. Searches should be conducted randomly or at systematically heliostats and troughs to the extent that equals 33% or more of the project area. Detection trials should be integrated into the searches.
- Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including minor modifications of panels to reduce the illusory characteristics of heliostats and troughs. What is considered to be significant will have to be established on a species specific basis by the avifaunal specialist.
- The exact protocol to be followed for the carcass searches and bird counts must be compiled by the avifaunal specialist in consultation with the facility operator and Environmental Control Officer before the commencement of operations.
- The facility must be designed so the heliostats do not focus the reflected rays on the tower during standby mode but on randomized aim-points. The plant must further be designed that during standby no more than four heliostats focus on the same spot. This will eliminate the danger to birds flying through the concentrated rays as they will be exposed to only four "suns".

### 9.3.5 Air quality mitigation measures

No mitigation is proposed, as the impacts during this phased are considered to be insignificant.

## 9.4 Decommissioning phase recommendations

As indicated in the Final ESEIA a study must be undertaken at the time of decommissioning to assess the impacts and to make recommendations as to how to manage such impacts is still recommended in this amendment.

# 10 SUSTAINABILITY OF PROJECT

*The purpose of this section is to understand the implications of the proposed CSP facility in the greater context of development within the Erongo Region and to assess how the project meets the goals identified for sustainable development in the region, as part of the Uranium Rush SEA (MME, 2010)).*

Similar to the Erongo Coal-fired Power project, the proposed CSP facility was assessed against the development goals for the Erongo Region, as identified in the Uranium Rush SEA. The goals and how the proposed CSP facility meet these goals are available in Annexure G3.

This assessment concluded that the aspects identified as significant in terms of achieving the desired development state for the Erongo region have informed the studies undertaken in the Erongo Coal-fired Power Station ESEIA and this Amendment Report. The recommendations made for the proposed CSP facility are in line with those recommended in the Uranium Rush SEA (MME, 2010). Furthermore, the development of a power station in the region was identified as a goal for the Erongo region to support the development needs. The proposed CSP facility is therefore aligned with the development goals for the area, while the development thereof has complied with the strategic recommendations for the area.

# 11 CONCLUSION

There are a number of highly significant positive impacts associated with the proposed development of a CSP facility. All the positive impacts of the operational phase relate to socio-economic considerations which may be experienced at local, regional and national levels. The most important of these is national energy security and a reliable source of electricity to drive economic development in Namibia. This will allow Namibia to meet certain of its commitments in terms of Vision 2030 and the Millennium Goals, as related to facilitating development in Namibia and improving the quality of life for its people.

Overall, the potential negative impact of the proposed CSP facility would be less than the approved Erongo Coal-fired Power Station as shown in Table 54 below. Biodiversity impacts were identified as a high negative for the CSP facility and relate to the loss of a restricted and sensitive habitat as a direct result of infrastructure development. However, it will only be possible to calculate the magnitude of the expected change once actual infrastructure footprints and their sizes are available which then can be mitigated to Medium. The negative impact on visual resources is predicted to be high for the Erongo Coal-fired Power Station which remains similar for the solar power tower technology alternative. Negative impacts of medium significance related to greenhouse gasses for the Erongo Coal-fired Power Station is not applicable to the CSP facility. The additional impact on avifauna due to the displacement of priority species is also considered to be of medium significance.

Because the detailed design for the CSP facility is not yet available there are certain uncertainties related to the significance ratings of negative impacts on biodiversity, avifauna and archaeological resources. A conservative approach has been taken in order to accommodate the uncertainty but it is recommended that the biodiversity and archaeological assessments be re-assessed once the final layout plans are available to verify the findings. To fully understand the potential impact on avifauna, monitoring would be very important during the operational phase to identify any additional mitigation measures required to manage this impact appropriately.

The potential operational risks that were identified for the Erongo Coal-fired Power Station will need to be re-assessed once the final design for the proposed CSP facility is available. A desktop climate risk screening has also been undertaken to assess potential risks that climate change may have on the proposed CSP facility and to identify effective resilience strategies that could be incorporated in the planning and design phase.

**Table 54: Medium and high significance impacts associated with the Erongo Coal-fired Power Station and proposed CSP facility**

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Construction** | | | |
| ***Socio-Economic*** | Job creation | High (+) | High (+) |
| ***Biodiversity*** | Direct habitat loss through infrastructure development | High (-) | High (-) |
| ***Socio-Economic*** | Multiplier effects on local economy | Medium (+) | Medium (+) |
| | Increased social pathologies | Medium (-) | Medium (-) |

| FIELD | IMPACT | SIGNIFICANCE | |
|---|---|---|---|
| | | COAL-FIRED POWER STATION | CSP |
| **Operational** | | | |
| ***Socio-Economic*** | Increased availability of electricity | High (+) | High (+) |
| | Diversification & growth of local economy | High (+) | High (+) |
| | Opportunities resulting from Corporate Social Investment into community | High (+) | High (+) |
| | Job creation | High (+) | High (+) |
| ***Visual*** | Visibility of plant & of stack/ tower (solar power tower) | High (-) | High (-) |
| ***Greenhouse Gases*** | Increased use of fossil fuels (coal) | Medium (-) | None |
| | Increase in National GHG Emissions | Medium (-) | None |
| ***Socio-Economic*** | Impacts on Tourism | Medium (-) | Low (-) |
| ***Aviation safety*** | Visual impacts from glare and glint (solar power tower) | None | Medium (-) |
| ***Avifauna*** | Displacement of priority species due to habitat transformation | None | Medium (-) |

Similar to the Erongo Coal-fired Power Station, the proposed CSP facility will also have high positive impacts that are of national significance. Without power security, Namibia will be disadvantaged to unacceptable levels. There is currently a critical lack of power generation capacity in the Southern African Power Pool region, which poses high levels of risk to Namibia in the immediate future.

With reference to the information available at this stage of the project planning cycle, the confidence in the environmental assessment undertaken for this amendment application is regarded as acceptable for decision making, due to the fact that the assessment is based on worst case scenarios for both the Erongo Coal-fired Power Station and the proposed CSP facility. Potential impacts are well defined and understood, based on experience gained on South African renewable energy projects, and work undertaken in the Erongo region on other projects by the entire team.

It is acknowledged that the project details may evolve during the detailed design and construction phases. However, these are unlikely to change the overall environmental acceptability of the proposed project. Furthermore, any significant deviation from that assessed in this Amendment Report should be subject to further assessment and may require an amendment to the conditions of the MET: DEA clearance, after due process has been met.

**Way Forward**

All stakeholders have been provided with notification of the availability of the Draft Amendment Report for review and commenting purposes (in libraries and on the Aurecon and NamPower websites). All comments and issues submitted have been captured and responded to in a Comments and Response Report and where relevant the Final Amendment Report has been updated in response. The Comments and Response Report has been forwarded to the registered I&APs.

The Final Amendment Report, including the Comments and Response Report, has been submitted to MET: DEA for decision making. Once the decision has been issued, all registered I&APs will be informed of the outcome of this amendment application.