PRE-FEASIBILITY STUDY FOR THE ESTABLISHMENT OF A PRE-COMMERCIAL CONCENTRATED SOLAR POWER PLANT IN NAMIBIA

EXECUTIVE SUMMARY

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Promoter: POLYTECHNIC OF NAMIBIA

Sponsors: MINISTRY OF MINES AND ENERGY; EEP ENERGY AND ENVIRONMENT PARTNERSHIP / SOUTHERN AND EAST AFRICA

Developers: Gesto ENERGY CONSULTING; Solar Consulting Services; CSP Services CONCENTRATING SOLAR POWER SERVICES; SIJ | SOLAR-INSTITUT JÜLICH FH AACHEN UNIVERSITY OF APPLIED SCIENCES; CONSULTING SERVICES AFRICA

Executive Summary

The Renewable Energy and Energy Efficiency Institute (REEEI) at the 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 (EEP S&EA), sought technical services on a pre-feasibility study for the establishment of a pre-commercial concentrated solar power plant in Namibia.

The awarded consortium was headed by GESTO Energy Consulting, from Portugal, and included Solar Consulting Services, from the United States of America, Solar - Institut Jülich and CSP Services GmbH (Concentrating Solar Power Services, a spin-off from German Aerospace Agency), both from Germany, and the local company Consulting Services Africa. The consortium team included reputable experts, such as Chris Gueymard, Christian Faber, Eckhard Lüpfert, Norbert Geuder, Antoine Bittar, Agostinho Miguel Garcia and Miguel Barreto. Additionally, the Solar irradiation satellite data was provided by Geomodel, from Slovakia.

Furthermore, in this pre-feasibility study for the establishment of a pre-commercial solar power plant in Namibia several points had to be investigated, as follows:

(i) Namibian electricity sector overview

The economic and development context, namely, the background and future expectations, has been further explored to highlight the full picture of the Namibian Electrical Supply Industry.

(ii) Nation-wide solar resource assessment

Coupled with the available satellite irradiation data, a specific AOD (Aerosols Optical depth) analysis has been performed to generate new data and increase the accuracy as well as to develop the new Solar Atlas of Namibia.

(iii) Site selection and environmental analysis – Top 5 sites

A GIS (Geographical Information System) study based on local data to identify suitable locations for CSP development, 20 site inspections and validation allowed to rank the sites, providing the 5 most suitable sites for developing CSP projects.

(iv) CSP high level technology review, power plant layout and basic engineering for the top 5 sites

CSP technologies overview coupled with selection of technologies for site specific conditions, basic engineering and simple layout of the power plants, and financial analysis for the top 5 sites.

(v) Best practices on solar ground measurements

Best-practices sharing to enable the development, operation and maintenance of a network of ground measurement stations that guarantees solar resource meaningful statistical data.

(vi) CSP development in Namibia and Technology Transfer Program

Definition of the business models for the development of CSP and Renewable Energies to cater Namibia's current and future power needs. Development of a program to develop the CSP industry in Namibia and provide opportunities for skills development and job creation associated with the CSP chain value.

In that sense, the results of this study portrays Concentrated Solar Power as a viable and economic solution for Namibia, as follows:

(i) Namibia has one of the best solar resources in the world

Namibia is endowed with an extraordinary solar resource – almost 3000 kWh/m^2 day in the southern part of the country - ranging at the top worldwide - second only to northern Chile - regarding Direct Normal Irradiation (DNI, which is solar irradiation component required for

Concentrated Solar power), that is, the whole country is a hotspot in terms of solar irradiation.

(ii) CSP is a mature technology that can take advantage of Namibia's exceptional solar resource

With more than 1 GW of deployed projects worldwide, CSP can be considered a mature and proven technology. In addition, generally, there are four CSP technologies available for harnessing solar radiation: parabolic troughs power plants, power towers, linear Fresnel collectors and dish Stirling systems. For last, CSP is also possible to be coupled with natural gas, biomass and coal, increasing the interest of deploying this technology in Namibia.

(iii) CSP plants can store solar energy during the day and produce at night peak time

Renewable Energies are claimed to be non-dispatchable and so not able to cater peaks in a reliable fashion. In addition, in order to be dispatchable, they need to encompass storage and the cost of the projects rise as well as the cost of the unit of electricity generated. In this line of thought, the advantage of CSP technology when compared to other renewable energy technologies is the possibility of storing energy. With round-the-clock operation becoming possible, CSP plants have the potential to be used as peaking plant or even as a base load power plant.

(iv) CSP based solar energy can be less expensive than fossil fuel alternatives

Without short-term investment in power generation and only considering the peak and mid-peak periods, Namibia may be confronted with an energy shortage between 2013 and 2016. In addition, the peak demand is expected to be met with rental diesel, given the current generation options of Namibia, and the cost of diesel generated electricity is very high when compared with Renewable Energies. Thus, if Namibia uses part of these potential costs to reduce the initial investment in a CSP plant instead of importing diesel, this would

reduce the investment and the required cost for CSP development, becoming cost competitive even with coal.

(v) Namibia has more than 33,000 km^2 of potential sites for CSP development and more than 250,000 MWe of projects

Namibia has suitable land for the development of 250,000 MWe CSP projects, taking into consideration all parameters of site selection: irradiation, slope, soil type, power evacuation facilities, access infra-structure, environmental and social restrictions. More than 40 sites in Namibia were selected with excellent conditions for CSP technologies, 20 of which were ranked and inspected – more than 3,000 km were driven - providing a final top 5 selection – Hochland (south near to the border with South Africa), Skorpion Mine (near Rosh Pina), Ausnek (near Aus), Kokerboom (near Ketmanshoop) and Gerus (near Otjiwarongo).

Additionally, mainly based on the available DNI data and the national load, but also considering the restraining conditions on the sites, several options were considered for the generation profile on the selected sites, as follows:

Location	Type	Storage
Hochland	Pure CSP - Parabolic troughs or Power towers	7 ~ 8 hours
Skorpion Mine		6 ~ 7 hours
Ausnek		7 ~ 8 hours
Kokerboom		
Gerus	CSP with biomass - Parabolic troughs, power towers or Linear Fresnel	No storage

(vi) A bet on CSP allows the production of cheap and clean energy reducing imports and promoting a national cluster that creates jobs and wealth

Given Namibian energy gap and the most suitable supply options, according to investment, cost, timing and fit with local installed capacity, a two-step approach for capacity development should be pursued: development of up to 100 MW of Wind or Solar PV projects and backup diesel as well as up to 50 MW of CSP power projects (1st step, until 2014) and ~100 MW CSP projects (2nd step, until 2016).

Additionally, the development of CSP in Namibia would have a positive impact on the economy and education sectors, namely, enabling access to development funding for renewable energies in Africa, enhancing Namibia's international visibility and credibility, guaranteeing that up to 40% of the investment in a CSP plant would be sourced from Namibia's economy and promoting local job creation, which would require the creation of new competences in education and, through a CSP technology transfer program, would enhance the renewable competences of Namibian research and education institutions.