

Scatec Solar

**Environmental and Social Impact Assessment
For Aswan PV Power SAE 50 MW(AC)
in Benban, Aswan**

Prepared by:



April 2016

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List of Acronyms

AC	Alternating current
CO ₂	Carbon Dioxide
BDA	Benban Developers Association
dB	Decibel
DC	Direct current
EBRD	European Bank for Reconstruction and Development
EEAA	Egyptian Environmental Affairs Agency
EETC	Egyptian Electricity Transmission Company
EHS/HSE	Environment, Health and Safety
EMP	Environmental management plan
EPC	Engineering, Procurement, and Construction
ESIA	Environmental Social Impact Assessment
ESMP	Environmental and Social Management Plans
ESMS	Environmental and Social Management System
FIT	Feed-in tariff
GHG	Greenhouse gas
GWH	Gigawatt hours
HW	Hazardous waste
IFC	International Finance Corporation
ISO	International Organization for Standardization
km	Kilometre
kV	Kilovolt
MW	Megawatt
NREA	New & Renewable Energy Authority
O&M	Operations & Maintenance
OHSAS	Occupational Health and Safety Management Systems
PPE	Personal Protective Equipment
PS	Performance standard
PV	Photovoltaics
SCADA	Supervisory Control And Data Acquisition
SEP	Stakeholder engagement plan
SESA	Strategic environmental and social impact assessment
SPV	Special Purpose Vehicle/Entity
UPS	Uninterruptible power supply
WW	Wastewater

Executive Summary

Introduction

Environics was assigned by Scatec Solar to develop an Environmental and Social Impact Assessment (ESIA) for the establishment a 50 MW solar PV power generation project under FIT Scheme in Benban, Aswan. The project is located in the PV power plant park in Benban near Kom Ombo in Aswan Governorate where the Egyptian New & Renewable Energy Authority (NREA) has allocated 37 km² for generating electricity from solar power. The electricity generated is intended to be connected to the national electricity grid.

The proposed project will be compliant with Egyptian Laws and would be managed to levels where environmental impacts will be not significant.

Project Description

The project site is located in the desert of Upper Egypt approximately 50 km to the north of Aswan airport, 25 km to the west of Kom Ombo city, with an approximately 5.3 km from the paved Western Desert Highway Luxor-Aswan. The project area is a 970,000 m² desert land and the nearest residential area (Benban village) is about 15 km to the east of the site and at the Nile bank.

The proposed project comprises three broad components as follows:

- **Solar Field (PV Modules):** The solar energy conversion to electricity takes place in a semiconductor device that is called a solar cell. A number of solar cells are connected together to form a PV module (solar panel). These are the heart of the PV system.
- **Electro and electromechanical equipment:** The electric current produced by the PV modules is DC current, which is transformed to AC current through the inverters. In addition, transformers and switchgears are used to control the power output of the solar modules.
- **Connection to the grid:** The project is a utility scale type and will be directly connected to the National Grid through lines and substations to be established by NREA/EETC.

Existing Environmental Conditions

Climate

The project area is located within the Western Desert, and accordingly is characterized by hyper-arid conditions. The climate is generally extremely dry, bright and sunny year-round.

Surface Topography and Geomorphology

The area is mostly flat lowland with the presence of a few sand dunes ranging between 2 to 4 m high. Elevation in the project site varies between 159 and 164 meters above the mean sea level. The project site is located 50 km north-west of Aswan City, and it can be accessed through Aswan suspension bridge. The study area is located within the upper unit of the Nubian sandstone.

Hydrology and Hydrogeology

The main course of the Nile represents the main source of surface water and is located 18 km east of the project site. No flash flood drains were noticed in the study area during the site visit. However, based on the Flash Flood Atlas for Aswan Governorate¹ it is indicated that the PV park area is located within an area of low to medium flood intensity² and flood risk.

Seismicity and Earthquake Hazards

Few of earthquakes occurred in the west Kom Ombo area from 1981 to 2003 were recorded.

During the period from Dec. 1981 to July 1982, seven earthquakes were located 25-50 km around Kom Ombo area. On March 22, 2003 an earthquake occurred in the west Kom Ombo area, it was felt in the area and its surroundings.

Ecology

The main type of habitat present in the project's area of influence is sand dunes representing extreme natural habitats characterized by lack of vegetation and water resources.

The proposed project site is located in an arid/extremely arid area, the presence of flora is totally not observed within the project location.

The surveyed project area is located in one of the typical western desert faunal habitats that is mainly composed of sandy and rocky plains and represents extreme habitats mostly without any vegetation and water resources.

The nearest protected area to the project location is Saluga and Ghazal Islands. The project is located about 40 km from the border of the protected area.

Socio-economic Environment and Archeology

The project is located 15 km from Benban village, near the Luxor-Aswan Road. Benban village consist of three affiliated villages, Benban Qebli, Benban Bahari and El Raqaba villages. Kom Ombo is the second close urban center to the PV Park at a distance of about 25 km. The literacy rate in Kom Ombo it was estimated to 28% (CAPMAS, 2006), which is less than the national average (65.7%). The majority of the population works in fishing and agriculture.

Benban residents have access to health care units, treated water and electricity.

The project site and contiguous areas have no tourism activities; the nearest tourist area is Kom Ombo located 25 km away from the site.

¹ Flood Atlas for Aswan Governorate, 2012, Ministry of Water Resources and Irrigation

² Flood Intensity (m^2/sec) is estimated as a function of two hydraulic parameters; namely flood depth and flow velocity, Flood intensity= flood depth * flow velocity

Analyses of Project Alternatives

The “no-development” alternative was not given consideration as if this project was not undertaken, the land proposed for the development would still be used for other renewable energy projects. This is because the site is owned by NREA and has been designated for renewable energy projects.

Alternative site location

The project is located within the PV Park, in the vast and largely unoccupied Western Desert, owned by NREA where other 39 parcels are located and dedicated for solar energy projects over around 37 km². Therefore this location is considered the most suitable for the establishment of the project and other locations outside NREA’s land area has not been considered.

Alternative PV technology

Concentrator photovoltaics (CPV) have high efficiency, low system cost, and low capital investment. However, they are not yet reliable and are to be used in smaller areas with limited access to land. Thus, this option is not considered in this ESIA.

Alternative PV Types

The three main types of PV modules are compared namely, Mono and Poly crystalline Silicon, Thin-Film Silicon and Compound Thin-Film. Poly Crystalline type is shown to be more efficient in terms of land use and requires less area per MW. Thus, this type is most suitable for utility-scale power plants.

Tracking Alternatives

Tracking systems clearly outperform fixed-tilt systems as a single axis tracker increases annual output by approximately 15% to 25%. Thus, they are selected for this project.

Alternative module cleaning

Module cleaning methods include wiping with dry cloths, wiping with wet cloths and washing with high pressure water. Scatec Solar has opted for wiping with dry cloth.

Alternative water sources

The site is not connected to any water sources thus the potential options would include: groundwater abstraction, construction of water pipeline from the Nile water and trucking.

Water is to be trucked to the site and stored in an onsite water tanks for construction and cleaning purposes. Drinking water will be provided either from a secure source, or bottled.

Assessment of Environmental Impacts

Potential impacts were identified by Leopold matrix, and were evaluated in relation to their effects on potential receptors.

Positive project impacts included the provision of employment opportunities during construction and operation. The project will contribute to satisfying part of Egypt's electricity demands in such a way that does not deplete fossil fuel resources and thus reducing greenhouse gas emissions.

Potential negative impacts on ambient *air quality* may result during construction from equipment engine exhaust and dust, which is released during earthworks, soil and rock transport as well as from soil disposal areas. These impacts are typical of most construction sites and were considered insignificant if proper measures were applied.

Similarly, ambient noise and vibration related impacts would mainly result from use of heavy machinery. These were found insignificant as the site is remote and the impacts were considered short-term and localized.

Potential impacts on *soil* would generally be related leakages from septic tanks, release of solid and hazardous waste and oil leaks and fuel spills. Moreover, measures to ensure proper housekeeping would be applied. Thus, these impacts are considered insignificant.

Socio-economic impacts were also found acceptable if mitigation measures are and site management practices are applied. Potential impacts in relation to *traffic, workplace health and safety and water resources* were also assessed and considered only moderate.

Potential impacts of the environment on the project were finally assessed. Those related to *sand storms* were identified and were considered during the project design. The impact of *earthquakes and flashflood* was also identified and mitigation protection measures described. The impacts of the environment on the project were considered insignificant.

Cumulative Impacts

The individual PV projects generally do not pose environmental adverse impacts during operation activities, and the potential impacts during construction are localized and short term and considered insignificant for the individual project. However, the cumulative impacts from all projects within the PV park can be significant during construction and operation phases. In this respect, the potential *cumulative impacts* will be addressed by the Facility Management Company that will be selected by Benban Developers' Association during April 2016. Such impacts to be considered by the collective assessment for all projects within the PV park would include:

- **Impact on water resources**
- **Traffic and logistics management**
- **Influx of workers and worker accommodation, catering and transport**
- **Site security**
- **Stakeholders Engagement plans**

Environmental Management Plans

A management plan was formulated to list measures that the contractors should follow and include within their construction plans.

The project will develop various environmental and social management plans addressing the different environmental and social aspects. The environmental plans to be developed will address:

- Hazardous and solid waste management
- Water and wastewater management
- Preventative and corrective maintenance
- Module Cleaning Philosophy
- Housekeeping
- Fire Fighting and emergency response
- Emergency Response Plan
- Risk management approach
- Training and awareness
- Contractor management
- Community Safety and site security
- Information disclosure and Stakeholder Engagement
- Project Decommissioning Plans

A monitoring plan was formulated to ensure that the performance is meeting the set standards and that the mitigation measures are working to achieve the desired level of impact minimization.

Monitoring will include:

- Air Quality
- Workplace
- Workplace Noise
- Solid and Hazardous Wastes

Conclusion

The project is anticipated to result in a net positive environmental impact. Moderately significant impacts were identified for the proposed project activities and will be mitigated through the adoption of environmental controls in design and through the implementation of management plans during all project phases. The residual impacts have been evaluated to comply with Egyptian and international standards, and a monitoring program will verify compliance. The project will be managed to levels where the environmental impact will be not significant. Whereas, the cumulative impacts will be investigated by the Facility Management Company.

1. Introduction

1.1 Background

The Egyptian New & Renewable Energy Authority (NREA) is planning to establish a PV power plant park (approximately 1740 MW of AC) in Benban near Kom Ombo in Aswan Governorate. The project has been tendered to investors and service providers to build and operate PV plants ranging from 20 to 50 MW of AC. About 40 investors have been assigned land plot under the Feed-in Tariff Scheme (FIT). NREA will construct the required transmission lines and substation to accommodate the generated electricity from all PV plants and connect to the national electricity grid.

In accordance with the FIT Scheme, Scatec Solar ASA has established the corresponding Special Purpose Vehicle (SPV) Company Aswan PV Solar SAE (the Company). Subsequently, in accordance with the Memorandum of Understanding (MoU) signed by the Company and NREA plot no. 16-2 in Benban has been handed over to the SPV for conducting required preliminary studies and technical measurements for establishing a 50 MW solar PV power generation project (the Project) under FIT Scheme. The electricity generated is intended to be connected to the national electricity grid. The area is mainly desert area and does not include residential or other human activities. The project is located in plot 16 in Benban, Aswan. Figure (1-1) below shows the overall PV solar park and the location of the Company's plot within the park.

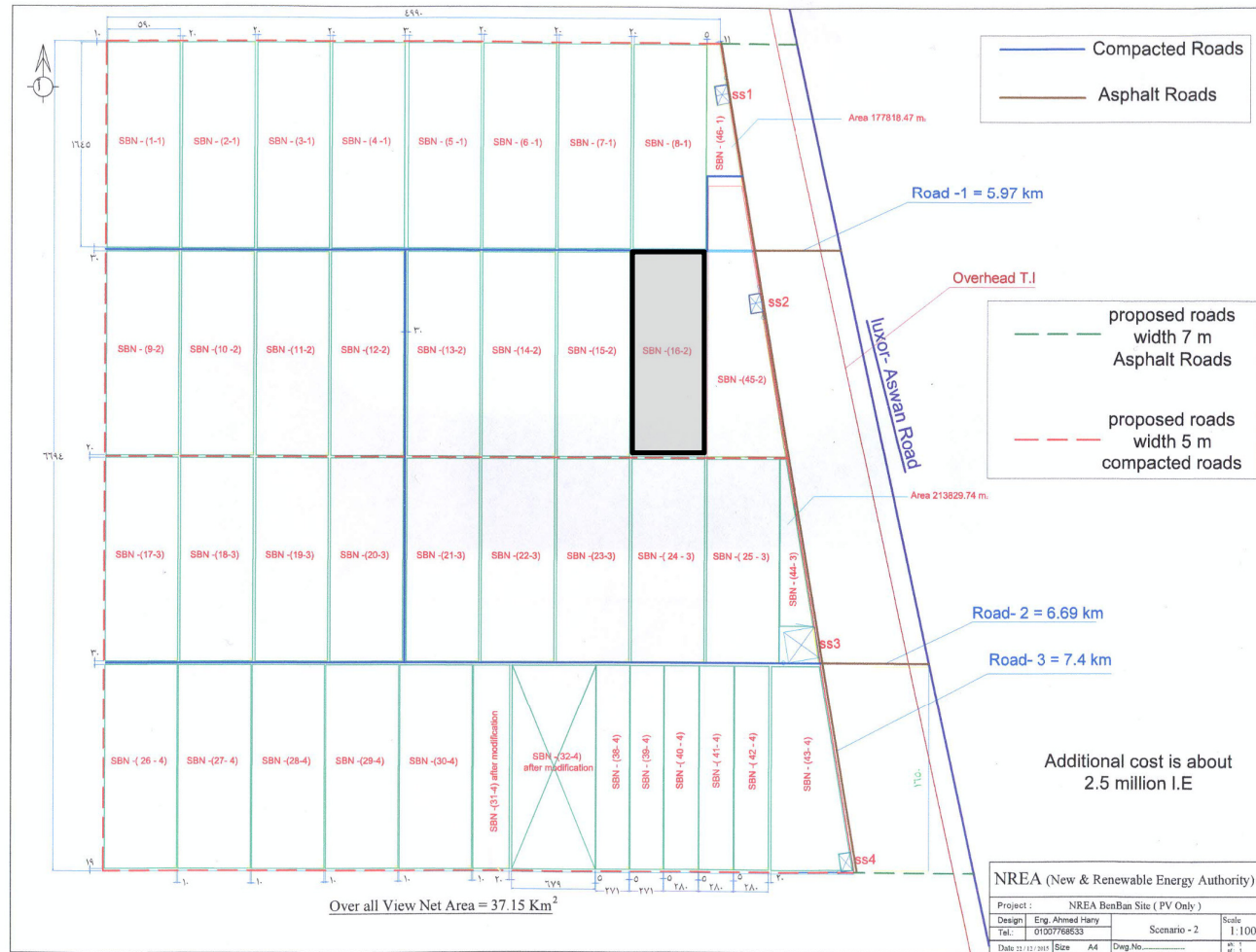


Figure 1-1: PV solar park and the location of Aswan PV

The project is categorized by Egyptian Environmental Affairs Agency (EEAA) under 'Category Scoped B' Projects - which will require a full ESIA according to the modified EIA categorization lists issued by EEAA in 2016. However, NREA has prepared a Strategic Environmental Impact Assessment Study (SESA) for the wider development location in which the different common and associated facilities are covered. Thus and in this respect, and was approved by EEAA in March 2016, thus the individual projects will be categorized under the lower EIA level, namely Form B ESIA, which does not require individual stakeholders' consultation and engagement plans

1.2 Interface with the Strategic Environmental and Social Impact Assessment (SESA)

The SESA study initiated by NREA, EBRD and NREA commenced in July 2015 and an environmental consultant was nominated to develop a Strategic Environmental and Social Assessment (SESA) for the solar park in Benban. The SESA process has been prepared as a high level assessment for the environmental aspects of the solar park in Benban. The SESA did not address the project specific characteristics, as these are addressed in each project's individual Category B ESIA. The individual ESIA's (Form B ESIA) do not require extensive socio-economic assessment or public scoping and disclosure activities. In this respect, the SESA was intended to support the individual ESIA process and save time for the Form B ESIA preparation as well as reduce cost of consultation process. The SESA has been approved in March 2016. Accordingly additional baseline information will be incorporated or referred to in in this ESIA as necessary. Annex 1 presents copy of the SESA approval.

The SESA has identified a list of key project aspects that can have considerable cumulative impacts on the surrounding environment and that need to be addressed collectively and jointly by all developers. These are summarized as follows:

- Traffic management and volume of overall traffic
- Water consumption and wastewater management
- Solid waste
- Labour influx and workers' accommodation, catering and transport
- Community safety and Site security
- Community engagement and grievance systems
- Corporate Social Responsibility

In this respect, the Developers' Association issued a Request for Proposal in February 2016, for performing the Complementary Environmental and Social Studies related to the cumulative aspects identified by the SESA as well as provision of Facility Management Services. The facility management company will be selected within April 2016

The activities required are to review, update and/or confirm the various aspects related to common activities of the developers, including impact assessment of the cumulative effects of the aspects indicated above.

Corresponding mitigation measures will be suggested and the Consultant will be responsible for implementation on behalf of the Developers' Association. Particular focus will be put on the integration of the various work streams, including but not limited to the logistics coordination and traffic management as well as establishing Environmental and Social Management System for the PV park and E&S Team Capacity.

Due to the above, this Form B ESIA does not include impact assessment related to the cumulative effects of the aspects above.

1.3 Objective of the ESIA

The objective of the ESIA is to ensure that the project is environmentally and socially sound and sustainable, and that any potential negative environmental impacts are recognized early in the project cycle and taken into account before project implementation. Furthermore, it is also intended to satisfy the environmental legal requirements of the Egyptian Environmental Law 4 of 1994 amended by Law 9/2009 and its executive regulations No. 338 of 1995 modified by Prime Minister Decree no. 1741/ 2005, modified in 2011/2012 and 2015 as well as the EEAA (Egyptian Environmental Affairs Agency) guidelines for EIAs issued 2009 and the modified project categorization lists in 2016..

Moreover, the ESIA is also intended to satisfy the environmental requirements of the international funding institutions including specifically the Performance Standards (PS) of International Finance Cooperation (IFC) and the Performance Requirements (PR) of the EBRD as well as Good International Industry Practice.

Based on the Guidance Note for Developers on Lenders' Environmental and Social Assessment / Due Diligence Requirements, issued by the IFC on 5th October 2015 it is likely that each project will be Category B (or equivalent), unless it is concluded by the focused environmental and social assessment carried out on a Project level that there are particular sensitivities would trigger IFC Category A requirements. The categorisation for each Project should be confirmed in consultation with the Lenders to that Project

1.4 Scope of Work

The ESIA of the proposed project would evaluate the project potential environmental impacts in its area of influence; identify ways of improving project environmental performance during its different stages by preventing, minimizing or mitigating potential adverse environmental impacts and enhancing positive impacts. The ESIA will cover the different components of the plant at the different phases of site preparation, construction, startup, operation and decommissioning.

The scope of work covers the specific “terrestrial” impacts of the plant within the facility premises, which includes construction, operation and decommissioning of the PV plant.

1.5 Outline of ESIA study

This ESIA report includes:

- **Chapter 1:** Introduction and Background on the project for which the ESIA is developed as well as the scope and objectives of the ESIA study.
- **Chapter 2:** Description of the local regulatory framework as well as the IFC Performance Standards applicable to the project activities
- **Chapter 3:** Description of the intended PV plant construction and operation phases and the expected environmental aspects
- **Chapter 4:** Description of the baseline environment in the project area
- **Chapter 5:** Discussion of alternatives for different project components.
- **Chapter 6:** Assessment of the potential environmental impacts and their mitigation measures.
- **Chapter 7:** The environmental management and monitoring plan for the PV plant

2. Policy, Legal and Administrative Framework

This section summarizes the environmental and social legislation and regulations of relevance to the project. They were identified according to the type of the proposed activity (described in detail in chapter 3), its geographic location and the expected impacts. Consideration is first given to the national legislations pertaining to the execution of the ESIA, followed by a review of guidelines of international financing institutions for environmental requirements relevant to the project as well as the Company's environmental, health and safety framework requirements.

2.1 National Legislation Pertaining to EIA

According to Law 4/1994, the project proponent must prepare an Environmental Impact Assessment (EIA). Accordingly, environmental requirements are integrated into the existing licensing system.

According to the Egyptian Guidelines for EIA (EEAA, 2009), proposed developments are classified to four categories according to the severity of potential impacts. They reflect the increasing level of environmental impact assessment. The three categories¹ are:

- **Category A:** projects with minor environmental impacts
- **Category B Scope:** projects with substantial impacts with specific focus on specific project activities/components
- **Category B:** projects with substantial impacts
- **Category C:** projects with high potential impacts requiring full EIA

According to EEAA requirements, this project has been classified as category B Scope project. Therefore, the proposed PV plant requires an ESIA that should cover construction and operation phases. However, since NREA has prepared a Strategic Environmental Impact Assessment Study (SESA) for the wider development of entire PV Park in Benban, the individual projects will be categorized under the lower EIA level, namely Form B ESIA, thus not requiring stakeholders' consultation and engagement plans. However, the results of the stakeholders' consultation activities will be referred to in this ESIA.

According to law 4/1994, modified by Law 9/2009, and its executive regulations (ER), the EIA report will be submitted to the Competent Administrative Authority (CAA), under which jurisdiction the project falls. For the PV project the CAA is the New and Renewable Energy Authority (NREA). The CAA would send the EIA to EEAA to issue its response within 30 days. If no response is received beyond this period, the assessment shall be deemed approved.

¹ The IFC World Bank EIA categorization is in a reverse order as it considers Category A projects have the most significant and Category C projects have the least significant impacts.

2.2 National Regulations Pertaining to the Project

2.2.1 Air Quality

Article 36 of Law 4/1994 and article 37 of its modified ERs (710/2012) give the maximum allowable limits for exhaust gases from machines, engines and vehicles.

Article 35 of Law 4/1994 and article 34 of its modified ERs give the maximum allowable limits for ambient air pollutants. Table (2.1) gives the maximum allowable limits for ambient air emissions

For this specific project, the legal stipulations related to the industrial areas apply mainly to potential air emissions during the construction phase.

Table (2-1): Maximum Limits of Ambient Air Pollutants According to Annex (5) of the Modified ERs of Law 4/1994 as well as the international guidelines (IFC)

Pollutant	Area	Maximum Allowable limits			
		1 hr	8 hrs	24 hrs	1 year
Sulfur Dioxide ($\mu\text{g}/\text{m}^3$)	Urban Areas	300	-	125	50
	Industrial Areas	350	-	150	60
<i>International guidelines (IFC)</i>		-	-	20	-
Carbon Monoxide (mg/m^3)	Urban Areas	30	10	-	-
	Industrial Areas	30	10	-	-
<i>International guidelines (IFC)</i>		30	10	-	-
Nitrogen Dioxide ($\mu\text{g}/\text{m}^3$)	Urban Areas	300	-	150	60
	Industrial Areas	300	-	150	80
<i>International guidelines (IFC)</i>		400	-	150	-
Total Suspended Particles ($\mu\text{g}/\text{m}^3$)	Urban Areas	-	-	230	125
	Industrial Areas	-	-	230	125
<i>International guidelines (IFC)</i>		-	-	230	90
PM ₁₀ ($\mu\text{g}/\text{m}^3$)	Urban Areas	-	-	150	70
	Industrial Areas	-	-	150	70
<i>International guidelines (IFC)</i>		-	-	150	70

2.2.2 Noise

Article 42 of Law 4/1994 and article 44 of its modified ER (710/2012) give the maximum allowable limits for sound intensity. Table (2.2) shows the maximum limits of ambient noise levels in different areas.

For this specific project, these legal stipulations apply mainly to potential noise levels during the construction phase.

Table (2-2): Maximum Limit Permissible for Noise Level in the Different Zones According to Annex (7) of the Modified ERs of Law 4/1994

Type of zone	Permissible limit for noise level, dB (A)	
	Day time 7 am – 10 pm	Night 10 pm – 7 am
Areas on roads whose width is 12 m or more, or industrial areas which comprise light industries and other activities	70	60
<i>International guidelines</i>	70	70

2.2.3 Solid Wastes

Articles 37 of Law 9/2009, modifying Law 4/1994, and articles 38 and 39 of the modified ERs are concerned with the collection and transportation of solid wastes.

Article 39 of Law 4/1994 and article 41 of its ERs set the precautions to be taken during digging, construction, demolition or transport of resulting waste and dust so as to avoid wafting, according to the following precautions:

- Construction waste storage is to be carried out at site such that it does not obstruct movement of vehicles and personnel.
- waste subject to emission should be covered to avoid air pollution
- waste is to be submitted to authorized waste contractors

Law 38/1967 concerning cleanliness and sanitation and its executive regulations (decree 134/1968) regulates the collection, transportation, storage and disposal of solid waste.

The sewage and sludge in the septic tank is to be collected and disposed of through an authorized contractor

For this specific project, the legal stipulations related to the management of solid waste and sewage apply the construction and operation phase.

2.2.4 Hazardous Substances and Wastes

Article 33 of Law 4/1994 specifies that all precautions must be taken when handling hazardous material either gaseous, liquid, or solid form to avoid any environmental damage.

Article 28 of the ERs of Law No. 4 of 1994 identifies requirements for hazardous waste management including the following:

- Identification: using the Hazardous Waste (HW) lists issued by the competent authority².
- Minimization: strive to reduced quantitatively and qualitatively the generation of the HW
- Segregation: HW is to be separated from other types of non-hazardous waste. In addition, the different types of HW must not be mixed together.
- On site Storage: HW is to be stored in designated area, and containers must be made of suitable materials and be properly sealed to avoid any leakages or spills into the surroundings.
- Off-site transportation: HW is to be submitted to authorized HW contractors.

For this specific project, the legal stipulations apply to the generation of waste during construction and operation phase, such as used oil, grease and other lubricating materials.

2.2.5 Drinking water guidelines

The Decree of the Minister of Health 458/2007 provides the acceptable specifications of potable water. The parameters are categorized under five categories as follows:

- i. Physical parameters: such as colour, odour, turbidity and pH.
- ii. Inorganic parameters: such as hardness, dissolved salts, sulphates and chlorides and metallic
- iii. Heavy metals and organic pesticides
- iv. Microbiological parameters
- v. Radiactive substances

Table 2-3 below presents example parameters relevant to potable water quality for drinking and domestic purposes according to national law.

² Ministry of Electricity Hazardous Waste List, 2007

Table (2-3): Parameters Relevant To Potable Water Quality

Parameter	Maximum allowable limits mg/l
<i>Physical Parameters</i>	
Dissolved salts at 120 ⁰ C	1000
Total hardness (as CaCO ₃)	500
Sulphates (SO ₄)	250
Chlorides (Cl)	250
Iron (Fe)	0.3
Manganese (Mn)	0.4
Copper (Cu)	2
Zinc (Zn)	3
Sodium (Na)	200
Aluminum (Al)	0.2
<i>Microbiology parameters</i>	
Total bacteria count	– not exceeding 50cell/cm ³ at 37 ⁰ C for 24 hrs – not exceeding 50cell/cm ³ at 22 ⁰ C for 48 hrs
Total coliform	– 95% of the samples up to 100cm ³ examined /year should be totally free of coliforms – No sample should exceed 2 cell/100 cm ³ provided that this limit does not occur in two successive samples from one sampling source.
Streptococcus pyogenes	– none
Algae	– microcystene should not exceed 1µg/l in case of blue green algal bloom
Microscopic examination	– totally free of living protozoa and pathogenic organisms

For this specific project, the legal stipulations related to the quality of potable water apply to the construction and operation phases.

2.2.6 Work Environment

The Egyptian Labour Law number 12/2003 organizes working conditions and management of worker relationship. The national labour law in its different articles; addresses the individual labour contracts, terms of employment, wages and leaves, collective negotiations and collective labour agreements and litigations as well as vocational training are addressed in sections one to four. A number of explanatory notes and ministerial decrees have been issued detailing the different stipulations of the law.

Part 3 of Book 5 of the labor law number 12/2003, articles 208 through 215, address the responsibility of companies to protect workers against risks resulting from handling of gaseous, liquid and solid chemical substances.

The Ministerial Decree 134/2003 requires that organizations hiring more than 50 employees establish an occupational health and safety department to be responsible for the workplace and employees' safety and provide the necessary equipment for measuring and monitoring pollution in the work environment. Besides, Ministerial Decree 211/2003 of the Ministry of Manpower also addresses the requirements to prevent adverse physical, chemical, biological, mechanical hazards and the dynamic electricity hazard in the workplace as well as keeping medical surveillance records for the employees

According to articles 43 and 45 of Law 4/1994 and articles 44, 45, 46 and 47 of its executive regulations, the facility owner must provide the protective equipment and all necessary safety measures for the workers against noise, heat stress and gaseous emissions inside the work place. In addition, it is the responsibility of the facility's owner to provide all closed and semi-closed places with efficient ventilation system. Moreover, article 32 of the decree 211/2003 addressed the protection against high voltage risks in electricity generation plants. It describes measures for occupational safety measures when handling and maintaining electric equipment, wires and cables.

The following tables provide the maximum allowable limits for workplace exposure:

Noise:

Law 4/1994: Maximum Permissible Noise Levels inside the Workplace (dB (LAeq)) Annex 7 Executive Regulations of Law 4, 1994 (as amended by Decree No. 710 of 2012)

Table (2-4): Law 4/1994: Period of Workplace Exposure to noise in dB (A)

Type of Place and Activity	Maximum Permissible Noise Level	Exposure time*
Workplace (workshops and factories) with up to 8 hour shifts (licensed before 2014)	90	8
Workplace (workshops and factories) with up to 8 hour shifts (licensed starting from 2014)	85	8
Administrative offices - Work rooms for computers, typewriters and similar equipment	65	-
Work rooms for activities requiring routine mental concentration - banks public squares – industrial activities control rooms – restaurants	60	-

*Exposure duration to be reduced by 50% with each 3 dBA increase in noise intensity

Table (2-5): Law 4/1994: Period of Workplace Exposure in case of Noise Level instantaneous intensity from heavy hammers (should not exceed 135 dB (A))

Maximum Noise intensity level dB (A)	Number of allowed knocking during a working day
135	300
130	1000
125	3000
120	10000
115	30000

Table (2-6): Labour Law: Decree 211/2003 – Workers exposure to noise in workplace

Maximum Noise intensity level dB (A)	90	95	100	105	110	115
Exposure duration (hours)	8	4	2	1	0.5	0.25

The legal stipulations apply to the workplace conditions during construction and operation phases.

2.2.7 Management of Liquid Wastes

Decree 44/2000 of the Ministry of Housing modifying the executive regulations of Law 93/1962 address the conditions and maximum allowable limits for discharge of wastewater to public sewer network,

There will be no public sewer system extended to the site. However, the Decree provides general conditions and criteria to be fulfilled for treated sanitary wastewaters that are re-used for agricultural/landscaping purposes (Article 15).

The legal stipulations apply to the discharge of domestic sewage water resulting from workforce during construction and operation activities.

2.2.8 Environmental and Other Registers

Article 22 of Law 4/1994 and article 17 of its modified executive regulations stipulates that establishments should maintain an environmental register for its activities. Article 17 and Annex (3) of the ER provide the content of the environmental register and state that the owner of the facility must inform EEAA with any non-compliance.

Furthermore, articles 26, 28 and 29 of the modified ERs are concerned with the rules and procedures of hazardous substances and waste management.

Accordingly, a register for the hazardous waste should be maintained as well as record for the hazardous substances used.

In addition, article 211 of the Labour Law 12/2003 and article 34 of the Decree of the Minister of Labour and Manpower no. 211/2003 regarding requirements to prevent adverse physical, chemical, biological and mechanical hazards in the workplace, stipulates that companies should prepare, records/reports/register for chemical safety.

The legal stipulations apply to construction and operation phase.

2.2.9 Labour working conditions

The Egyptian Labour Law number 12/2003 organizes working conditions and management of worker relationship in chapters one to four of Book 5 of the Labour Law. The national labour law in its different articles; addresses the following aspects:

- the individual labour contracts,
- terms of employment,
- wages and leaves,
- collective negotiations and collective labour agreements and litigations, and
- vocational training

The legal stipulations apply to construction and operation phase.

2.2.10 Legislation applicable to Cultural Heritage

Law No. 117 of 1983 promulgating the Antiquities' Protection Law, as amended by Law No. 3 of 2010, deals with the protection of antiquities. It is the main law in Egypt regarding the protection of archaeological and historical sites. The Ministry of State for Antiquities (MSA) is the authority concerned with the supervision of all archaeological affairs and sites in the country (Article 5). The Ministry of State for Antiquities (MSA) is responsible for discovery of antiquities and all exploration activities on Egyptian territory. MSA must be notified in the event that an unrecorded ruin is found by any person (Article 23). Although there are no cultural heritage areas in the site vicinity, the EIA report will refer to relevant regulations for unlikely cases of chance finds.

No cultural heritage is indicated in the project area or its proximity. However, the legal stipulations apply to construction phase and the Contractor's development of procedures in case of findings is required.

2.3 Guidelines of the International Financing institutions

In addition to Law 4/1994, this ESIA is prepared according to the requirements of the international finance institutions particularly the IFC for projects proposed for financing. In this context, the IFC requires the projects to abide by its Performance Standards to ensure that they are environmentally sound and sustainable. Performance Standards (PSs) are applied to manage social and environmental risks and impacts. The performance standards define clients' roles and responsibilities for managing their projects and the requirements. The standards also include requirements to disclose information. The IFC PSs are:

Performance Standard 1: Social and Environmental Assessment and Management System

Establishes the importance of: (i) integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of social and environmental performance throughout the life of the project.

This performance standard is relevant to most projects and applies to the current one.

Performance Standard 2: Labor and Working Conditions

Recognizes that the economic growth through employment creation and income generation should balance with protection for basic rights of workers.

This performance standard applies to the aspects of employment during the different project phases.

Performance Standard 3: Pollution Prevention and Abatement

Recognizes that industrial activities often generate increased levels of pollution to air, water and land, which can have potential adverse impact on the surrounding environment.

The performance standard applies to the potential emissions and wastes (solid and liquid) from different sources during construction and operation phases and their potential impacts.

Performance Standard 4: Community Health, Safety and Security

Recognizes that the project activities and infrastructure can increase the potential for community exposure to risks and impacts arising from equipment accidents, structural failure and releases of hazardous materials. Impacts may also arise from exposure to diseases and the use of safety and security personnel.

Regarding the proposed project is a PV power plant and is located inside the premises of Benban Plant at distance of about 15 km from the nearest community, Benban village, and about 2 Km from Cairo-Aswan Highway.

However worker's accommodation will be within proximity of local communities.

Performance Standard 5: Land Acquisition and Involuntary Resettlement

Recognizes that the project design minimizes economic and physical displacement, balancing social environmental and financial costs and benefits. The location of the proposed project is within Benban Plant premises assigned to NREA, thus no involuntary resettlement for this specific project or change in current land use would take place.

Provisions of this performance standard do not apply to the proposed project since the activities will not involve any involuntary resettlement or change in the land use.

Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management

This PS addresses how projects can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources.

As a significant part of the ESIA, the biological baseline in the project area is to be described. Preliminary information about the proposed project area indicates absence of significant ecological diversity. Yet, the ESIA will describe the different habitats and biodiversity surrounding the area and investigates the potential project impact on them, where/if applicable.

Performance Standard 7: Indigenous Peoples

This PS aims at preventing adverse impacts of the projects on communities of Indigenous peoples and to provide opportunities for development benefits.

Provisions of this PS do not apply to the proposed project since there are no indigenous communities in the area.

Performance Standards 8: Cultural Heritage

The objective of this PS is to protect the cultural heritage from the adverse impacts of the project activities and support its preservation.

No cultural heritage components are expected. Moreover, there are no registered archeological sites within or in close proximity to the proposed project location. However, cases of chance find will be addressed in the ESIA.

2.4 Guidelines of Scatec Solar ASA

Scatec Solar adopts a set of policies for social and environmental issues. Those policies mostly apply to projects undertaken by Scatec Solar world-wide.

Scatec Solar defines and communicates the environment, health and safety standards to their employees and contractors. Scatec Solar's goal is to ensure that they directly and indirectly have positive impacts on the societies in which they operate. In this respect, Scatec Solar strives to:

- Employ local labour and enable knowledge transfer and job creation in local communities
- Use local suppliers whenever feasible

- Plan for and contribute to local development initiatives
- Ensure that their efforts to impact positively on local communities are done with integrity and awareness of zero tolerance for corruption
- Train and educate people in how best to operate in a new, often foreign, culture to make every project friction free and a collaborative enterprise
- Increase access to renewable electricity generation capacity in countries experiencing energy shortage
- Conduct environmental and social impact assessments, and additional due diligence if significant matters are uncovered in initial impact assessments
- Develop all projects in accordance with the IFC performance standards and the Equator Principles
- Design systems and services to minimize the environmental impacts, with an emphasis on protecting local biodiversity and using water responsibly.

3. Project Description

3.1 Project Objective

Following completion of construction, the project will directly provide electricity from solar energy at utility scale and will contribute to increase the national energy independency. Accordingly, it would contribute to minimization of the dependence on the depleting fossil fuels and minimize their environmental adverse impacts.

The project will also allow Egypt to benefit from one of its main renewable energy resources, namely the solar energy. The project will also contribute to meeting part of continuously increasing needs of the energy requirements in Egypt.

3.2 Project Location

Scatec Solar through its local SPV Aswan PV Solar are planning to establish a 50 MW Photovoltaic (PV) plant within Benban PV Solar Park, where NREA has allocated 37 km² for generating electricity from solar power. The project site is located in the desert of Upper Egypt approximately 50 km to the north of Aswan airport, 25 km to the west of Kom Ombo city, with an approximately 1.7 km from the paved Western Desert Highway Luxor-Aswan. The project area is desert land and the nearest residential area (Benban village) is about 15 km to the east of the site and at the Nile bank. Figure 3-1 below shows the activities surrounding the proposed location of the PV plant.

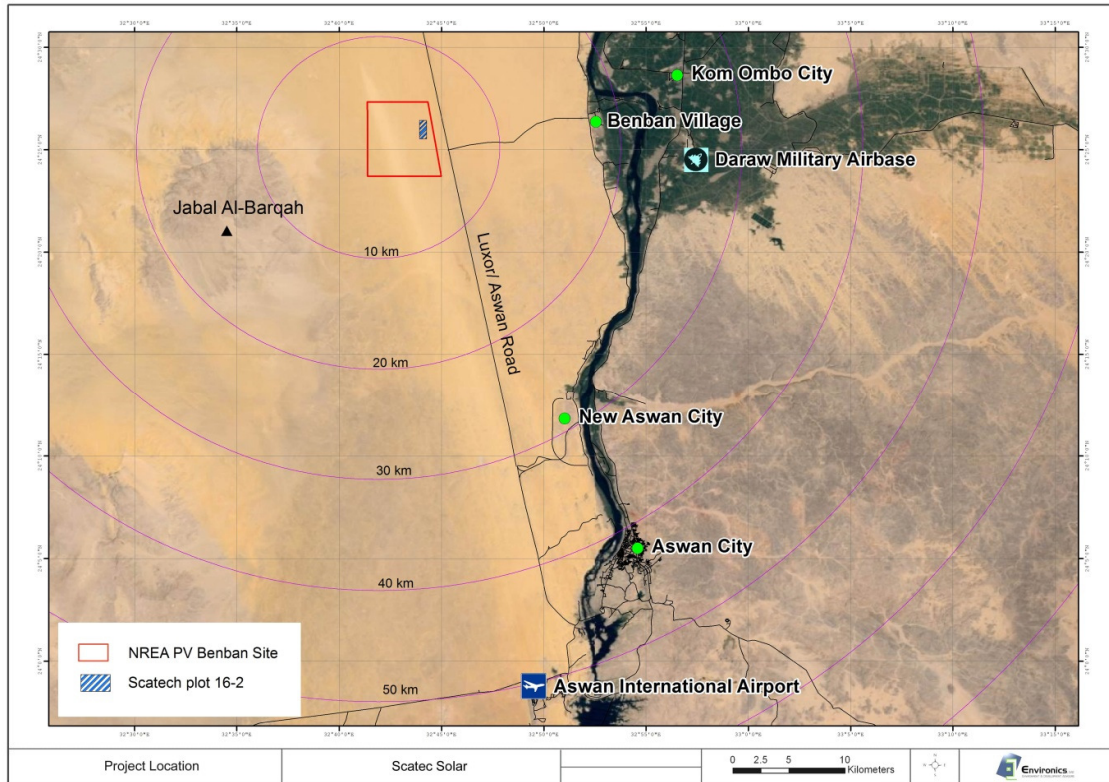


Figure 3-1: The Project and Surrounding Activities

The proposed project will occupy the parcel SBN-(16-2). Currently, the site within Benban PV park is surrounded by empty undeveloped land plots that have been designated for other developers. In the future, the site will be surrounded by other PV plants. Benban village is located at distance of about 15 km from the solar park premises. Kom Ombo city and Daraw military Air base located at about 25 km eastern the solar park premises. Figure (3-2) shows the location of Aswan PV site within the solar park.

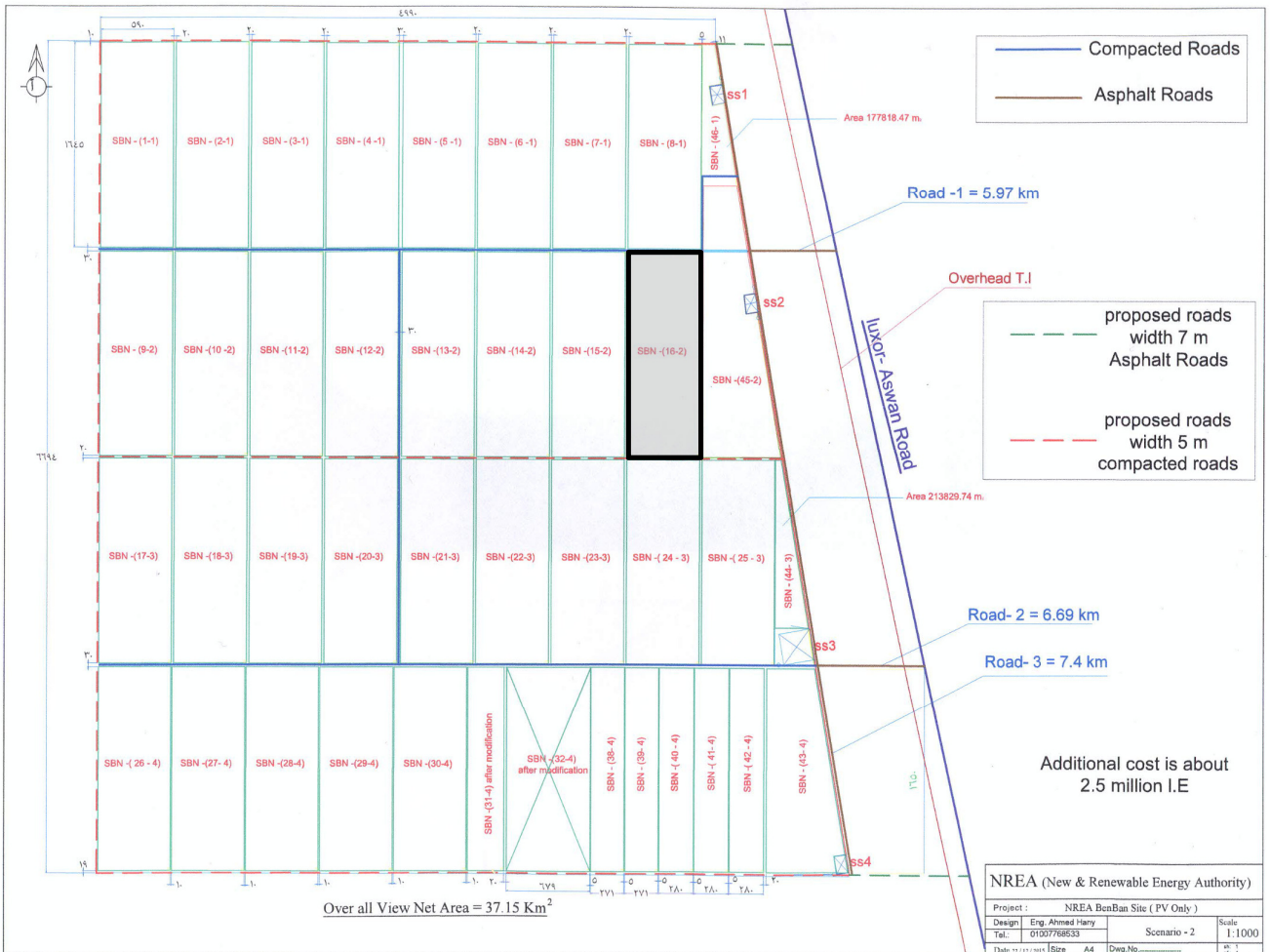


Figure 3-2: Scatec Solar - Aswan Project (plot 16-2)

3.3 Process Description

3.3.1 General Outline

NREA is planning to construct four substations to connect the electric power produced by the individual PV plants within Benban complex to the national grid. The proposed project is one of these utility scale and grid connected plants.

The proposed project comprises three broad components as follows:

- **Solar Field (PV Modules):** The solar energy conversion to electricity takes place in a semiconductor device that is called a solar cell. A number of solar cells are connected together to form a PV module (solar panel). These are the heart of the PV system.
- **Electro and electromechanical equipment:** The electric current produced by the PV modules is DC current, which is transformed to AC current through the inverters. In addition, transformers and switchgears are used to control the power output of the solar modules.
- **Connection to the grid:** The project is a utility scale type and will be directly connected to the National Grid through lines and substations to be established by NREA/EETC.

The following sections address the process description of the proposed project.

3.3.2 Solar Field

The project involves installation of a 50 MWac capacity solar field plant.

- **Solar Field Technologies and Positioning**

PV module technologies can be classified into three categories depending mostly on the module manufacturing technology and/or the main material type and grade employed in producing PV modules. These categories are:

- Mono and Poly Crystalline Silicon
- Thin-Film Silicon
- Compound Thin-Film

The project will utilize Poly Crystalline Silicon PV modules.

- **Orientation of the Modules with Respect to the Angle of the Sun**

For optimal performance, PV systems aim to maximize the time they face the sun. In static mounted systems modules are often set to latitude tilt, an angle equal to the latitude. To continuously orient the panels towards the sun, the project will adopt a single-axis horizontal tracking system.

Approx. 210,000 pieces of 320 Wp Poly Crystalline Silicon modules will be installed. PV modules will be installed at single-axis horizontal tracking system that has a maximum height of approx. 3.5 m at $\pm 45^\circ$ turning angle range. The following table describes the PV module.

Table 3- 1: Module Description

Module Type	Polycrystalline silicon (72 cells)
Module Voltage Rating	1500 V
Number of Modules per string	32 modules
Module maximum power rating	320 Wp
Number of strings	6544 strings
Number of modules	209,408 modules

It is worth mentioning that no or only limited leveling of original topography is considered and adequate spacing according to local topographic conditions will be kept between the PV arrays in order to limit the effect of shade.

3.3.3 Electric Equipment

After combining the DC current produced from the solar field stage (PV modules), power production mechanism takes place through the following electrical equipment:

- **Inverters**

Inverters will convert direct current (DC) from the combiner boxes to alternating current (AC) and are to be constructed by Scatec. The project will use 16 inverters of 3,333 kVA each one. The LV transformer will elevate the incoming voltage from 400 V to 22 kV.

- **Switchgear**

Once the current is converted into AC 22 kV, the energy will be conducted to the plant switchgear, which is a circuit breaker that protects the downstream circuits against short circuits, over-loads and other electrical faults.

3.3.4 Connection to the Grid

As mentioned before, and as part of the interconnection installations, it is planned by EETC to build substations to receive the electrical production from the PV plant (22 kV) and to elevate to the line voltage to 220 and 500 kV respectively.

Figure 3-3 shows the electrical block diagram of the project.

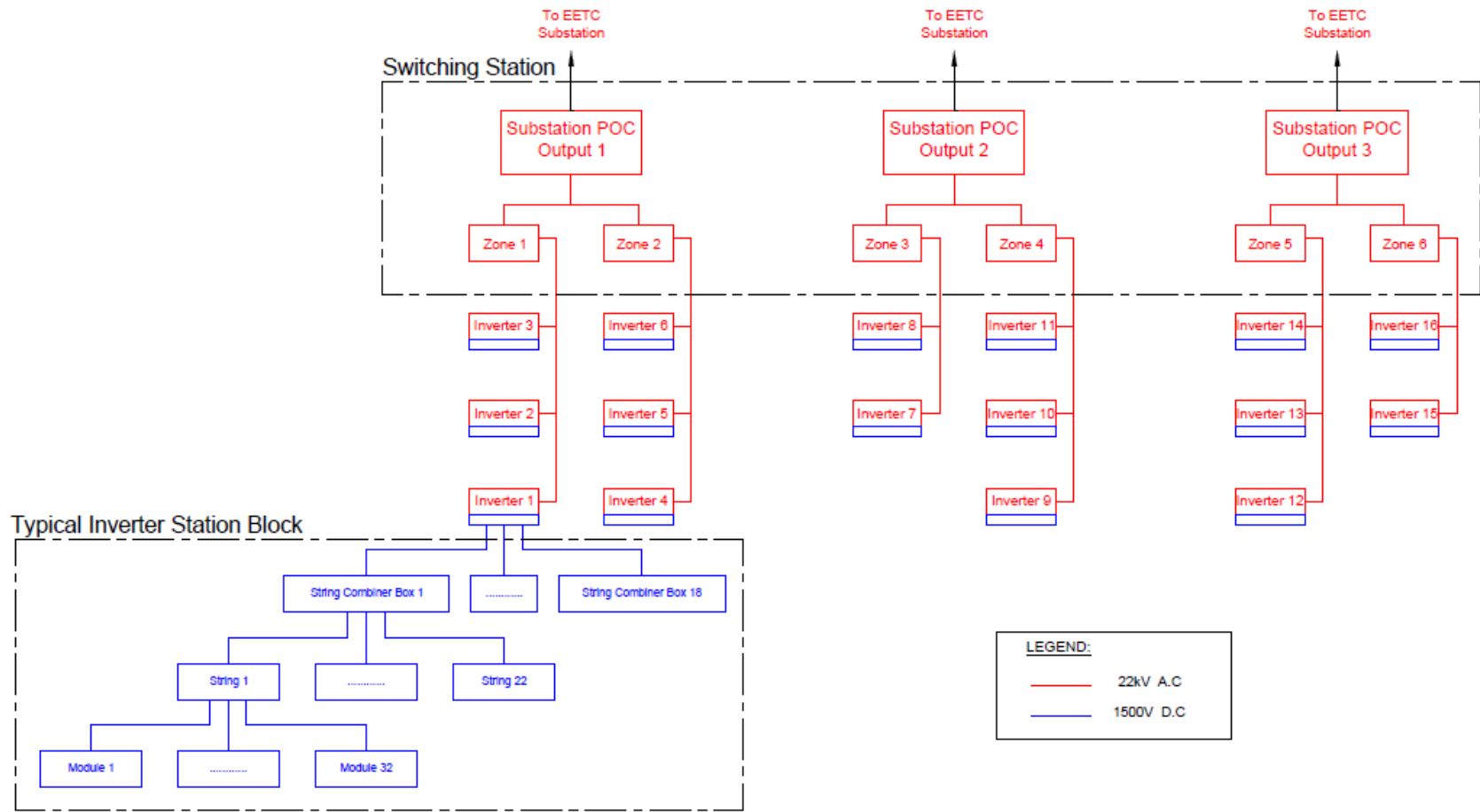


Figure 3-3: Project's Electrical Block Diagram

3.4 Requirements during Construction and Operation

3.4.1 Buildings and constructions

The project will require various utility units, including temporary and permanent installations such as:

- **Temporary buildings (during construction)**

During construction phase, the following facilities are required on site to service employees, contractors and employer's representatives (laydown areas).

- Offices for the employers (air-conditioned)
- Prayer rooms
- Warehouses
- Mess / eating facilities
- Sanitary facilities

When the construction work is completed, all such temporary structures and facilities will be removed from the site and areas disturbed by those structures and their use will be restored to a condition at least equal to their original, undisturbed condition.

Temporary external facilities such as storage area or accommodation might be built or rented outside physical project boundaries but within responsibilities of the project. Nevertheless, priority for equipment storage will be given to laydown areas on site. Whereas for accommodation priority will be given to existing housing and other facilities.

- **Permanent buildings (for Operation)**

For the operation phase, permanent buildings will be constructed at site to house employees and operation and maintenance (O&M) activities. The buildings will either be prefabricated or brick constructed. Some facilities set up within construction phase will be used in operation phase as well. The following facilities will be constructed;

- Warehouse facilities with an area of approximately 100 m²
- Secured control room with an area of approximately 10 m²
- Secured server room with an area of approximately 8 m² (air-conditioned)
- Facilities at security gates with an area of approximately 12 m²
- Meeting room facilities with an area of approximately 15 m²
- Offices (air-conditioned)
- Kitchen/mess area
- Segregated sanitary facilities with provisions for disabled persons
- Prayer room with an area of approximately 24 m²

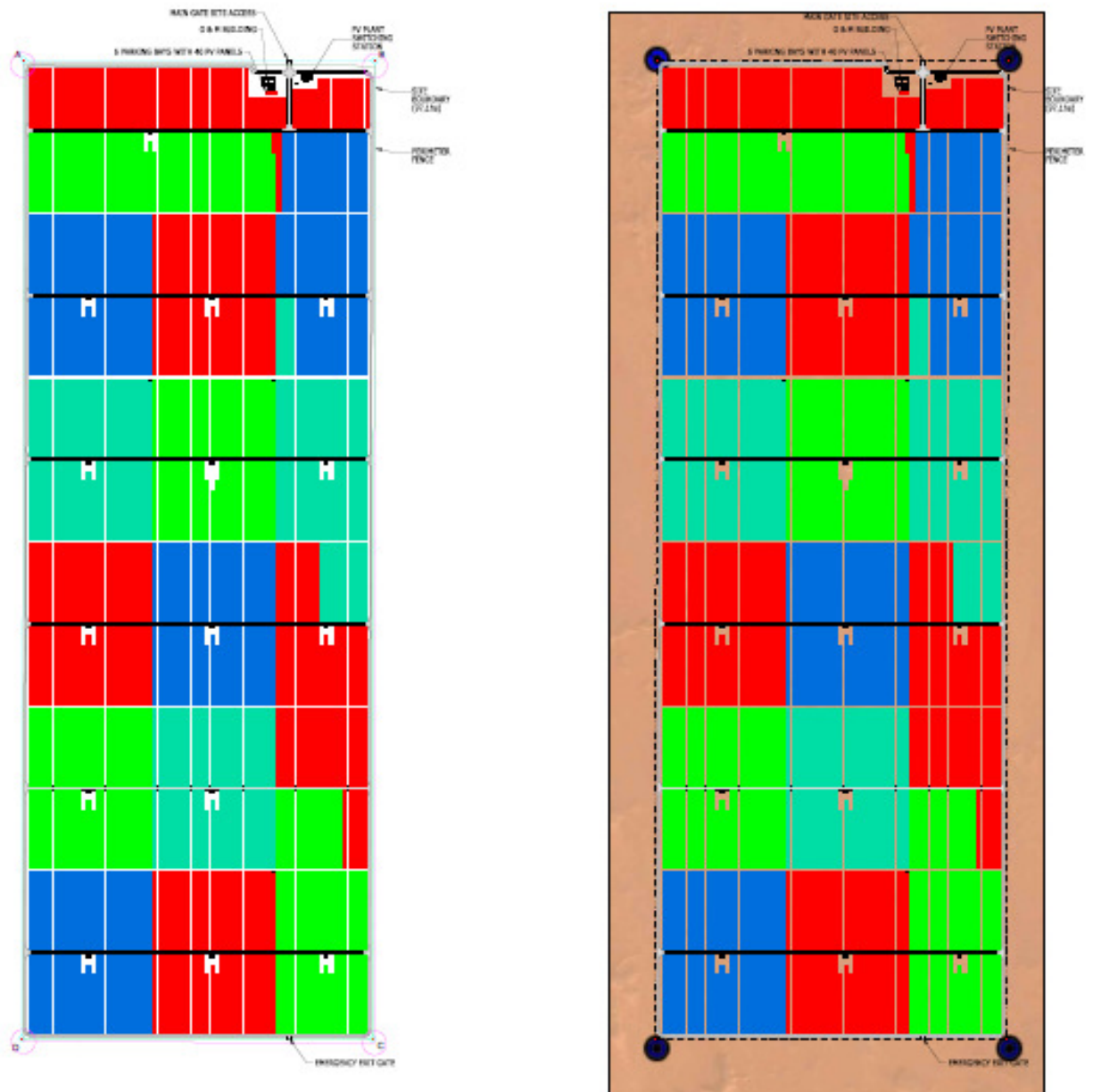


Figure 3-4: Buildings' location within the project area (different color of modules indicates sections being connected to different inverters)

3.4.2 Water and wastewater tanks

- Water required for activities and sanitary purposes during construction phase will be supplied from trucks and stored in a constructed or prefabricated tank on site. The tanks will be located close to sanitary and eating facilities. The daily consumption is expected to be 30-60 m³/day during construction and the max capacity of the tank and associated infrastructure is planned to be 150 m³. If premixed concrete is preferred, the water requirements on site will be less than stipulated above.
- Drinking water for workers will be provided separately.
- During operation, the same tank will be used to store water required for sanitary purposes and domestic use. The water will be trucked to site when needed. The consumption on site is expected to be limited to 10 m³/month, as the method used for regular cleaning of PV modules will be dry cleaning. Occasional water cleaning (approximate twice a year) will require higher volumes in the range of 100 - 200 m³.
- Sewage tanks will be used for the wastewater collection within the project site during construction and operation. The sewage tanks will be located close to the O&M building and other strategic places such as eating facilities. They will be unloaded by external contractors authorized by the governorate for WW disposal. The generated wastewater will be unloaded by external trucks of authorized WW contractors.

There will be no discharge from the PV cleaning process as the wastewater from PV cleaning process, will evaporate or drain during the cleaning.

- **Fire protection;** In addition to fire extinguishers located on site the water storage shall be used as water reservoir for any fire protection purposes¹ Fire protection plan for the site is to be approved by the Civil Defense Authority.

3.4.3 Diesel and fuel tanks

Diesel will be used to power generator(s) for construction works and emergency power during operation phase, and will be stored in a 1,500 litre "Above ground Storage Tank" (AST).

During operation, this tank will also be used for storing diesel for operating tractors for cleaning the PV modules. The fuel is expected to be provided through a subcontractor.

Part of the generated energy during operation will be directed to the lightning system and buildings and the tracking system.

¹ According to the labor law (12/2003), firefighting measures and plans have to be devised by the company. This plan has to be approved and reviewed by the civil defense authority.

In addition, there will be an off-grid solar PV system for backup power and UPS including battery storage for supplying SCADA system, weather station and emergency lighting in the O&M building.

3.4.4 Labour

The direct labour force required for the project construction will be in the average of 600 to 800 workers, including skilled and unskilled persons. The company will encourage contractors to hire most workers from local communities.

Permanent employees on site are expected to be from 5 to 7 individuals. According to the company's employment policy, preference will be given to workers from neighbouring areas, depending availability of suitable qualifications.

3.5 Construction Activities

3.5.1 Main Activities and Schedule

According to the determined timeframe, the project will be delivered after about 17 months upon obtaining all the necessary permits and approvals, starting late July 2016. Sub-EPC works including site facilities, civil, electrical and mechanical works are expected to take about 11 months.

Major on-site activities will include civil works, construction of buildings, installation of equipment and utilities, testing and commissioning of equipment.

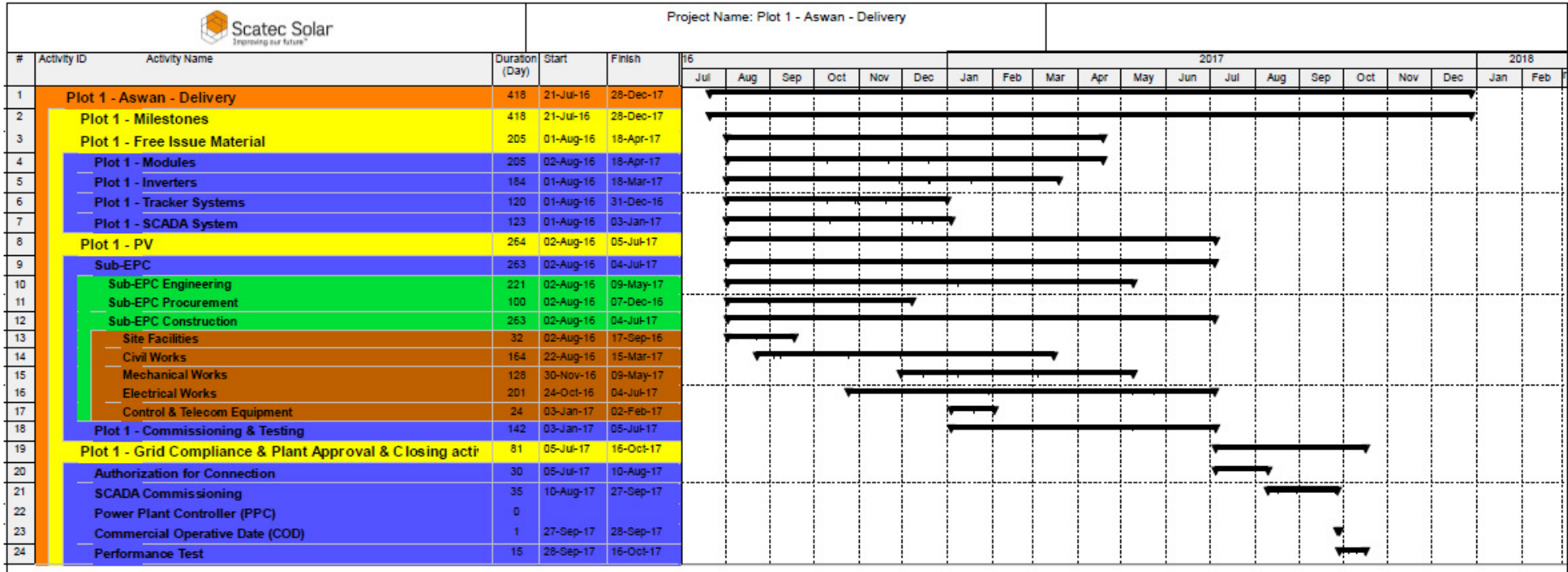


Table 3-2: Construction Schedule

- **Site preparation**

The following activities will be implemented during the site preparation stage:

- Site survey and geotechnical investigations will be conducted to prepare the site for construction.
- Clearing the site of rocks, vegetation, levelling the ground.
- Ensuring that adequate space is provided for satisfactory operation and maintenance of the plant items.
- Complying with drainage requirements with minimum site preparation costs.
- On site soils testing of all foundation compactions.
- Warehouse and temporary storage area preparation
- Concrete works
- Water and sewage pipes
- Underground sewage tank

- **Access roads & entrances**

Roads related to the project and constructed by Scatec Solar are:

- Internal roads for handling construction equipment (construction material: tar or gravel) and operation activities
- Perimeter roads for handling traffic and as a firebreak (construction material: gravel)
- Roads of the solar field will consist of compacted site material and gravel capable of support of the transit loads during construction and operation.

Roads related to the project and constructed by NREA are:

- Four External access roads (construction material: tar and gravel) (s. updated road map in Figure 3-2)
 - Clean surface material will be reused to the most possible extent for road filling and will be provided on site.

- **Storm water and site drainage system**

Flood investigation study has been carried out for the proposed project, it indicated that the area is subject to flood impacts that may occur from several drainage basins. The results of the hydrological study are discussed in Chapter 5. Subsequently a drainage and protection system has to be built during construction phase including the following:

- Design and size the site drainage system for the storm event.
- Grade the site so that storm water will not accumulate in the solar field and/or any part of the project.
- Design the system to help keep the areas within the project area limits functional.

- **Fencing and gates**

The perimeter fence height will be minimum 2 meters above grade and have climb-over protection. Gates will be sliding and remotely controlled.

3.6 Operation Activities

Operation activities are mainly due to maintenance and control of the PV panels, such as:

- Preventive maintenance
- Regular production measurements
- Monitoring
- Identification of any physical damages

3.7 Emissions and Wastes

Construction operations may generate gaseous emissions, liquid effluents, noise and solid waste as listed below. These might have an impact on the surrounding environment and are assessed thoroughly in chapter 5.

- **Noise**
The main noise sources during construction include transport vehicles, heavy equipment, and cutting machines and vehicle movement.
- **Air Emissions**
Air emissions during construction phase include smoke, fumes, exhaust gases and dust from transport vehicles, site clearance, excavations and filling, construction and transportation of construction materials.
- **Wastewater**
The generated wastewater will be unloaded by external truck of authorized WW contractors.
- **Solid Waste**
Non-hazardous solid wastes will include:
 - Packaging and wood scrap waste
 - Unused construction materials, off-cuts from piping and cabling bulks;
 - Civil wastes such as sand, cement, bricks, aggregates, steel parts, aluminium, wood, etc.
 - Municipal solid waste from workforce, offices and administration buildings.

The solid waste will be collected by a licensed contractor for safe disposal through the approved sites.

During operation phase, non-hazardous solid wastes will include mainly municipal solid waste from workforce, offices and administration buildings. The solid waste will be collected by a licensed contractor for safe disposal through the approved sites.

Potential hazardous wastes from the operation phase include mineral oils and transformers cooling oils. These will be temporarily stored in designated area inside tightly closed barrels and finally disposed through Petrotrade Company²

² Petrotrade is the company authorized by the Egyptian General Petroleum Company for collection and treatment of waste oil from industrial activities.

4. Environmental and Social Baseline

The content of this chapter is based on review of the available and publicly accessible documentation addressing the relevant environmental aspects of the project in addition to site visit and ecological survey in 28th of July 2015 and 11th of November 2015. The environmental baseline addresses the following issues in particular:

- **Physical Environment**
- **Biological Environment**
- **Socio-economic characteristics**

The environmental baseline also aims to provide assessment of the environmental sensitivity at and/or surrounding the Project site and potential hazards of the whole PV park study area.

4.1 Physical Environment

This section provides a description of the current main physical environmental components at the project area including climate and meteorology, air quality and noise, as well as infrastructure such as road and electricity. The aim of presenting these data is providing benchmark analysis of the status of these components before commencing the project activities to provide information for decision makers as well as secure reference conditions for future environmental monitoring/audit, if any.

The project site within the proposed PV park, it is located in the desert in south Egypt, approximately 50 km the north of Aswan airport, 20 km west of the city Kom Ombo, and 17 km west of Benban Village, which is the nearest residential area. The site is approximately 4 km from the paved Western Desert Highway Luxor-Aswan. The following table shows the project site coordinates.

Table 4-1: Project Site Coordinates

Point	Latitude (North)	Longitude (East)
1	24° 26' 25.407''	32° 44' 16.155''
2	24° 25' 31.921''	32° 44' 16.145''
3	24° 25' 31.924''	32° 43' 55.198''
4	24° 26' 25.409''	32° 43' 55.206''

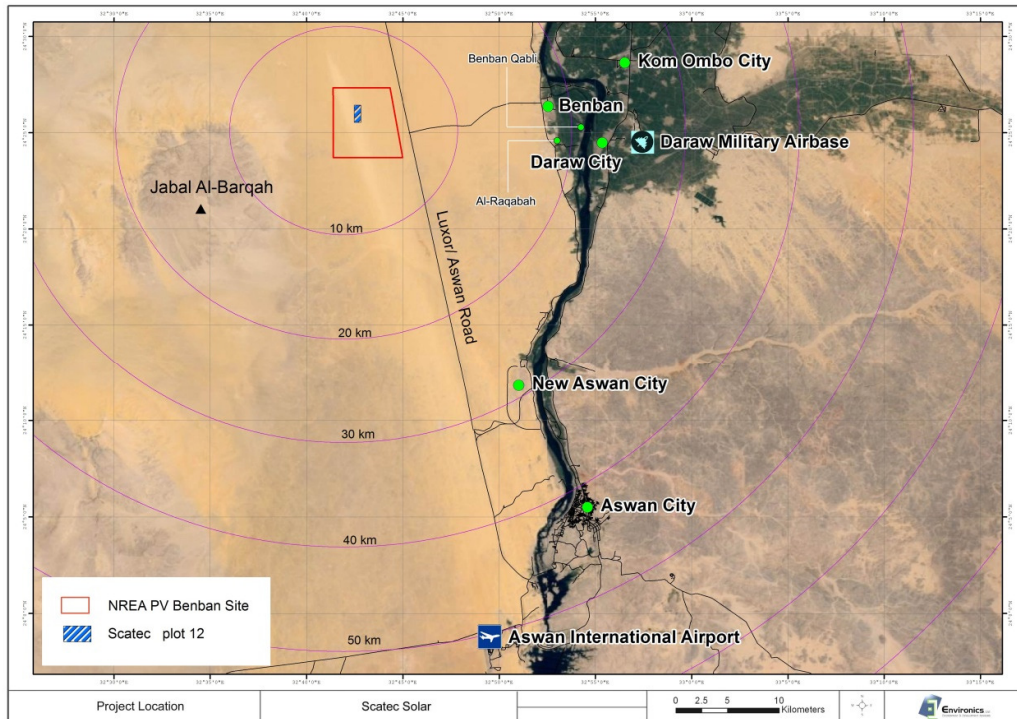


Figure 4-1: Location and surrounding area of the proposed Benban PV plant. The project site is marked with blue hatching

4.1.1 Climate

The climatic and meteorological data presented herein were obtained from the closest station located in Aswan. The study area is located within the Western Desert, and accordingly is characterized by hyper-arid conditions. The climate is generally extremely dry, bright and sunny year-round, with annual average of rainfall about 1.9 mm and averages high temperatures are consistently about 32.5 °C according to Aswan meteorological station, Egyptian Meteorological Authority in 2011, as shown on table (4-2).

Table 4-2: Climate Indicators of Aswan station

Annual average of air temperature	25 °C
Annual maximum average of air temperature	32.5 °C
Annual minimum average of air temperature	17.5 °C

Source: Aswan meteorological station, Egyptian Meteorological Authority, 2011

a) Wind

The prevailing wind is NW-NNW, which dominates most of the year. Generally, the wind speed varies between 15.37km/h in December and 17.41km/h in April. During winter season at Aswan, the wind speed varies between 15.37 and 17.41 km/h, while in summer season it varies between 16.11 and 16.85 km/h, as shown on the following table.

Table 4-3: Monthly average of Wind Speed

Month	Wind Speed (km/h)
January	16.11
February	16.85
March	17.41
April	17.41
May	16.85
June	16.85
July	16.30
August	16.11
September	16.67
October	16.48
November	15.56
December	15.37
Average	16.48

With regards to sand storm events the table below presents the monthly average sandstorm days within the range of Aswan meteorological station over 30 years, 1981-2010 (a full climatic cycle).

Table 4-4: Monthly Average Sandstorm Days:

Month	Jan	Feb	Mar	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec
No. of days (day/month)	0.23	0.4	0.9	1.1	0.9	0.03	0.07	0.27	0	0.13	0.1	0.03

*Data provided based on the meteorological records of Aswan covering an area with radius of about 50km for wind speed above 25knots/sec (above 12 m/sec) **Source: Egyptian Meteorological Authority (EMA), 2016**

b) Temperature

January is the coldest month, where it has the minimal air temperature throughout the year about 9.5 °C, while July is the hottest month and the air temperature reaches its maximum value of about 39.5 °C. Table 4-5 and its illustration in figure (4-2) shows the monthly distribution of monthly maximum, minimum and average air temperature in Aswan from the Egyptian Meteorological Authority.

Table 4-5: Monthly maximum, minimum and average of air temperature

Month	Minimum (°C)	Maximum (°C)	Average
January	9.5	23.5	16.5
February	10.5	25.5	18
March	13	28	20.5
April	17.5	33	25.25
May	20.5	37.5	29
June	23	39	31
July	24.5	39.5	32
August	24.5	39	31.75
September	22.5	37	29.75
October	19	34	26.5
November	14.5	28.5	21.5
December	10.5	24.5	17.5

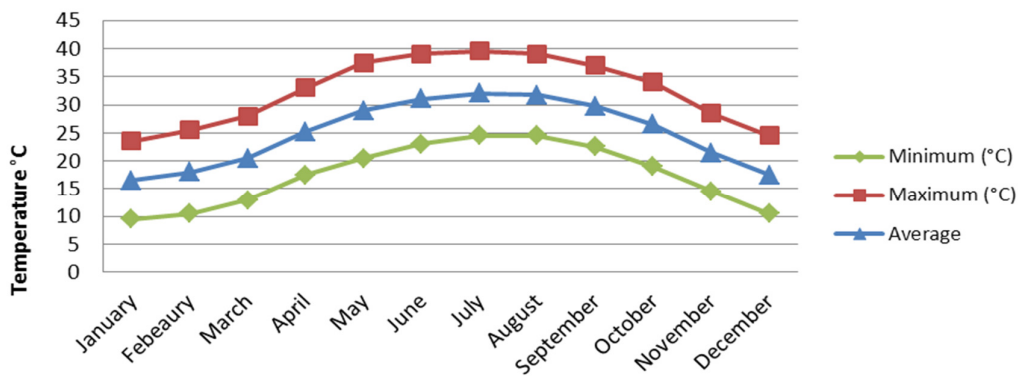


Figure 4-2: Monthly maximum, minimum and average of air temperature

c) Rainfall

In general rainfall doesn't occur every year and the average rainfall over the year is less than 2 mm/year. Based on the flood Atlas for Aswan governorate, the rainfall frequency analysis of Kom Ombo station, which is the nearest metrological station to the PV park, were used to estimate the maximum daily rainfalls for 2, 5, 10, 25, 50 and 100 year return period. Accordingly, estimated rainfall values for the required years are presented in Table 4-6) below. These rainfall values have been used as an input to the hydrological model in order to estimate the flood hydrograph within the hydrological study presented in Annex 2 of this ESIA report.

Table 4-6: Results of the statistical analysis of the rainfall data at Kom Ombo station

Flood return period (Year)	2	5	10	25	50	100
Rainfall values (mm)	4.82	7.22	10.9	19.4	29.1	43.7

d) Global Solar Radiation

An accurate knowledge of solar radiation distribution at a particular geographical location is of vital importance for the development of any solar energy devices and for estimates of their performances. Global radiation is the total short-wave radiation from the sun falling onto a horizontal surface on the ground. It includes both the direct solar radiation and the diffuse radiation resulting from reflected or scattered sunlight.

The Solar Atlas was issued in 1991¹ by NREA and the United States Agency for International Development (USAID), indicating that Egypt as one of the sun belt countries is endowed with high intensity of direct solar radiation ranging between 2000 – 2600 kWh / m² / year from North to South. The sunshine duration ranges between 9 – 11 hours with few cloudy days all over the year.

Figure (4-3) shows the direct normal irradiation over Egypt, high irradiation values can be observed in the project site.

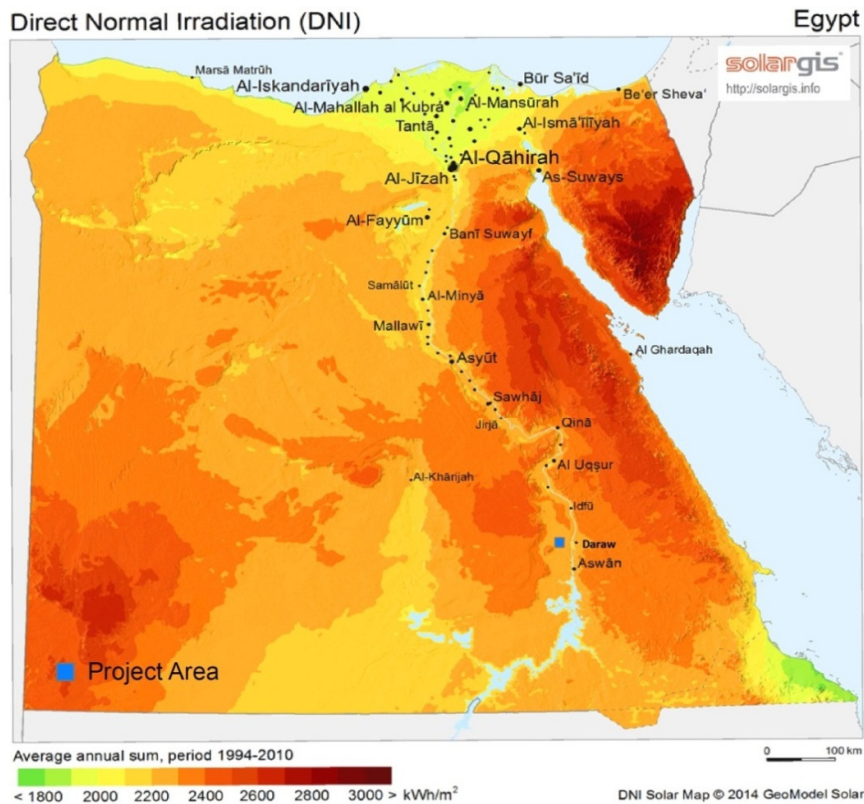


Figure 4-3: Solar Map of Egypt

¹ New and Renewable Energy Authority (NREA), Ministry of Electricity as part of the Renewable Energy Testing Project initiated and managed by NREA and the US Agency for International Development (USAID) 1991

The project site is expected to receive an annual irradiation of 2,289.8 kWh/m²/year.²

e) Evaporation

The evaporation rate is generally high in Aswan, with a maximum of 19.3 mm/day in June and a minimum of 6.3 mm/day in January.

f) Relative Humidity

The average relative humidity is 25.25% over the year (Table 4-7). It fluctuates according to the air temperature and wind conditions.

The relative humidity pattern refers to the presence of two summits through the year in Aswan during January, and December. The average relative humidity varies between 16% during May and 40% during December, as shown on (table 4-7).

Table 4-7: Monthly averages of relative humidity

Months	Average Relative humidity (%)
January	39
February	30
March	23
April	18
May	16
June	16
July	18
August	20
September	22
October	26
November	35
December	40
Average	25.25

4.1.2 Geomorphology, Geology and Hydrology

a) Surface Topography and Geomorphology

The area is mostly flat lowland with the presence of a few sand dunes ranging between 2 to 4 m high. Elevation in the project site varies between 159 and 164 meters above the mean sea level. The project site is located 50 km north-west of Aswan City, and it can be accessed through Aswan suspension bridge, which links eastern and western parts of Aswan city, for 10 km, then another 34 km along the northern-west side of Aswan suspension bridge. Proposed roads (dusty paths), in the study area, are located at intervals ranging between 3 and 7 km, west of the western desert highway.

² According to Scatec, calculated from GHI Average from Meteonorm7, SolarGIS, PVGIS and Kom Ombo CSP

Mountain Jabal El Barqah is located at about 13 km west of the project site. The rock unit is fragmented sandstone with interventions of gravels and conglomerate.

The study area is located within the upper unit of the Nubian sandstone Table (4-8).

Nubian sandstones are widespread along the western side of the Nile Valley. While on the Eastern site, Nubian sandstones start narrowly to show north of the High Dam surrounded by igneous and metamorphic rocks; then sandstones start to show up again. The Nubian Sandstone consists of alternating beds of sandstone and clay. The clay beds are laterally discontinuous and separate. The sandstone is separated into a multi-layered aquifer system, bounded below by impervious basement rocks. The Nubian Sandstone is occasionally overlain by impervious rocks and interbedded by clays. The thickness of the sandstone system ranges between 500-1000m near the Sudanese borders and in regions north of Kharga Oasis, 500-2000m in Farafra and 500-3500m in regions south of Siwa. The regional salinity distribution shows a decrease of salinity towards south from highly saline in the north to fresh water in the south with average salinity of less than 1000ppm.

Table (4-8) shows the characteristics of main aquifer systems of Egypt. The proposed PV project is located within the Kharga aquifer system, as shown in Figure (4-4) below.

Table 4-8: Characteristics of main Aquifer Systems of Egypt

Name of aquifer	Type locality	Depth of top aquifer (m)	Saturated thickness (m)	Depth to water table (m)	Hydraulic conductivity (m/day)	Porosity (%)	Salinity (ppm)	
Granular rocks								
Nile Valley and Delta aquifer	Nile Valley	0-20	10-200	0-5	50-70	25-30	<1,500	
	Nile Delta (south)	0-20	100-500	0-5	50-100	25-30	<1,500	
	Nile Delta (north)	20-100	500-1,000	0-2	<50	>30	>5,000	
Coastal aquifers	Mediterranean	0	<5	±15	15-25	>30	1,000-6,000	
	El-Qaa plain	50-100	60-80	50-70	5-10		600-2,500	
	El-Arish aquifer	15-30	40-50	0-30	5-20		1,500-6,000	
Nubian Sandstone	Western Desert							
	Kharga	50-200	500-700	0-30	2-4	20	<1,000	
	Dakhla	200	500-1,000	0-20	6-7	20-25	<1,000	
	Bahariya	150-300	1000-1,500	0-20	5-10	20-40	<1,000	
	Farafra	200-500	1000-2,000	Flow	2-5	20-30	<1,000	
	East Oweinat	10-20	100-300	20-30	10-20	20-30	<1,000	
	Nile basin fringes							
	Qena area	100-250	500	Flow	1-2		2,000-2,500	
	Laqeita area	100-500	200-400	Flow	1-3		1500-2,000	
	Eastern Desert							
	Esh El Mallaha	0-30	>200	Flow			3,000-4,000	
	Nubian Sandstone	Sinai						
		Nakhla	1000	2,000	200			1,500-2,000
Oyun Moussa		100-500	1,500	Flow			1,000-4,000	
Mohgra aquifer	Natron/Qattara	0-200	500-900	100		20	1,000-1,2000	
Fissured rocks								
Carbonates	Wadi Araba	0-100	500	Flow			1,000-1,2000	
Hard rocks	South Sinai	0-50		+50			1,000-2,000	

Depths are measured from ground surface

Source:: Goundwater of Egypt” an environmental overview, M.R.El Tahlawi, A.A. Farrag, S.S. Ahmed, Environ Geol, 2007
Groundwater Assessment in Egypt, K.Hefny, M. Samir Farid, M. Hussein, Planning for Goundwater Development in Arid and Semi Arid Regions, Round Table Meeting October, 1991.”

The strategic impact assessment study, SESA indicated that wells drilled by farmers in the wider area of the project site at a short distance east of the south-eastern corner of the Benban site showed that the groundwater level might be at 245m below surface, producing slightly brackish water³. Recent groundwater analysis performed in February 2016 by the Health Directorate Regional Laboratory of Aswan Governorate indicated that the microbiological characteristics of the groundwater are complying with the national drinking water guidelines (Law 458/2007), however, it is exceeding the allowable limits regarding the chlorides and TDS. The table below presents the groundwater analysis results compared with the regulatory allowable limits.

³ Specific well location and was not indicated

Table 4-9: Results of Groundwater Analysis from a nearby well

Parameter	Analysis Results	Maximum allowable limits mg/l
pH	7.6	6.5-8.5
Turbidity	9.4 NTU	1 NTU
Dissolved salts at 120 ⁰ C	1766	1000
Total alkalinity	340	
Total hardness (as CaCO ₃)	110	500
Sulphates (SO ₄)	69.8	250
Chorides (Cl)	650	250
Iron (Fe)	0.1	0.3
Magnesium (Mg)	14.4	
Calcium (Ca)	20	
Total bacteria count		<ul style="list-style-type: none"> - Not exceeding 50cell/cm³ at 37⁰C for 24 hrs - Not exceeding 50cell/cm³ at 22⁰C for 48 hrs
Total coliform		<ul style="list-style-type: none"> - 95% of the samples up to 100cm³ examined /year should be totally free of coliforms - No sample should exceed 2 cell/100 cm³ provided that this limit does not occur in two successive samples form one sampling source.
Microscopic examination		- Totally free of living protozoa

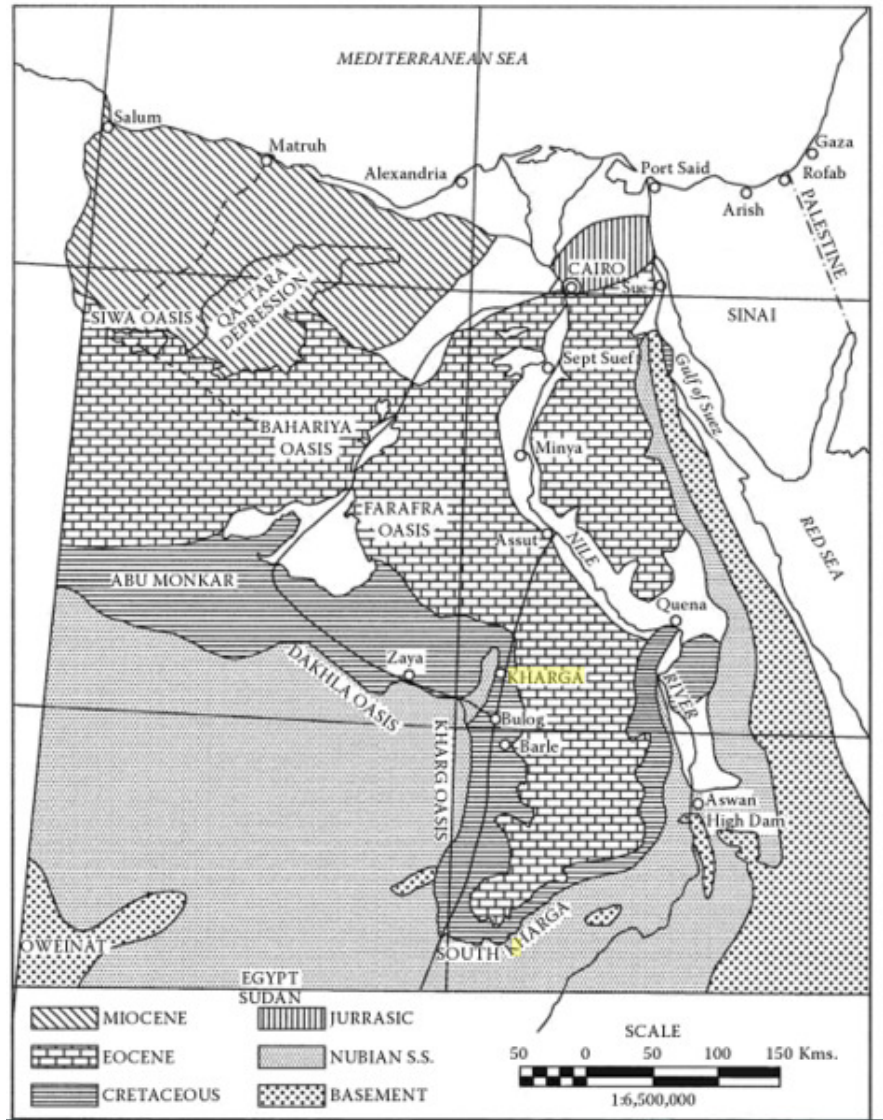


Figure 4-4: Geological map of the project area

Source: Environmental Hydrogeology, Second Edition 2nd Edition by Philip E. LaMoreaux, James W. LaMoreaux, Mostafa M. Soliman, Bashir A. Memon, Fakhry A. Assaad, 2009

To the north of Daraw, there is a wide valley on the western side of the Nile surrounded by wavy sandstones. On the eastern side, there are sand dunes in Kom Ombo plain in the form of a semi-circle or a large arc starting from New Balana, New Toshka and Enaiba (which represents the middle of the arc) passing through Ibeem and Nasser till its final destination at Al-Selsela mountain with vertical ridges at both sides of the river.

Loose sand sediments are widespread, and formed as a result of erosion factors that disintegrated sandstones, covering the surface of the area. When wind blows, it carries such sand over a long distance to deposit it, when it gets weaker, behind the isolated heights or at the top of plateaus and dunes interrupting such winds. When sand settles during the journey, it takes the forms of waves or dunes. Resulting shapes are small waves ranging between 1 cm and 2 meters (Mahsoub 1984 p.115).

The soil is well-sorted sand. Followed by consecutive sedimentations of boulders, conglomerate and gravel with a bonding material containing ferrous oxides show up. The following table (**Table 4-10**) shows results of the geological survey of soil samples in Benban area.

Table 4-10: Soil Characteristics in the study area

Sample location	Depth (cm)	Clay %	Silt %	Fine sand %	Coarse sand %	Calcium carbonate	Dissolved salts
Benban Bahary (West of Daraw)	0 - 30	7.5	2.5	31.29	55.68	2.78	2.25
	30 - 60	6	3.5	31.22	55.33	3.73	0.22
	60 - 100	2.5	1.5	28.81	64.43	2.64	0.12

Annual report of Geological Survey Authority (1954).



Figure 4-5: Some pictures taken during the field visit showing nature of soil at the project site

b) Hydrology and Hydrogeology

The main course of the Nile represents the main source of surface water and is located 18 km east of the project site. No flash flood drains were noticed in the study area during the site visit. However, based on the Flash Flood Atlas for Aswan Governorate⁴ it is indicated that the PV park area is located within an area of low to medium flood intensity⁵ and flood risk as shown in the figures below.

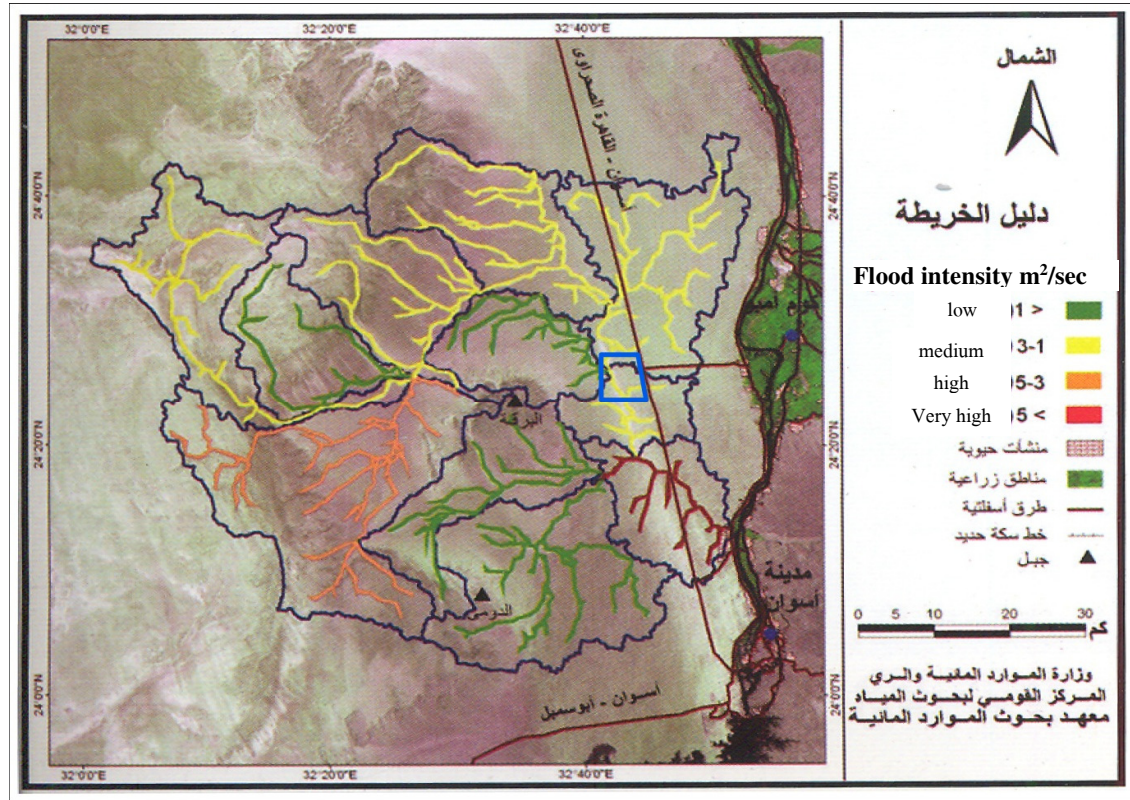


Figure 4-6: Flood Intensity

Source: Flood Atlas for Aswan Governorate, 2012, Ministry of Water Resources and Irrigation

⁴ Flood Atlas for Aswan Governorate, 2012, Ministry of Water Resources and Irrigation

⁵ Flood Intensity (m²/sec) is estimated as a function of two hydraulic parameters; namely flood depth and flow velocity, Flood intensity= flood depth * flow velocity

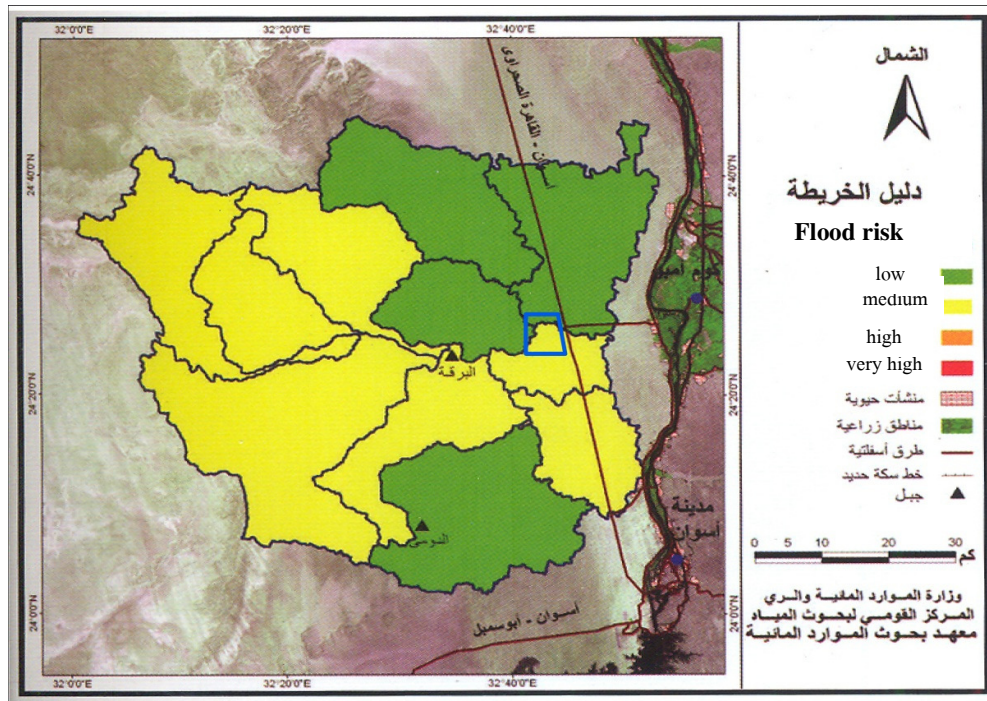


Figure 4-7: Flood Risk

Source: Flood Atlas for Aswan Governorate, 2012, Ministry of Water Resources and Irrigation

According to the hydrogeological map of Egypt, the ground water in the project area is about 50 -200m depth.

4.1.3 Seismicity and Earthquake Hazards

The seismicity of Egypt has been investigated through numerous studies, and is well documented (El-Hadidy, S. et al 2003). During the last century, the 1995 Gulf of Aqaba was the strongest event in Egypt since the 1969 Shedwan Island earthquake. In addition, the 1992 Cairo earthquake was the worst in terms of associated severe damage compared to the other events (Abou El Enein K. M. et al 2007).

Few of earthquakes occurred in the west Kom Ombo area from 1981 to 2003 were recorded.

During the period from Dec. 1981 to July 1982, seven earthquakes were located 25-50 km around Kom Ombo area. The magnitudes of these events were found to vary from 2.3-3.8. Among these earthquakes, 4 were located in the western side of the Nile River, while the rest were located in the eastern side. Some areas such as Kalabsha (60 km southwest of Aswan, approximately 100 km distance to the Benban site) are known to be seismically active. An earthquake in November of 1981 had a magnitude of 5.5 (Helwan station) or 5.1- Richter Scale (NOAA). It was strongly felt in Aswan and in areas to the north up to Assiut and to the south up to Khartoum. (SESA 2016)

In July 1982, during monitoring of the seismic activity in the area, a few number of earthquakes were recorded and located in the western side of the Nile River around the northern end of Gebel el-Barqa fault.

On March 22, 2003 an earthquake (MD 4.0) occurred in the west Kom Ombo area, it was felt in the area and its surroundings, the event was followed by two aftershocks with magnitudes 2.7 and 3.0. Location of the main shock and its aftershocks were determined and they were found near to the northern part of Gebel el-Barqa fault in the Western Desert. The following figure presents the faults and earthquake epicentre distribution in and around the PV park during the period from 1981-2003.

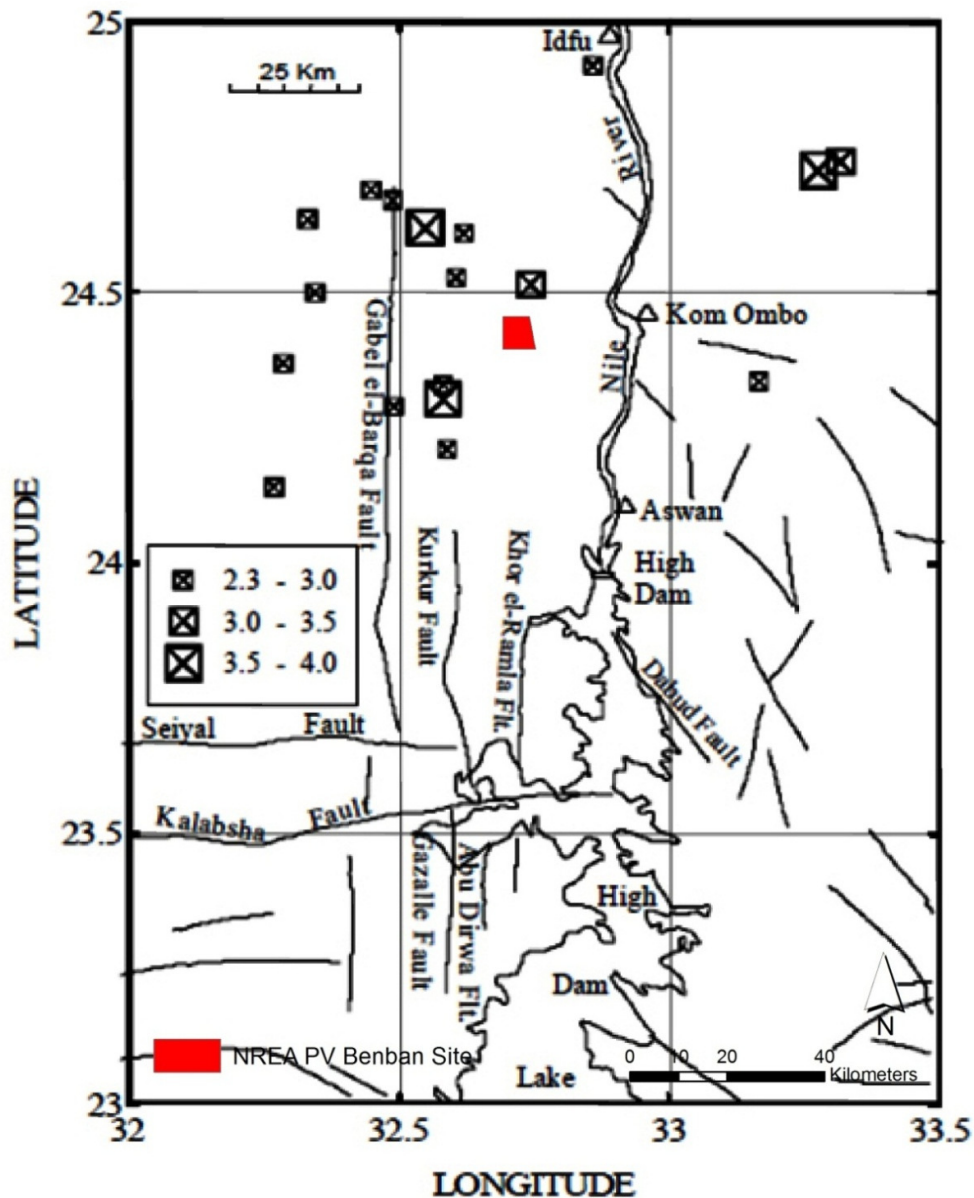


Figure 4-8: Significant faults and Earthquake Epicentre distribution in and around the study area during the period from 1981-2003

Source: Raafat E. Fat-Helbary* And Haggag H. Mohamed., 2004:" Seismicity And ismotectonics Of The West Kom Ombo Area, Aswan, Egypt". Acta Geodyn. Geomater.Vol.1, No.2 (134), 2004

4.2 Biological Environment

4.2.1 Habitats

The main type of habitat present in the project's area of influence is Sand dunes as seen in the following figures. This is composed of desert sandy and rocky plains characterized by variable sheet with gravel interaction, and small plateaus mainly composed of boulders and conglomerates. This represents extreme natural habitats characterized by lack of vegetation and water resources.



Figure 4-9: Sand Dunes habitat in the project site

4.2.2 Flora and Fauna

The proposed project site is located in an arid/extremely arid area, the presence of flora is totally not observed within the project location.

The surveyed project area is located in one of the typical western desert faunal habitats that is mainly composed of sandy and rocky plains and represents extreme habitats mostly without any vegetation and water resources.

Some of the key mammalian species potentially present in these habitats are *Dorcas Gazelle*, *Gazella dorcas*, Red fox, *Vulpes* and *Ruepple Fox Vulpes rueppleii* and other small mammals, which were recorded before in such western desert habitats.



Figure 4-10: Fox trace in the project site

Many of the key avian species are recorded in literature, which represents these habitats such as Passerines including; wheatears, Larks, shrikes and warblers, also, raptors and some species of family Corvidae.

According to the SESA report (SESA 2016), no terrestrial animals or birds were observed during the site visits in 2015, but there are records of a limited number of species observed on the same site during the Kom Ombo CSP study on the same site. There were no fauna databases available. For the CSP study in 2013, the Consultant had conducted baseline surveys in order to assess the presence and distribution of ecologically sensitive species and habitats.

Consequently, it was concluded that no endangered faunal or floral species according to IUCN Red List of threatened species have been recorded at the projects areas. All recorded species are under the Least Concern Category.

4.2.3 Nearest Protected Areas

The nearest protected area to the project location is Saluga and Ghazal Islands which is declared by the Prime Minister Decree number 298/1986 as protected area. The two islands of Salouga and Ghazal in the River Nile are about 3 km north of Aswan dam with total area 0.5 km². The project is located about 40 km from the border of the protected area.

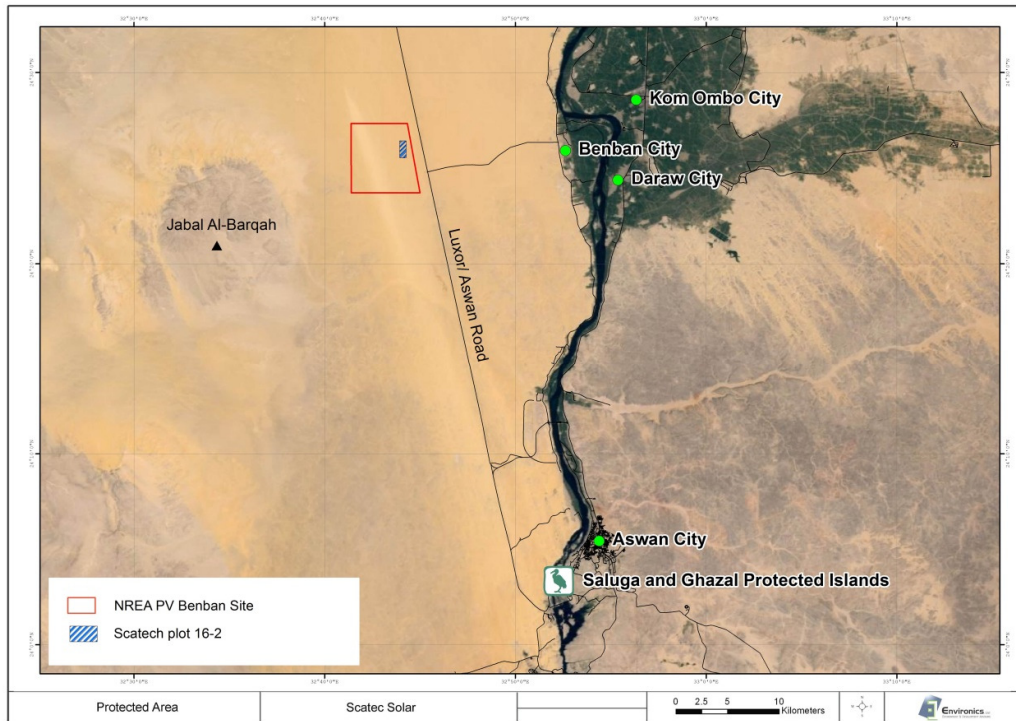


Figure 4-11: Saluga and Ghazal Protected Area

4.3 Socio-economic Conditions

The project is planned to be located in Aswan Governorate- Markaz Daraw approximately 40 km north-west of Aswan city and 15 km from nearest village Benban, near the Luxor-Aswan Road. Benban village consist of three affiliated villages, Benban Qebli, Benban Bahari and El Raqaba villages⁶. Kom Ombo Markaz is the second close urban centre to the PV park at a distance of about 25 km.

⁶ The Administrative Classification of Aswan Governorate, Governorate Information Centre, 2011

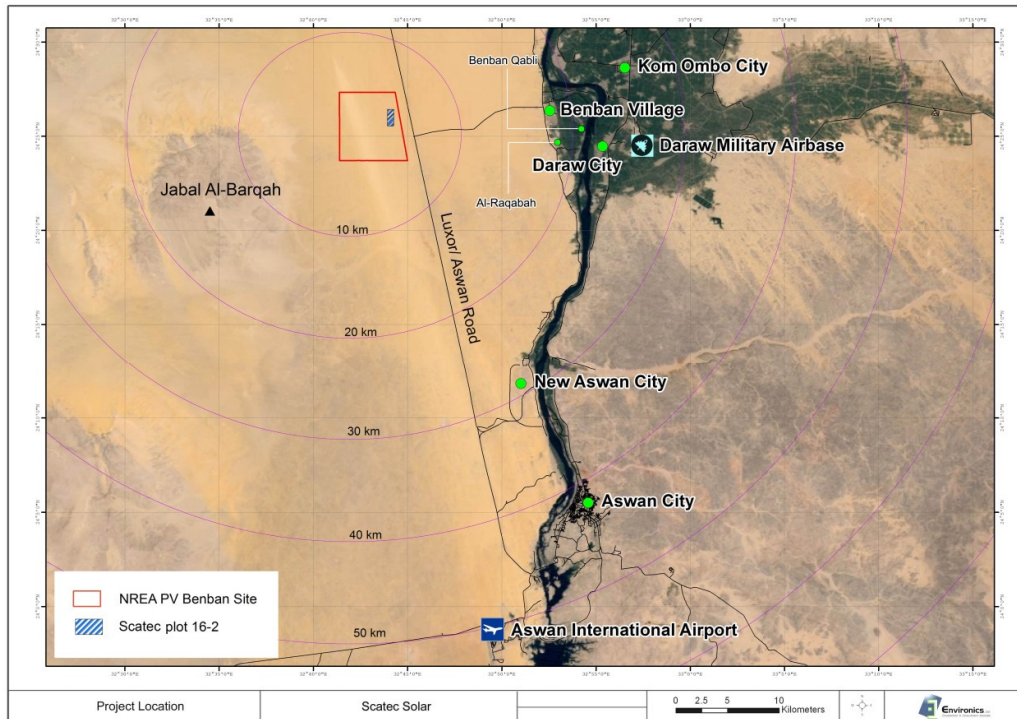


Figure 4-12: Villages neighboring the site

The following section presents the socio-economic data for the Project location and the areas influenced by the construction and operation activities. In this respect it is important to point out that most of the data source presented herein rely on the latest official census data issued by CAMPAS in 2006 (Central Agency for Public Mobilization and Statistics), however, more recent data were obtained through Aswan Governorate Information Centre, although these are not exhaustive and do not cover all socio-economic aspects. In this context, reference for each data source has been indicated in the following text.

CAPMAS data for Markaz Daraw and its affiliated Benban village are presented in the sections below, in addition to Kom Ombo data.

4.3.1 Population

According to the Information and Decision Support Center of Aswan Governorate 2013 Census, the Daraw population was 111,857 capita represent 8.2% of total Aswan population, while Kom Ombo was 343,363 capita representing 25.3% of Aswan Governorate. Benban Bahari, Benban Qabli villages with a 16,015 capita in addition to Al-Raqabah with about 8948 capita total population in Markaz Daraw respectively.

Table 4-11: Aswan population

	Kom Ombo	Daraw	Benban Bahari and Qebli	Al Raqaba
Population	343,363	111,857	16,015	8948

Sources: Information and Decision Support Center of Aswan Governorate 2013 Census

Daraw is one of the most important trade centers between Egypt and Sudan. It developed fame as it hosts dwellers of Al-Ga'afra, Ababdah and Ansar tribes⁷ who live in Egypt. It is also famous for being the most important camel market. One of the most important villages in Daraw is Benban which is the heartland of Ga'afra tribes (family) in Aswan⁸.

4.3.2 Religion

Almost all Benban inhabitants are Muslim. About 3.0% are Christian (Copt). Benban has a small church administered by a resident priest. In general, Benban residents value traditions and norms and have formed local a dispute settlement committee (Shoura Council). (SESA 2016)

4.3.3 Education

The literacy rate (10+) in Daraw was in 2006 estimated to be 26.5% while in Kom Ombo it was estimated to 28% (CAPMAS, 2006), which is less than the national average (65.7%). There are two higher institutions Aswan University and Arab Academy for Science & Technology and Maritime in Aswan, and 463 primary schools.

Table (4-12) presents the specific illiteracy and educational levels in the villages of Benban (CAPMAS 2006)

Table 4-12: Education Levels in Benban

Illiteracy and education	El Raqaba	Benban Bahari	Benban Qebli
Illiterate	1876	2143	1584
can read and write	660	689	571
literacy	110	72	25
below middle education	1561	1715	1114
middle education	1557	1419	1588
middle higher education	117	74	59
Higher education	158	116	146
Post graduate education	0	0	2

4.3.4 Employment

Unemployment rates at Daraw, as a whole were estimated by CAPMAS 2006 at 15%, this is considered relatively high in comparison to the national rate (9.9%) and lower than Governorate level (18.7%). The following table shows the employment status breakdown in the different Benban villages.

⁷ They are not identified as indigenous peoples according the definition of the World Bank. The WB defines these groups as social groups with identities that are often distinct from dominant groups in their national societies, they have collective attachment to geographically distinct habitats or ancestral territories in the project area and they have customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture. Indigenous Peoples are frequently among the most marginalized and vulnerable segments of the population.

⁸ Description of Egypt Book, IDSC, 2010

Table 4-13: Employment Breakdown

	El Raqaba	Benban	Benban Qebli
Business owners	11	21	12
Works for his own	27	33	26
Works with financial compensation	1744	1,595	1,645
Workers with no financial compensation and working for the family	3	2	2
Workers with no financial compensation and working for other people	0	2	-
Unemployed but previously had job	5	9	17
Unemployed and never had a job	254	268	160
Fulltime student	652	662	499
Housewives	2110	2,155	1,819
Retired	50	74	70
Unemployed elderly	234	278	186
Unable to work	32	43	15
Uninterested in work	62	63	25
Other	126	139	74

Source: CAPMAS, 2006

4.3.5 Regional Health services

The closest hospitals to the project site are located in Daraw and Kom Ombo. The following table shows the health facilities in both cities.

Table 4-14: Health Facilities in Daraw and Kom Ombo

	General Hospital	Primary Care Units	Ambulance Points	Ambulances
Daraw	1	22	4	6
Kom Ombo	1	40	4	7

Source: Yearly Statistical Book, Aswan Governorate, 2013

The hospitals are located only in the cities of Markaz (Daraw and Kom Ombo), while in Benban specifically there are 8 health care units that are accessible to the local population. The specialized hospitals are concentrated in Aswan city (the capital of governorate).

According to Aswan Environmental Profile, 2003⁹, the most registered diseases are those resulting from the contaminated water, especially hepatitis A and typhoid¹⁰. Moreover, a high percentage of children less than five years old visiting doctors and hospitals have some sort of respiratory disease (28 %) for the governorate as a whole). The highest percentages are encountered in

⁹ <http://www.eea.gov.eg/portals/0/eeaaReports/GovProfiles/final/Aswan%20Des.pdf>

¹⁰ This could be attributed to lack of reliable sewage systems in the governorate, Aswan Environmental Profile, 2003

Edfu and Kom Ombo, where 55 % and 42% of the visits are due to respiratory diseases respectively.

There are 7 civil associations, 1 social unit, 678 productive families in Benban and in Daraw 49 civil associations, 3 social units, 1004 productive families in addition to 1 special needs unit.

4.3.6 Potable Water

Daily production of potable water in Daraw is about 27,000 m³/day (Description of the Egyptian Governorates by Information, 2008). There are three water treatment plants in the area of Benban village that treat the Nile water to potable water standards. The water intake to the village treatment plant is 13 km away from the project area. The table below describes the capacity of water production for the different water treatment plants.

Table 4-15: Potable Water Supply in Benban Village in 2014

	Potable water	
	No of plants	Capacity(m ³ /hr)
Benban Bahary	2	200
Benban Qebly	3	300
El Raqaba	1	100
Total	1100(m ³ /hr)	

Source: based on SESA 2016

The total household units connected to water networks is 23,384 (91.4%). The population percentage not connected to water supply obtain their water resources from public mains or other sources, specific data are not available. (CAPMAS 2006)

4.3.7 Electricity

The total number of customers who have formal contracts with the electricity distribution company is 6,640: 2,600 units in Benban Bahary; 1,960 units in Benban Qebly; and 2,080 units in El Raqaba.(SESA 2016). The total annual consumption of electricity in Daraw is about 130.20 Million kWh/year, of which about 79.56 and 50.64 Million kWh/year are for lighting and industrial activities respectively¹¹.

4.3.8 Waste and Waste Water Management

Access to a proper sewage system is not high in Aswan Governorate. The connectivity rate is only 27.09 % in Daraw and Kom Ombo. With regards to the project areas, the dominant sewage facility is septic tanks that need to be regularly emptied. Two sewage plants are located in Daraw and one in Kom Ombo. The capacity of the sewage treatment plant in Daraw Markaz is 18.00 thousand m³/ Day, whereas there is no sewage system in Kom Ombo. Septic tanks evacuation services are provided through the Local Governmental Unit

¹¹ Description of the Egyptian Governorates by Information, 2008, <http://www.eip.gov.eg/Periodicals/WasfMisrGovs/2010/4/4.pdf>

and private contractors. Each local unit has 2-4 vehicles that empty the tanks. The governmental vehicles cost 30 EGP, while the private contractors charge 50 EGP (SESA, 2016).

4.3.9 Transportation

Public transport is available along all the major roads leading to the towns. Public and private bus lines link the towns developing centers with other main governorates (such as Cairo, Upper Egypt and Nile Delta) with stops in all major settlements and connected by the national rail network. In addition, there are taxis regularly operating the area. The total regional road lengths in Aswan about 1,566 km.

There are no access roads to the location from the main highway. The infrastructure is pending and it will be required for the construction, operation and maintenance period.

4.3.10 Economic Activities

The people of Aswan work in various economic sectors such as agriculture, fishing and commerce. The following table details the number of adults/employable people working in different economic activities.

Table 4-16: Economic Activities breakdown

Economic Sector	El Raqaba	Benban	Benban Qebli
Agriculture and fisheries	734	734	990
mining	4	4	-
Transformative Industries	74	74	25
Electricity and Gas supply	10	10	10
water and wastewater supply	14	14	6
Building and construction	264	264	48
Trade	116	116	145
Storage and transportation	85	85	81
food services	4	4	10
Information and Communication	4	4	4
Insurance and brokering	8	8	7
Real Estate	0		
Technical and Scientific activities	4	4	15
Administrative activities	3	3	3
General Management	102	102	82
Education	152	152	151
Health and Social activities	51	51	89
Art and innovations	2	2	
Services	25	25	26
not clear	3	3	-
not engaged in activities	3682	3,682	2,848

Source: CAPMAS, 2006

a) Tourism

The project site and contiguous areas have no tourism activities, the nearest tourist area is Kom Ombo located 25 km away from the site. Aswan is characterized by several tourist features that made it an international destination for tourists from all over the world, especially in winter as it has a moderate and dry climate due to its location on the Nile banks. It is also an open museum for many archeological landmarks, which date back to various ages and spread all over the city.

Aswan Governorate statistics¹² show that there are approximately 21 operating hotels and resorts, with a carrying capacity of 2,363 rooms or 4,714 beds.



Figure 4-13: Tourism tour at the Temple of Kom Ombo

b) Agriculture and fishing

Agriculture and fishing are the main economic activities in Aswan. The total cultivated lands represent more than 96 thousand feddans (= 40,320 ha), while cultivated lands in nearby communities of Benban and Kom Ombo represent 10% and 33.3% of the total respectively. The most common crops in project area are wheat, barley and onions. There are animal husbandry in Daraw and Benban but not the main activity, about 2,250 cattle in Benban and 2,400 in Daraw (CAPMAS 2006)

4.3.11 Cultural Heritage

Kom Ombo Temple is one of the main touristic site in Aswan and located about 25 km east of project site. It was constructed in the Age of Ptolemy VI on the eastern bank of the river Nile. The main entrance pylon has now been destroyed, but entering through a portal at the southeast the visitor comes into a large court with remains of a Roman columned portico, which has preserved its color in some places on the walls. The exterior of the temple of Horus

¹² Yearly Statistical Book, Aswan Governorate, 2013

contain unique reliefs of a pair of goddesses with surgical instruments related to childbirth.

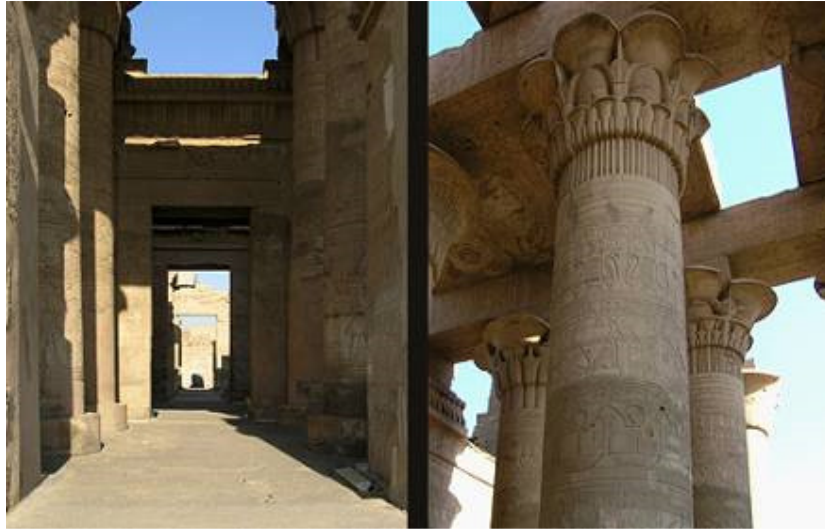


Figure 4-14: Roman Columns of Kom Ombo Temple

5. Environmental and Social Impacts Assessment and Mitigation

5.1 Methodology

Environmental assessment was carried out to identify potential impacts of the project on the environment as well as impacts of the environment on the project. The assessment was carried out in three main steps, as follows:

1. Identification of potential impacts
2. Evaluation and assessment of the impacts in terms of their significance
3. Identification/ proposing mitigation measures for minimizing the effects of the significant impacts.

After exclusion of the irrelevant impacts, the remaining aspects were assessed based on the following criteria:

- **Magnitude** of the impact.
- **Duration:** period of time that impact lasts.
- **Mitigation measures;** its availability whether integrated in the project design or implemented as management measures.
- **Residual impacts**

Where negative environmental impacts are expected, most of them will be experienced during the construction phase. To help offset the potential negative impacts, mitigation measures are suggested and the residual impact evaluated.

5.1.1 Identification of Potential Environmental and Socio-economic Impacts

Potential impacts of the proposed project and the specific project site are identified based on a modification of the Leopold matrix (Table 0(5-1)). The matrix is used to identify the potential impact of a project on the environment. It has been designed so that the key potential impacts associated with the project become immediately apparent. The layout of the matrix is arranged as follows:

- The “rows” of the matrix consist of a list of activities presented according to construction and operation activities. It also consists of the list of aspects associated with each activity or group of activities.
- The “columns” consist of the resources and receptors susceptible to impacts categorized as physical, biological and socio-economic environment. Identified resources and/or receptors were:
 - Air quality
 - Noise level
 - Soil
 - Groundwater quality
 - Surface water
 - Marine water quality

- Terrestrial life
- Aquatic life
- Public health
- Employment
- Workplace health and safety

5.1.2 Evaluation and Assessment of Impacts

Interaction between the different activities and the environmental receptors, identified through the baseline information, was carried out. Such interactions may result in negative or positive impacts. The different types of impacts were identified.

Based on the analysis of the baseline environmental conditions and the nature of the receiving environment, some aspects were found to be irrelevant to specific activities of this particular project. These are identified as "scoped out impacts".

Potential relevant impacts were subject to a process of impact evaluation, based on the analysis of the proposed project components and activities, in order to determine the significance of the different impacts. The evaluation process takes into account the information collected in the field, available in the literature and/or based on the professional judgment of the consulting team and public consultation

Impact evaluation is based on pre-set criteria including, impact magnitude, duration, planned mitigation measures, regulatory standards and sensitivity of environmental receptors.

5.1.3 Scoped out Impacts

Potential impacts in the Leopold matrix were identified in relation to their effects on potential receptors. This step would facilitate eliminating and scoping out irrelevant impacts taking into consideration the following:

- Type of project
- Location
- Characteristics of the surrounding environment.
- Receptor sensitivity or importance: depends on its nature, value, scarcity etc. There are three types of receptors:
 - On site receptors encompassing soil and workplace.
 - Receptors surrounding the site such as ambient air, humans, plants and animals.
 - Final sinks/receptors such as surface and groundwater.

Examination of the environmental setting of the area and the operational processes has shown that impact on the following resources/receptors are irrelevant:

Marine water quality

As the location of the project is in southern Egypt, there is no marine water in the vicinity of the project and impacts on marine water can be scoped out.

Impacts on “surface water quality” and “aquatic life”

The project activities will have limited impact with surface water or aquatic life. However, this is to be considered when studying the cumulative effects of the PV Park

Interaction with birds’ migration route

The project has no interaction with the bird migration routes. It has no elevated structures that can interfere with the migration routes. Moreover, it is not expected to have birds roosting and perching on the photovoltaic panels. Moreover, there has been no sufficient evidence that PV are reflective so as to be mistaken by lake surfaces to attract birds¹.

Impact on groundwater

Based on the nature of the project there will not be any interaction with the groundwater in the area. For water supply purposes, only surface water will be used. The groundwater table is at considerable depth (50-200mbgl) and will not be endangered by the potential spills from the project site.

The Table (5-1) below presents the project aspects during its construction and operation phases and their potential (adverse/positive) impacts on the relevant environmental attributes. Consequently, the coming sections present the assessment of extent of potential adverse impacts as well as the proposed measures to be implemented for mitigation.

¹ Guidelines to minimize the impact on birds of Solar Facilities and Associated Infrastructure in South Africa. Smit, Hanneline A., BirdLife South Africa, 2012

Table 0(5-1): Potential / Residual Impacts Matrix

		Environmental Attributes ⁽²⁾								
Activities (Sources of impacts)	Aspects	Physical Environment			Biological Env.	Socio-economic				
		Air Quality	Noise level	Soil	Terrestrial life	Water Resources	Employment & community	Accommodation & Work place H & S	Infrastructure (Roads)	Cultural Heritage
Construction Phase										
Site leveling	• Labor	NA	NA	NA	NA	NA	+	NA	NA	NA
Civil and Construction Works	• Dust Emissions	-I _m	NA	NA	-I _m	NA	NA	-I _m	NA	NA
System components installation	• Gas emissions (vehicles & equipment)	-I _m	NA	-I _m	-I _m	NA	NA	-I _m	NA	NA
Electrical and instrumentation	• Noise (vehicles & equipment)	NA	-I _m	NA	NA	NA	NA	-I _m	NA	NA
Mechanical completion	• Construction Waste (including generation of solid and liquid municipal waste and sewage)	NA	NA	-I _m	NA	NA	NA	-I _m	NA	NA
Pre-commissioning	• Accidents (vehicles & equipment)	NA	NA	-I _m	-I _m	-I _m	NA	-I _m	I _m	NA
Transport of materials etc	• Spills (vehicles & equipment)	NA	NA	-I _m	NA	NA	NA	-I _m	NA	NA
	• Sewage from workers at site	NA	NA	-I _m	NA	NA	NA	-I _m	NA	NA
Workers' accommodation and transport to and from project site	• Dust and gas emissions from workers' transport within local communities	-I _m	NA	NA	NA	NA	-I _m	-I _m	NA	NA
	• Noise (transport vehicles)	-I _m	NA	NA	NA	NA	-I _m	-I _m	NA	NA
	• Sewage from workers' accommodation	NA	NA	NA	NA	-I _m	NA	-I _m	NA	NA
Operation Phase										
Operation activities	• Labor	NA	NA	NA	NA	NA	+	NA	NA	NA
	• solid waste generation	-I _m	NA	-I _m	NA	-I _m	NA	-I _m	NA	NA
	• Sewage generation	NA	NA	NA	NA	NA	NA	NA	NA	NA

²⁾(-): Negative impact(+): positive impact

I_m: minor residual impacts acceptable after mitigation through management

I_d: minor residual impacts acceptable after design integrated mitigation

NA: Not applicable

		Environmental Attributes ⁽²⁾								
Activities (Sources of impacts)	Aspects	Physical Environment			Biological Env.	Socio-economic				
		Air Quality	Noise level	Soil	Terrestrial life	Water Resources	Employment & community	Accommodation & Work place H & S	Infrastructure (Roads)	Cultural Heritage
	• Modules cleaning	NA	NA	NA	NA	-/ I _{d,m}	NA	NA	NA	NA
	• Noise from transformers and inverters	NA	-/I _{d,m}	NA	NA	NA	NA	- /I _{d,m}	NA	NA
	• Electromagnetic fields from cables and high voltage lines	NA	NA	NA	NA	NA	NA	I _{d,m}	NA	NA

5.1.4 Mitigation Measures

The project intends to result in a net positive environmental impact. Mitigation measures to achieve the intentions are either incorporated as integral part of the project design or through environmental management and monitoring measures. By implementing both types of mitigation measures, the residual impacts, which are those potentially, remaining after implementing the mitigation measures, will be minimal/insignificant/ acceptable. As much as possible, the avoidance and prevention of impacts is favored over minimization, mitigation or compensation. Based on the impact identification and evaluation process, irrelevant impacts are scoped out of the assessment process, and mitigation measures are proposed for significant impacts, while minor impacts are integrated within the management plans of the facility.

5.2 Impact Assessment

5.2.1 Impact on Physical Environment

5.2.1.1 Ambient Air Quality

Construction Phase

Construction activities may result in minor, localized, short term, air quality impacts in the form of dust/particulate matter from excavation, soil leveling, road works, and emissions from construction equipment and transport vehicles.

A diesel generator will be used for electricity supply during construction. Accordingly, air emissions during construction include dust, nitrogen oxides, sulphur oxides and carbon monoxide.

Such impacts will occur for relatively short duration and expected to affect mainly the workplace environment. Furthermore, impact on public health from activities on site is unlikely due to the fact that the nearest residential area to the site is Benban village located more than 15km to the east of the proposed site. This impact is considered *minor*.

Mitigation Measures

The developer will ensure that contractors on site will carry out the necessary measures to minimize impacts. This is to be included in the contractor's scope of work (contract). Potential Effective mitigation measures include:

- Dust suppression using minimum water consuming technologies³. Wet suppression and wind speed reduction are two common methods used to control open dust sources at construction sites. Other types (such as fog suppression, physical barriers, site traffic control, watering sprays, soil compaction, etc...);

³ Wet suppression and wind speed reduction are two common methods used to control open dust sources at construction sites. Other types (such as fog suppression, physical barriers, site traffic control, watering sprays, soil compaction, etc...), Guidelines for Controlling Dust from Construction Sites, Parramatta City Council - AP-42, CH 13.2.3: Heavy Construction Operation - <http://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s02-3.pdf>

- Dust management through slowing the driving speed of material transportation vehicles;
- To the extent possible: use local gravel from project site to improve internal roads;
- Maintaining machinery and vehicles in good working conditions to minimize fugitive emissions and exhaust;
- Excavated materials will be covered, as feasible, to reduce potential for windblown matter.

Residual Impacts

The above mitigation measures are anticipated to be efficient for minimizing the potential impacts at site. Therefore, the residual impacts of construction on the air quality are negligible.

Operation phase

There are no global warming emissions associated with operation of solar energy plant itself. Thus, air emissions generated during operation are limited to emissions from transport vehicles providing required materials and supplies to the project site. Such impacts are considered to be limited during the operation phase.

Mitigation Measures

The developer will ensure that contractors will carry out the necessary measures to minimize impacts. Mitigation measures would include:

- Dust management through slowing the driving speed of material transportation vehicles; Maintaining machinery and vehicles in good working conditions to minimize fugitive emissions and exhaust.

Residual Impacts

The above mitigation measures are anticipated to be efficient for minimizing the potential impacts. Therefore, the residual impacts of construction on the air quality are negligible.

In addition, the project contributes positively to minimizing the greenhouse gases emissions, particularly CO₂, that would have been generated if the same amount of energy was generated from fossil fuel fired power plants. The mean GHG emissions of manufacturing silicon modules (Lifecycle GHG emissions) is about 85 tCO₂e/GWh⁴ compared to 888, 499, 733 tCO₂e/GWh⁴ for coal, natural gas and diesel oil respectively. In Egypt, the total average CO₂ emission from all thermal power plants is about 540tCO₂e/GWh⁵.

⁴ Comparison of Life Cycle Greenhouse emissions of various Electricity Generation Sources, World Nuclear Association, July 2011

⁵ Annual Report for Performance Indicators for Electricity Generation Companies, Egyptian Electric Utility and Consumer Protection Regulatory Agency, 2012-2013

5.2.1.2 Ambient Noise Levels

Construction phase

The use of construction equipment may result in localized, short term, increase in noise levels.

Table 0(5-2) shows typical noise levels, in decibels, expected at various distances from construction machinery. It is not expected that noise from the construction activities on site would pose impacts on the neighboring areas (roads or nearby communities) as they are located at significant distances. The impact on ambient noise from the construction activities at the project site is considered minor on the local communities. However, the impact of construction activities on workers can be potentially significant.

Table 0(5-2): Average noise levels from Construction Equipment

Equipment Type	Distance from Noise Source (dBA)		
	10m	50m	100m
Crane	72	58	52
Bulldozer	74	60	54
Generator	76	62	56
Backhoe	79	65	59

* Doubling the distance drops the intensity by about 6 dB and that 10 times the distance drops the intensity by 20 dB⁶

Mitigation Measures

- When construction equipment are used, such as during site excavation, earth moving and land grading, workers will be provided with the suitable personal protection equipment (PPEs) to minimize possible impacts from noise.
- Maintaining machinery and vehicles in good working conditions to minimize noise generation.
- If necessary a grievance mechanism will be adopted for assessing complaints associated with construction noise, if any.

Residual Impacts

Noise resulting during construction activities is unlikely to have an impact on the general public, it is thus negligible. Impact of construction activities on workers can be potentially significant, but with implementing the above mitigations measures and health and safety procedures, residual impacts are considered negligible.

⁶ In the real world, the Inverse Square Law is an idealization because it assumes exactly equal sound propagation in all directions. If there are reflective surfaces in the sound field, then reflected sounds will add to the directed sound and you will get more sound at a field location than the inverse square law predicts. If there are barriers between the source and the point of measurement, the propagated noise intensity may get less than the inverse square law predicts. Nevertheless, the inverse square law is a logical first estimate of the sound at a distant point in a reasonably open area. **Estimating Sound Levels with the Inverse Square Law**, <http://hyperphysics.phy-astr.gsu.edu/hbase/acoustic/isprob2.html>

Operation phase

Noise during operation can result mainly from the transformers and inverters which are contained in an enclosure with restricted access, as well as vehicle transport to and on site. Such impacts are considered not significant.

Noise levels, expected at from the different equipment as shown in the **Table (05-3)** below, are less than the allowable limits of law 4/1994 as described in Chapter 2.2.5.

Table (05-3): Expected noise levels from different Instrumentation in workplace

Noise source	Noise level (dB(A))
Inverters	66.4dB(A)
Transformer	60 dB(A)*

*At 10m from source

**2 MW transformer with 24 kV voltage rating

The contribution of the facility to increasing the noise level to the surrounding environment is minimal taking into account the design mitigation measures in place and due to the fact that the distance to the nearest sensitive receptors, namely Benban village is about 15 km. Thus, all noise levels produced from the proposed facility would completely vanish by the time they reach the closest sensitive receptors.

Regarding the noise levels within the workplace during operation phase, implementing the mentioned mitigation measures below and implementation of effective occupational health and safety measures, including restricted access to the transformers area and providing the workers with the necessary PPEs and limiting the exposure period, the residual impacts in workplace are considered negligible.

Mitigation measures

The following mitigation measures could be implemented during operation to minimize the potential noise impacts:

- Potential noise generating machines and equipment are designed to meet statutory regulations concerning noise.
- Acoustic enclosures are installed for noise generating equipment, wherever possible such as inverters and transformers
- Workers at noise generating machinery and equipment will be provided with the suitable personal protective equipment (PPEs).
- If necessary a grievance mechanism will be adopted for assessing complaints associated with operation noise, if any

Residual Impacts

Residual noise during operation activities is unlikely to have an impact on the public. Furthermore, the impact of noise on workplace will be negligible with implementing the above mitigations measures and health and safety procedures.

5.2.1.3 Soil

Construction phase

Potential impacts during construction phase generally result from domestic wastewater management, material and waste storage, accidental spills from machinery, and potential spills from the diesel generator and lube oils.

The potential impacts on soil as result of the different activities during construction phase are considered moderate.

Mitigation measures

Mitigation measures mainly involve site management procedures, good housekeeping activities and proper waste management measures;

- Wastes generated during construction phase will be collected by an approved contractor and be disposed of in designated sites.
- Other construction wastes will be safely and temporarily stored on site and periodically disposed through authorized contractors.
- Diesel, fuel and other contaminants used on site are to be stored and contained to minimize release to soils.
- The contractor will implement measures for spill prevention, such as solid surface for machinery storage and where generators are being refueled, that will contribute to controlling and minimizing any potential impacts.
- In addition, an emergency response plan is to be developed to include response to acute spill scenarios.

Additionally, the contracts will describe required periodic inspection of equipment and machinery, which in turn will contribute to minimizing spills and leaks. The E&S site personnel will follow up on the contractors' performance to ensure they abide by the contract EHS stipulations.

Effective housekeeping can eliminate some workplace hazards and contribute to allow work to be carried out safely and in proper manner. Effective housekeeping involve (but are not limited to):

- Regular cleanliness of workplace
- Regular collection and disposal of waste
- Maintaining clean and orderly surfaces, aisles and stairways
- Organized and orderly storage of chemicals, hazard materials and equipment
- Spill control and cleanup

A septic tank will be constructed for collection of domestic wastewater. It will be insulated with Bituminous lining for leak prevention. Contents will be emptied regularly for disposal at the nearest wastewater treatment plant at adequate intervals through a licensed contractor.

Residual impacts

Impact on soil during construction activities will be negligible with implementing spill control from construction machinery, housekeeping and management measures as described above.

Operation phase

During the project operation, potential soil impacts may arise from domestic wastewater management, material and waste storage accidental spills from machinery, and potential spills from the diesel generator and lube oils, but is considered to be minor to the limited number of required equipment and personnel at site.

Mitigation measures

As part of its EMP, the project will develop a waste management system to comply with the national legislation as well as septic tank integrity checking. In addition, an emergency response plan is to be developed to include response to acute spill scenarios.

Domestic wastewater will be collected in an isolated internal sewage system and discharged to a lined concrete septic tank for periodic emptying through licensed seepage trucks.

Residual impacts

Upon implementation of the mitigation measures, potential impacts of the project operation on the soil are not significant.

5.2.2 Impact on Biological Environment

None of the species found on or near the location of the PV Park are endangered, rather common and only found in a small number. The project area is composed of desert sandy and rocky plains characterized by variable sheet with gravel interaction, and small plateaus mainly composed of boulders and conglomerates. The proposed project site is located in a arid/extremely arid area, no presence of flora was observed within the project site.

Construction Phase

The project area represents a small part of the vast desert plain and is not considered a critical habitat. Gaseous emissions, noise from construction machinery are short term and their impacts are considered not significant.

Mitigation Measures

Develop, implement and update a solid waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin.

Residual impacts

Residual impacts on a project site level are negligible with proper mitigation and management measures implemented.

Operation Phase

As mentioned above the project does not include activities that would affect the biological environment in the area. However, a solid waste management plan will be developed, implemented and updated to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin.

Residual impacts

Negative impacts on the biological environment are negligible

5.2.3 Socio-economic impacts**5.2.3.1 Water Resources*****Construction phase:***

The demand of potable water at site during construction phase is expected to be between 30 and 60 m³/day, or 8,100 m³ for the entire construction period. This includes water for sanitary purposes, catering, maintenance of machinery and module cleaning, but excludes drinking water for workers, which will be supplied separately.

Workers' accommodation is planned outside the project physical boundaries, preferably within local communities with an already existing water supply and wastewater network, and the expected demand is estimated to 50 liters per person per. day.

Water trucks will abstract water from existing nearby water facilities and transport the water to the project site. The required water volumes for one single project is limited compared to the capacity of the water facility and the project activities at site will have limited impact, as the water consumption and discharge is considered minimal.

Water supply and wastewater handling is within the responsibility of the developer, and with absent infrastructure, solutions as indicated for the project site applies. The impact from workers' accommodation is considered to be moderate without mitigation measures.

Mitigation measures:

The contractor will purchase water from a selected water facility. A water management plan will be developed.

Wastewater collected from site will be disposed according to national legislation to prevent any impact of surface water.

Wastewater generated during construction phase will be collected by an approved contractor and be discharged to designated treatment plants.

Residual impacts:

Limited for the single project site and related workers' accommodation.

Operation phase:

During operation phase, water will mainly be required for sanitary purposes, as dry cleaning method will be used for regular cleaning of PV modules. As there will be only 5-7 workers present during the operation, the daily water demand and wastewater generation will be limited.

More extensive cleaning will require higher water volumes, but with an expected frequency of twice a year, the impact on water resources is considered limited.

Mitigation measures:

Wastewater generated during operation phase will be collected by an approved contractor and be discharged to designated treatment plants.

As the water consumption and generation of wastewater is limited, no mitigation measures have been suggested for water consumption.

5.2.3.2 Employment

Construction phase

The construction phase of the project will provide temporary employment opportunities. Although priority will be given to local workers, the local work force is not expected to exceed 20% of the total demand, but additional, provision of services related to workers, such as catering, transport etc., may provide even more temporary jobs.

Regardless of the total number of local workers, the project will temporarily alleviate the rate of local unemployment.

Even if required work force for one single project site is limited, discussions held with local authorities and community leaders in Benban village indicated local communities in Benban are expected to provide around 2,000 workers, while Fares village may contribute an additional 1,000 for construction of the total PV park. However, availability of local work force might depend on other ongoing projects in the area. As only a certain amount of the workers can be unskilled, the contractors might have to seek qualified work force elsewhere due to availability.

Furthermore, as construction of the various PV sites will run in parallel, availability of local qualified personnel might be limited. However, construction will occur in phases, each having a different duration. In this respect, the availability and duration of jobs will depend on the job function and construction schedule. The limited duration of some job opportunities will reduce the significance of employment creation in the local area. The local workers will get on the job-training regardless of duration of their temporary employment. The contractor will execute such training.

It is assumed that approximately 80% percent of the jobs available during construction will be undertaken by semi-skilled and unskilled labour, while 20 percent of the construction jobs will require skilled labour. Labour will be mainly sought from the local communities, as available.

An additional direct benefit during the construction phase is the opportunity for 'on-the-job' training for local people. The highly skilled solar energy technicians can provide training to local employees, increasing their skills level so that they will be employable on other solar projects. In this context, related to indirect jobs creation, it is envisaged that local medium sized businesses will potentially be able to supply the majority of auxiliary components. Work opportunities would also be created for consultancies including monitoring measurements, O&M services etc. In this respect, the

positive impact of the project will reach farther than the employment at the site⁷.

Mitigation measures

To avoid potential negative impacts associated with sourcing local workforce, the Developers Association will coordinate and develop a comprehensive policy to Benban workers.

Residual impacts

Accordingly, the project will contribute to positive social impacts including community development and reduction of local unemployment mostly during peak construction phase.

Operation phase

The project itself will have small impact on the local unemployment level as operation personnel at the project site is expected to be only around 5-7 persons. However, the united PV Park and the Developers' Association has the potential to decrease the local unemployment levels also during operation phase such as for panel cleaning and maintenance services as well as indirect employment, such as catering and cleaning services.

Moreover, it would provide an opportunity for education, training and technology transfer to the Egyptian context related to Solar Energy. This is expected to contribute significantly to disseminating the project and relevant technical knowledge throughout Egypt.

Mitigation measures

Mitigation measures are mainly related to the cumulative effects of the overall development of the PV Park. Thus, these will be assessed and presented in the additional ESIA Study initiated by the Developers' Association.

5.2.3.3 Impact on the community

Construction phase

It is the common practice for EPC contractors work in Egypt to hire local workforce for the jobs that do not require significant skills, as their number is significant for construction and it is more economically viable. Whereas the required highly skilled labor may not be from the local communities. For individual projects the number of non-local workers will be considerably low and thus their impact on the community is not significant.

However, the total impact of development and construction of all projects sites in the PV park may be considerable, as the workers' influx to the area might cause stress on the available local resources and utilities. Thus the impact needs to be assessed on the cumulative level by the Facility Management Company.

⁷ Prospects of renewable Energy Sector in Egypt, Focus of Photovoltaics and Wind Energy, Environics 2010

Taking into consideration that the community is within a touristic governorate, impact on the community caused by any workers from outside should not be expected with respect to cause like religion, common behavior, etc.

Mitigation Measures

To be elaborated in the additional ESIA.

Residual impacts

To be elaborated in the additional ESIA.

Operation Phase

Workforce for individual projects during operation is considerably low. Thus, the impact on the local resources is considered negligible. However, the cumulative level would be investigated in the additional ESIA to assess the potential impacts during operation of the PV park.

Mitigation Measures

To be elaborated in the additional ESIA.

Residual impacts

To be elaborated in the additional ESIA.

5.2.3.4 Impacts on infrastructure

- **Impacts on land use**

Large scale PV facilities can raise concerns about land uptake. Concerning the subject project, it will be located in a desert and unoccupied land, which is designated by NREA for solar energy power generation. No land ownership or uptake issue will result as resulted from the project. Therefore, positive impact will arise from the proposed project on land use at the site.

- **Impact of Electromagnetic field**

According to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines, the levels for safe general public exposure and for the frequency of 50 Hz are:

- For electric Field strength, $E < 5 \text{ kV m}^{-1}$
- For magnetic Flux density, $B < 200 \text{ }^1\text{T}$

The relevant levels for safe occupational exposure are:

- For electric Field strength, $E < 10 \text{ kV m}^{-1}$
- For magnetic Flux density, $B < 1000 \text{ }^1\text{T}$

EMFs are strongest close to a source, and their strength rapidly diminishes with distance from it. Limited data is available about the EMF of utility scale PV units. However, values from some studies indicated that the

measured levels are far below the safe exposure levels⁸. A study by Massachusetts Clean Energy Center indicated that at the utility scale sites, electric field levels along the fenced PV array boundary, and at the locations set back 50 to 150 feet (45m) from the boundary, were not elevated above background levels (< 5 V/m). Electric fields near the inverters were also not elevated above background levels (< 5 V/m). At the residential site, indoor electric fields in the rooms closest to the roof-mounted panels and at locations near the inverters were not elevated above background levels (< 5 V/m).

- **Traffic**

Construction Phase

Concerning the relevant project site, only internal roads are considered relevant. Side-tracks will be compacted as well as the main access roads will be asphalt road to the Solar PV park, enabling trucking equipment and construction gear being safely transported to the project area. Approx. 210,000 PV modules and 16 inverters are required for this project.

Trucks of various sizes will be required for transportation of the project's components distributed throughout its construction period, about 11 months, with varying intensities. The traffic required for one single project site is expected to have only moderate impacts on the public roads network in the area during the project's construction. However, the cumulative effects of transport required for the cluster of project sites is considered significant.

The main road leading to the site, the western desert highway Luxor – Aswan, is a single lane road both ways, accommodating different types of transport means. According to the information by the different stakeholders, the road witnesses frequent accidents as the result of poor quality of the road and the lack of maintenance. In this respect, mitigation measures to improve safety for transporters, workers, and local population need to be implemented. Furthermore, this situation might affect the project trucking activities during construction phase for all developers and will be a challenge especially during the peak period. A facility manager contracted by the Developers' Association will develop a transportation, logistics and safety concept and will suggest mitigation measures for all developers.

The Omda (mayor) of Benban village indicated during the stakeholders' meeting that the communities along the road are initiating a community campaign on the Facebook and local media to highlight the problem to the officials in the governorate. Annex 3 presents the results of the scoping meetings with different stakeholders that took place during the first site visit in July 2015.

⁸ Study Of Acoustic and EMF Levels From Solar Photovoltaic Projects, Massachusetts Clean Energy Center, 2012 - Electric and Magnetic Fields Due to the Operation of Roof Mounted Photovoltaic Systems, PIERS Proceedings, Stockholm, Sweden, 2013)

Mitigation Measures

The transportation schedule for the project will be coordinated within the overall management plans of the PV park according to the Management Facility contractors. This issue is to be elaborated in the additional ESIA.

Residual impacts

To be elaborated in the additional ESIA.

Operation Phase

Workforce required for individual projects during operation is estimated to 5-7 workers per plot. Thus, the impact on traffic as result of workers transportation to the single project site is considered insignificant. However, the cumulative level would be investigated in the additional ESIA to assess the potential impacts during operation of the PV park.

Mitigation Measures

The workers transportation will be coordinated within the overall management plans of the PV park according to the Management Facility company. This issue is to be elaborated in the additional ESIA.

Residual impacts

To be elaborated in the additional ESIA

- **Visual Impact:**

Visual effects arise from changes in the composition and character of views available to receptors affected by the proposed development (e.g. residents, recreational users, tourists etc.). Visual impact assessment considers the response of the receptors who experience these effects, and it considers the overall consequence of these effects on the visual amenity of the view. There are no receptors near the project area, and these are limited to the transient drivers along the Luxor-Aswan Road. The individual project site could not be seen from the road. Thus, the visual effects of the project are insignificant.

- **Glare and Glint**

To maximize electricity generation, solar PV modules are designed to absorb light and reflections are contrary to their central purpose. However, panel glass remains relatively smooth and homogenous and may be physically capable of producing a concentrated reflection similar to a calm lake on a wind-free day.

The project site is located roughly more than 2 km from the road and thus potential glare is not significant.

- **Public Health**

The project does not entail construction of new high voltage networks, but will connect to the existing transmission lines. No additional impacts from construction of transmission lines are expected to occur.

- **Site Security and presence of security personnel**

For security measures, the project will undertake measures mentioned in 3.3.3 and assign an annually contracted security company to provide security services for the site premises. The security company will provide reasonable number of security staff on site, exchanging shifts.

Moreover, cameras are to be installed on the site perimeter and on the fence and the entrance gate will have one camera. The camera will keep record for 7 days and will be connected with an uninterruptible power supply (UPS)

All plant gates will be under video surveillance and data will be stored for at least 1 week. Motion Detection along fence may be used depending on the surroundings. The presence of guards may have a negative impact on the community if not properly trained, equipped and monitored.

According to the SESA report, a security arrangement was identified based on a meeting between the mayors of Benban Bahary, Qebly, Raqaba, and the head of Aswan security forces in 2013, in order to assign responsibility for securing the site. It was agreed that security guards should be from all tribes surrounding the site, and that the revenue from security activities will be equally distributed among the personnel. This representation arrangement was decided to limit any concerns pertaining to potential tribal tensions. The security group includes 16 men working over two shifts. They are managed by one of the residents in cooperation with the police investigation officer in Daraw District. An agreement with the local police (who are trained and authorized to carry and use arms) is in place in order to provide support to the local security personnel who are yet to obtain official security permits. Thus the potential impacts for a single project are considered minor. The cumulative impacts could be considerable and need to be addressed by the facility management company for the whole PV park.

Mitigation measure

The security personnel will be adequately trained, have appropriate conduct toward workers and community and to act within the applicable law. Furthermore, the grievance mechanism, outlined in Chapter 7, will be developed to allow the potentially affected community to express concerns about the security arrangements and acts of security personnel.

Apart from project security, the overall security of the PV complex needs to be addressed jointly by all developers.

Residual impacts

To be elaborated in the additional ESIA.

5.2.4 Impact on Cultural Heritage and Archaeological Features

There are no registered archeological or cultural heritage features in the project area. However, in the case of any findings, measures must be taken to avoid any damage.

Mitigation measure

In case of unlikely chance find, the appropriate chance find procedures will be implemented, which mainly entail halting the activities and fence the area while notifying the concerned authorities immediately according the stipulation of Law 117 of 1983 concerning the Protection of Antiquities.

Residual impact

Following the developed procedures, the impact on any cultural or archeological heritage is considered insignificant.

5.2.5 Impact on the Work Place

Construction Phase

Potential impacts during construction could arise from noise, accidental slipping of the workers and hazards from exposing to dust and emissions from material handling. As the local community experience diseases from water contamination, mitigation will be taken to prevent spreading diseases to local as well as foreign workers. In this context, the potential workplace impacts can be considered moderate.

Mitigation measures

The project will obligate the contractor, through the contracts, with the following measures and will follow up their implementation:

- A health and safety policy will be applied throughout the project and among all project contractors
- Abide by all national occupational health and safety regulations, Law 12/2003
- Provision of suitable PPE
- Equipment periodic maintenance according to manufacturers' schedule
- Sufficient drinking water supply
- Household/proper food preparation procedures

Residual impacts

Through implementation of the above mitigation measures, the expected residual impact on the workers' health is insignificant.

Operation Phase

Impacts on workplace during operation are relevant when considering replacement of modules, converters, transformers etc. However, the probability of replacement of these units is considered as minor due to their expected life time. Impact on workers' health with regards to diseases applies, as for construction phase.

Mitigation measures

- A health and safety policy will be applied
- Abide by all national occupational health and safety regulations, Law 12/2003
- Provision of suitable PPE
- Sufficient drinking water supply
- Household/food preparation procedures

Residual impacts

Through implementation of the above mitigation measures, the expected residual impact on the workers' health is insignificant.

5.2.6 Impact of the Environment on the project

Impact of Sand Storms

One of the impacts of strong wind is sand and dust deposition. The study area experiences sand storms during spring and autumn. Higher wind speeds potentially increases the performance losses due to abrasion and/or deposition of aeolian dust on PV cells. However, the design of the PV module has taken into consideration selection of coating material that will minimize the abrasive effect of dust.

Mitigation measures

Periodic module cleaning and maintenance will minimize the impact of deposited dust.

Residual impact

With appropriate design materials and with implementing proper maintenance and cleaning procedures the impact of dust will be minimized.

Impact of Earthquakes

As discussed in Chapter 4, Egypt is divided into 5 seismic zones, and the project is located within zone 2. The project is complying with Egyptian codes, regulations, particularly the Egyptian building code⁹ with respect to type of construction and design requirements.

Thus, taking into consideration the building code requirements in the project design, the residual impacts will be negligible.

Impact of Flash floods

The hydrological study has been performed for the project area with the purpose of identifying the potential flash flood impact on the project. In this respect, the occurrence of possible flash floods that may affect the project area, as well as the analysis of floodplain were assessed based on investigation and analysis of different data types including the following data:

- The available topographic and geologic maps of the project area;
- The Digital Elevation Model (DEM) of the project area;
- The available satellite images of the study area to describe the land-use;

⁹ The Egyptian Code no.201, 2011, for Calculation of Construction Loads and Forces.

- The statistically analyzed rainfall data for available ground stations nearby the project area;
- The ground elevations for the cross sections of the streams at intersection of watersheds outlets with the project area were extracted from the DEM.

To carry out the flood analysis **The Watershed Modeling System (WMS)**¹⁰ model was used. The model allows creating area boundaries using the graphical user interface; accordingly, geometric attributes such as area, slope and runoff distances can be computed automatically. Based on the results of the hydrological model for the area, it was indicated that the area (the PV park and the project site) are affected by six drainage basins as shown in Figure (5-1) below. The impact of these basins varies according to their different features such as area of the basin and its slope. In this context, Wadi (1) and Wadi (3) are of larger areas and high slopes while the remaining basins have smaller area and lower slopes. Wadi (3), Wadi (4) and Wadi (5) are affecting the PV park area from the western side, whereas Wadi (2) and Wadi (1) are affecting the northern side of the PV park area and Wadi (6) is affecting PV park area from the eastern side.

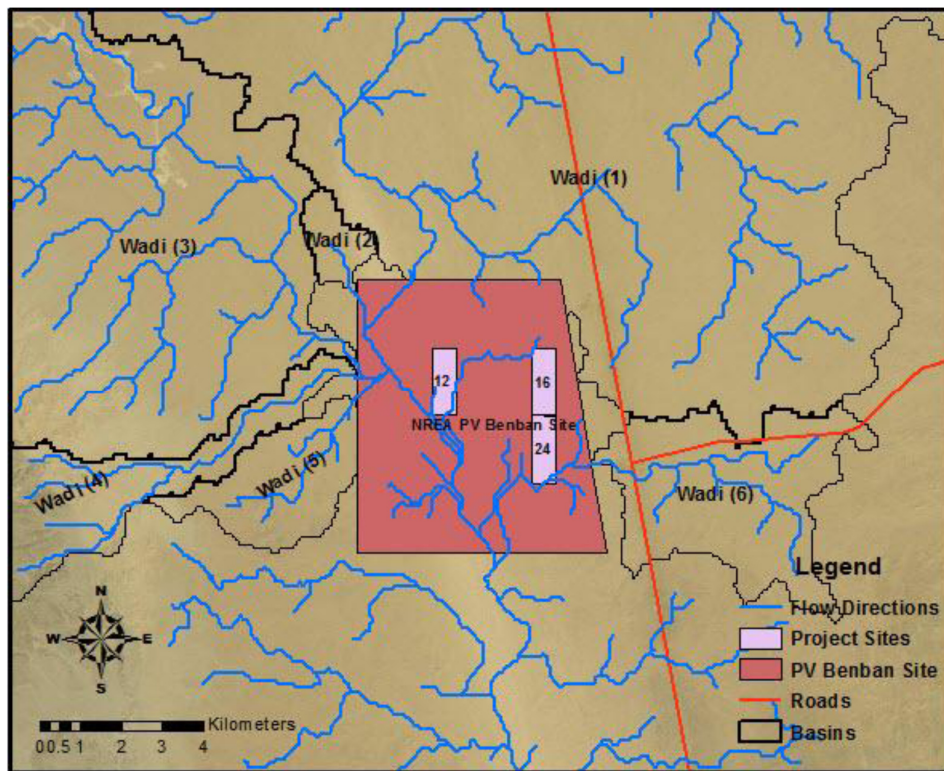


Figure (5-1): Drainage streams within the PV park area

The above figure indicates the PV park area is subject to floods from the different streams. In addition, all Scatec project sites are positioned in the flood flow direction. Project site no.(12) and no.(16) are affected by the

¹⁰ The WSM was developed by the Environmental Modeling Research Laboratory of Brigham Young University in cooperation with the U.S. Army Corps of Engineers Waterways Experiment Station

water from watersheds numbers (1), (2), (3), (4) and (5) while project site no.(24) is affected only by the water from watershed number (6).

Hydrological analysis

The hydrograph for each catchment for the different return periods have been performed using the HEC-1 model (built in module in the WMS model).

With the absence of the runoff measurements in the study area, synthetic unit hydrograph methods were used to calculate the characteristics of the surface runoff. The synthetic unit hydrograph of the Soil Conservation Service (SCS-UH) is one of the recommended methods and it is used worldwide. It is based on a dimensionless unit hydrograph developed from the analysis of a large number of unit hydrographs for many regions. This method was used to estimate the required hydrographs for the drainage basins affecting the project area where there is no possibility for calibration or validation of the model because of absence of field measurements. These hydrographs are given for 25, 50 and 100 years flood return period as shown in Table (5-4) below.

Table (5-4): Summary of the hydrological analysis

Drainage Basin	Flood Volume (m3)			Peak Discharge (m3/s)			Time to peak (min)
	25	50	100	25	50	100	
Wadi (1)	-	879,361.2	7,298,644.5	-	9.80	80.89	1695
Wadi (2)	-	-	3,120.3	-	-	0.35	255
Wadi (3)	-	16,092.9	340,059.6	-	0.54	11.33	510
Wadi (4)	2,844	34,643.7	131,096.7	0.39	4.54	16.02	210
Wadi (5)	-	-	12,897.0	-	-	0.89	315
Wadi (6)	-	-	24,259.5	-	-	1.36	360

According to these results, all the drainage basins give no water for 25-year return period except for wadi (4). This could be attributed to the fact that this wadi (4) has a higher slope compared to the other wadis (except for wadi (1)) which plays a significant role in reducing the amount of infiltrated water combined with its soil classification. For the 50-year return period, Wadi 2, 5 and 6 do not have a value of flood volumes. This could be due to the low amount of rainfall, low slope gradient and high infiltration rates at these wadis.

The maximum values of flood volumes and discharge occur for 100 year flood return period for wadi (1) and Wadi (3). The table also shows that floods do not take a long time in order to reach their peak values except for wadi (1). The lowest time which occurs for wadi (4) is about 3.5 hours. Taking into account the volume of this flood and the basin length and area, the risk of this flood is considered low. On the other hand, the highest flood takes more than 24 hours to reach to its peak value (wadi (1)).

The floodplain analysis was also performed using the available sources of data and different tools. The cross sections needed to carry out this study were extracted from DEM because of absence of surveying data. Results of this study are presented in terms of floods water depths and velocities at each cross section for the intersection locations with the project area. The results showed that most of the water velocities are inside the safe range and the water depths are below one meter except for wadi (1) as shown in Table (5-5) below.

Table (5-5): Floods Water Depths and Velocities

Locations of Cross Section	Water Depth (m)			Velocity (m/s)		
	100-Year	50-Year	25-Year	100-Year	50-Year	25-Year
Wadi (1)	1.59	0.72	0.00	1.8220	1.0810	0.0000
Wadi (2)	0.16	0.00	0.00	0.2990	0.0000	0.0000
Wadi (3)	0.25	0.06	0.00	0.8240	0.3100	0.0000
Wadi (4)	0.42	0.25	0.10	1.1390	0.7990	0.4250
Wadi (5)	0.16	0.00	0.00	0.3680	0.0000	0.0000
Wadi (6)	0.27	0.00	0.00	0.5290	0.0000	0.0000

The maximum flood velocity occurs at the outlet of wadi (1) with a value of 1.82 m/s, however this velocity is considered a low value for flash floods events since the average velocity usually exceeds 2-3 m/s. It could be concluded that these velocities are not destructive velocities but they still have an effect on the project area.

Within the context of the hydrological study, the following could be concluded:

- The PV park is generally subject to hazards from flash floods that may occur from several drainage basins.
- The total volume of the flood water indicates that some protection works against flash floods hazards are required to maintain the project area of concern safe and secure.
- Project site no. (12) and no.(16) are affected by the water flow from western and northern side while project site no.(24) is affected only by the water flow from the eastern side.
- During floods event all roads leading to these sites would be accessible.
- It is recommended to protect the whole Benban Solar Park area as one unit instead of building a separate construction for each site. Annex 2 of this ESIA report presents the detailed flash flood study.

Mitigation measures

No mitigation measures to be implemented on a single project base. An overall PV park protection measures need to be investigated

Residual impact

Not relevant

5.3 Cumulative Impacts

The IFC “Good Practice Handbook Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets”, indicates that although the environmental and social impact assessment (ESIA) process is essential to assessing and managing the environmental and social impacts of individual projects, it may be insufficient for identifying and managing incremental impacts on areas or resources used or directly affected by a given development from other existing, planned, or reasonably defined developments at the time the risks and impacts are identified.

The IFC Performance Standard 1 limit cumulative impacts to be addressed to those impacts generally recognized as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadways.

In this context, it is important to point out that PV projects generally do not pose environmental adverse impacts during operation activities, and the potential impacts during construction are localized and short term and considered insignificant for the individual project. In this respect, the main potential *cumulative impacts* to be considered by the collective assessment for all projects within the PV park would include:

- **Impact on water resources**
Cumulative effects rising from parallel construction activities for all sites in the PV Park will be significantly higher than for one single project. Considering similar water consumption for all sites in the PV park the water requirement for construction and sanitary purposes will result in 1,200 m³/d based on 30m³/day/site, and abstracting water from the existing water treatment plant may impact on the local communities served by the existing water pipeline due to capacity. The same applies to wastewater and treatment prior to discharging it to soil or water bodies, and will be addressed by the Developers’ Association.
- **Traffic and logistics management**
Workers may be accommodated in nearby local communities. Transport of workers to and from the projects sites may be significant in the high peak periods when all developers have ongoing works at site (up to 18 000 workers to be transported each day). Subsequently, air quality in the local community where workers’ accommodation is located will be affected.

As for air quality, transport of workers to and from their accommodation may cause significant noise in the local communities in high peak periods when all developers have ongoing works at site. For one single project this is not being considered, but the cumulative effects of

negative air quality and noise from workers' transport will be addressed by the Developers' Association.

– **Influx of workers and worker accommodation, catering and transport**

Transport of workers to and from the projects sites may be significant in the high peak periods when all developers have ongoing works at site (up to 18 000 workers to be transported each day), adding even more traffic congestion on the public roads. For one single project this is not being considered, but the cumulative effects will be addressed by the Facility Management Company.

– **Site security**

With regards to site security, and in a broader sense with regards to the safety of the community, one single project is not being considered, but the cumulative effects of the PV park will be addressed by the Facility Management Company.

– **Stakeholders Engagement plans**

With regards to stakeholders engagement in the context with the project of each developer this will not be considered per separate project but for most effective and efficient measures this will be addressed by the Facility Management Company.

The cumulative impacts have been addressed in the Strategic Impact Assessment prepared by NREA. The impact assessment of the cumulative aspects will be studied jointly by the different developers.

In this respect, the Developers' Association is to select the facility Management Company in April 2016.

6. Analysis of Alternatives

The project site is located within the PV Park already dedicated to development for solar energy projects.

When evaluating alternatives, particular emphasis was placed on the environmental and social implications of the alternatives to ensure that the option selected is environmentally sound and meets the Egyptian Laws and regulations.

6.1 No Development Option

The alternative not to develop the proposed plant was used in this ESIA as the scenario with which to compare the environmental and social impacts of project construction, operation and closure.

It is worth mentioning that if the “no-development” alternative be selected, the land proposed for the development would still be used for other renewable energy projects as the site is owned by NREA and has been designated for renewable energy projects.

Considering the type and nature of the single project and that its minimal potential impacts, the “no development” alternative has not been given further consideration.

6.2 Alternative Site Location

All utility-scale solar energy facilities require relatively large areas for solar radiation collection. Solar facilities may interfere with existing land uses, such as grazing, minerals production or any other developmental activities. Solar facilities could also potentially impact the use of nearby designated/protected areas such as areas of critical environmental concern, or special recreation management areas. Proper decision-making is a crucial parameter that would avoid land disturbance and land use impacts. In addition, the cost of land area puts financial burden on the overall project cost.

In this context, the proposed project is located within the PV Park, in the vast and largely unoccupied Western Desert, owned by NREA where other 39 parcels are located and dedicated for solar energy projects over around 37 km². Therefore this location is considered the most suitable to establish the project and other locations outside NREA land area has not been considered.

6.3 Alternative PV technology: CPV

Concentrator photovoltaic (CPV): CPV use lenses and curved mirrors to focus sunlight onto small, but highly efficient, multi-junction (MJ) solar cells. CPV systems must track the sun to keep the light focused on the PV cells, and sometimes a cooling system is required to further increase their efficiency. The primary advantages of CPV systems are high efficiency, low system cost,

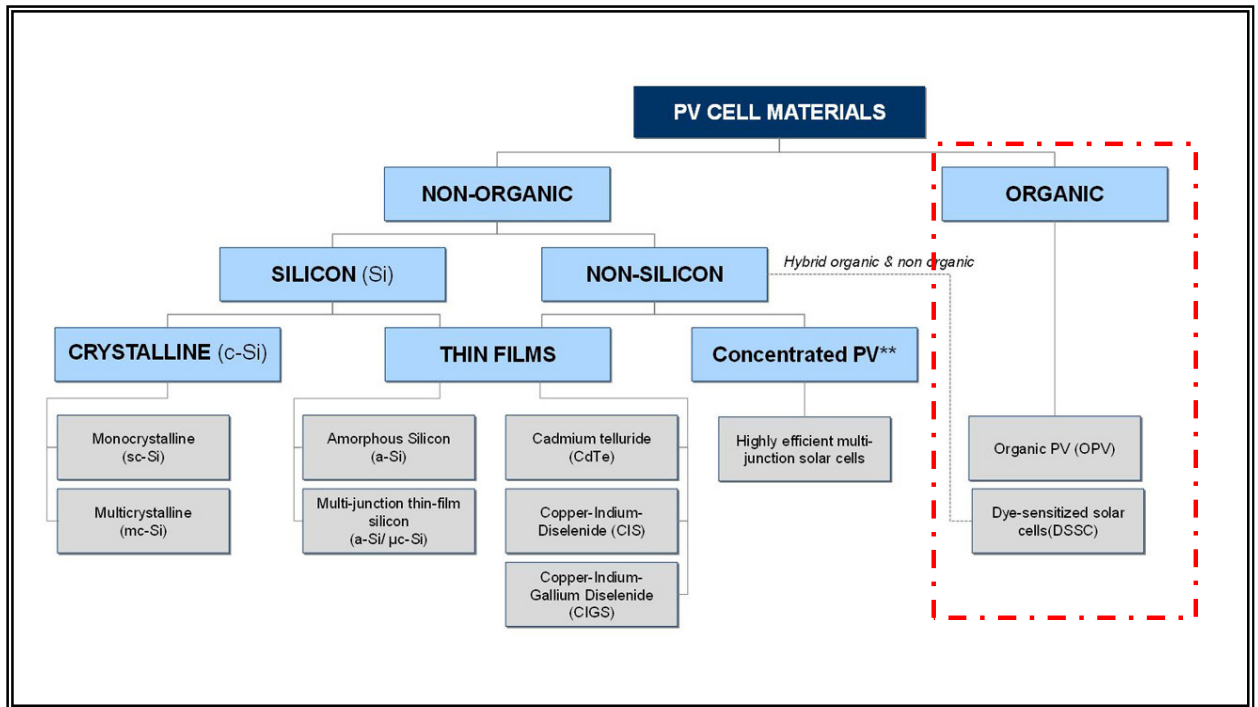
and low capital investment. Reliability, however, is an important technical challenge for this emerging technological approach. CPV systems generally require highly sophisticated tracking devices. Ongoing research and development is rapidly improving their competitiveness in the utility-scale segment. This type of solar technology can be thus used in smaller areas or with limited access to land.

6.4 Alternative PV Types

Types of PV module can be classified by the following 3 types:

- Mono and Poly Crystalline Silicon
- Thin-Film Silicon
- Compound Thin-Film

General classification of the types of PV module is shown in Figure 6-1. Materials marked with red dotted lines means that these are new emerging technologies modules are under research and development stage.



Source: http://sovoxxglobal.com/cell_classification.html

Figure 6-1: Types of PV modules

After comparing the three types of photovoltaic modules in terms of: cost; efficiency; temperature characteristics; life time; environmental consideration; and effect of shade, Poly Crystalline type is selected as possible module for this project mainly because the land use is more efficient than poly crystalline as it requires less area per MW.

In addition thin-film modules come with lower wattage per module and need more cabling and installation effort. Moreover, recycling and waste treatment is well established for crystalline cells and modules. Comparing mono and poly crystalline types, the difference in efficiency is marginal and poly crystalline is more feasible, especially for utility-scale power plants. Table (6-1) shows the comparison between various PV panel options.

Table (6-1): Evaluation Result for each Photovoltaic Module¹

	Silicon crystallized		Silicon Thin film		Compound thin film	
	Mono Crystalline	Poly Crystalline	Amorphous Silicon	MLTF	Cd-Te	CIS
Cost	High	Low	Middle	Low	Low	Low
Efficiency	Excellent	High	Low	Middle	Middle	Middle
Temperature Characteristic	Middle	Middle	Excellent	Excellent	Good	Good
Life time	Good	Good	Middle	Good	Good	Good
Environmental consideration	Safe	Safe	Safe	Safe	Includes hazardous substance Cd	Can include small amount of Cd
Land/per MW	4-5 acres (16187 – 20234 m ² /MW)		7.5-9 acres (30351 - 36421 m ² /MW)			

6.5 Tracking Alternatives

Solar panels can be either fixed to a certain tilt or set to track the sun’s movement across the sky. Solar trackers follow the sun’s trajectory and ensure that the solar panels are positioned for maximum exposure to sunlight.

Compared to a fixed mount, a single axis tracker increases annual output by approximately 15% to 25%².

Thus, tracking systems clearly outperform fixed-tilt systems and are selected for this project.

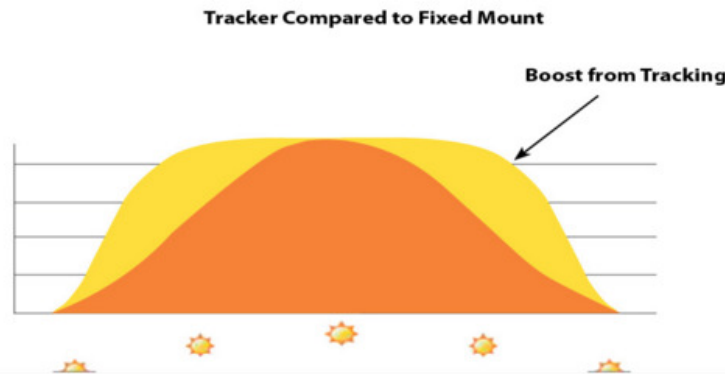


Figure (6-2): Daily power production, fixed tilt versus tracking

Source: First Solar

¹ Developed based on: <http://www.sunsinesolution.com/faq.aspx>, <http://www.slideshare.net/gouravkumar220/solar-panel-technology-ppt> - <http://www.geni.org/globalenergy/research/review-and-comparison-of-solar-technologies/Review-and-Comparison-of-Different-Solar-Technologies.pdt> ,

² Design of a Solar Tracker System for PV Power Plants, Tudorache. T, Kreindler, L. Acta Polytechnica Hungarica, Vol. 7, No. 1, 2010

6.6 Alternative module cleaning

Methods have been investigated for module cleaning, namely:

- **Dry cleaning** : Wiping modules with dry cloths
- **Wet cleaning**: Wiping modules with wet cloth
- **Washing**: Washing with high pressure water

Table 5-2 below presents a comparison between the different types of cleaning methods. It is expected that the cleaning method adopted by Scatec Solar is wiping with dry cloth. Estimated cleaning frequency will be at minimum fortnightly, approximately 25 times per year. For module cleaning Scatec Solar intends to deploy semi-automatic systems based on rotating brush/cloth carried by a tractor equipped with automatic steering. In consideration for redundancy and flexibility, two tractors including a rotating brush shall be deployed. Only in case of significant performance drop due to extraordinary soiling caused for instance by sandstorms, additional cleaning cycles shall be considered and cleaning will be with water almost twice a year.

Table (6-2): Evaluation of the ways of module cleaning

Items	Wipe with dry cloth	Wipe with wet cloth	Washing	Robotic Cleaning
Tools and resources	Rotating brush / cloth carried by tractor; fuel	Rotating brush / cloth carried by tractor; water ; fuel	Water truck; water; fuel	Cleaning machine, power
Number of workers	2 workers, one for each tractor per shift; two shift operation per day (fully manual cleaning would require 15 to 30 workers per shift working in two shifts per day for similar cleaning)		1 x Driver also functioning as Team Supervisor and first Water Operator 1 x second Water Operator 2 x Washer 2 x Squeegee Dryer 2 x Cloth Dryer	each cleaning robot can clean up to 6,000 m ² with one battery load; depending on design of plant / length of table rows min. 70 robots need to be deployed for daily cleaning; 2 workers per shift required for moving robots
Water volume	None	approx 0.4 – 0.6 ltr per module; in total 85 – 126 m ³ per cleaning cycle	approx 0.75 – 1.0 ltr per module	None
Working effort	Easy	Easy	Easy	Easy
Damage on glass surface	Scratch by dust on the surface might cause glass scratching	Stuck dust on the glass might remain and cannot be removed	No damage on the glass	No damage on the glass
Waste	Waste clothes	Waste clothes, waste water for washing clothes	Potential wastewater generation	No waste water
Conclusion	Does not need any water, but longer maintenance time, possible damage on the surface and produce significant waste quantities.	Does not need much water, but longer maintenance time, dust might stuck hard on panels.	High resource consumption and potential generation of wastewater	Continuous cleaning required for avoiding significant accumulation of soil stuck hard on panels

6.7 Alternative water sources

Water supply is required during construction activities and during operation activities for occasional panel cleaning, sanitary purposes and for drinking water.

For cleaning, fresh water (total dissolved solids (TDS) < 1500 mg/L) may be used to clean the modules. Reverse Osmosis (RO) provides the best results in this respect. When RO water is not available, tap water with low mineral content (total hardness <75mg/L) or deionized water may be used. Calcium should not exceed: 75 mg/ml³.

Drinking water is either to be provided through the city water treatment plants and trucked to the site, or using bottled water or water dispenses.

The site is not connected to any water sources thus the potential options would include:

Groundwater abstraction

There are no existing groundwater wells in the project area. The construction and utilization of groundwater wells needs permits from the Ministry of Irrigation and Water resources as well as Environmental Impact Assessment Study. In this context, the management of wells, potential well clogging and the disposal of the resulting pre-treatment liquid waste (brine and/or backwash of demineralization column) constitute the main constraints facing the option of groundwater usage. Moreover, as mentioned in Chapter 4 above, groundwater in the area is at significant depths and the costs for well construction may be significant.

In this respect, constructing water wells is not a preferred option for the project.

Construction of water pipeline from the Nile

The Nile is at distance of about 18 km to the east of the project area, and is at an approximate elevation of 90-1004 m above sea level. For construction of a water pipeline the distance from the river, the Luxor-Aswan road crossing as well as required pumping to the project elevation (at about 153 m above sea level) need to be considered. Additionally this option is likely to include water pre-treatment to remove human health hazards, floating debris and/or oil or other immiscible liquids and minimize excessive turbidity. This option is considered economically inefficient and thus not to be considered for this project (only for the entire PV Park it might be feasible).

³ First Solar (FS), FS-Series PV Module Cleaning Guidelines, 2013 www.firstsolar.com/.../PD-5-804_PV-Module-Cleaning...

⁴ Elevation values are approximate and obtained from Google earth data

Water trucking

Water trucking depends on the proposed cleaning philosophy to be adopted by Scatec Aswan project. As described in Chapter 3 above, a water tank of capacity 150 m³ will be constructed for domestic/sanitary purposes and PV cleaning. In this respect the water trucking does not involve additional infrastructure. Moreover, based on 10 m³ per truck it is estimated to receive about 3 trucks per day.

Accordingly, water is to be trucked to the site and stored in an onsite water tanks for construction and cleaning purposes. This option is a preferred option for PV cleaning.

Drinking water will be provided either from a secure source, bottled or in bigger units.

7. Environmental and Social Management Plan

The project's environmental and social management plan (ESMP) consists of a set of mitigation, monitoring and institutional measures that should be performed during the construction and operation phase to ensure the sound environmental performance of the project. The plan also includes the actions needed to be taken to implement these measures. The overall objective of this chapter is to describe how the Project plans to deliver the mitigation and management measures outlined in this ESIA Report.

The purpose of the ESMP is to:

- ensure continuing compliance with all Egyptian legislation, international Guidelines and Project policies;
- outline the ways in which the potential impacts identified in this ESIA report will be managed;
- provide assurance to regulators and other stakeholders that their requirements with respect to environmental performance are being met;
- ensure that appropriate monitoring is undertaken, including the establishment of a monitoring plan; and
- Provide a framework for the compliance auditing and inspection programmes that will enable the Project to be assured that its aims with respect to environmental performance are being met.

ESMPs will be developed in detail by the Project and their contractors as the PV project develops and as EPC contractors are appointed. The ESMP is to be considered as operational or 'live' documents that will be frequently updated by the project teams to reflect the activities at the project site

The project's EMP consists of the following:

1. **Summary of Impacts and Mitigation Measures** to reduce potentially significant adverse environmental impacts to acceptable levels as discussed in Chapter (5).
2. **Monitoring Plan** during project implementation to provide information about key environmental aspects of the project, particularly to monitor environmental impacts of the project and the effectiveness of mitigation measures.

7.1 Summary of Impacts and Mitigation Measures

Following is a brief summary of the mitigation measures for the construction and operation phases previously discussed in chapter (5). The mitigation measures either address the environmental aspect (for example preventing/avoiding/ minimizing the occurrence of the aspect) or address the potential exposure to the impact. The facility ESMP plan will be developed in accordance with the relevant national regulatory requirements and International Guidelines and project policies.

Contractors commissioned for the construction and operation will be required to undertake the necessary measures to protect the environment and the workers as per the guidelines outlined in section 2.2. The project will ensure that contractors will carry out necessary measures to minimize impacts. This is to be included in the contractor's scope of work (contract) and addressed in the contractor's management plan. This will be in accordance with chapter 2 (construction and work sites) of the Ministerial Decree 211/2003, implementing Labour law 12/2003 as well as the IFC EHS guidelines and the workers' accommodation processes and standards.

The Table (7-1) below presents a summary of the environmental and socioeconomic aspects, mitigation measures and residual impacts as assessed for the different project phases.

Table (7-1): Summary of Impacts

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Summary	Residual Impact
Construction Phase			
1- Ambient Air Quality			
<ul style="list-style-type: none"> Fuel combustion emissions from Diesel generator; Dust emissions during construction activities 	Minor	<ul style="list-style-type: none"> Maintenance of equipment and vehicles; Speed limit restrictions will be implemented on site Dust suppression methods will be adopted where applicable Excavated materials will be covered, as feasible, to reduce potential for windblown matter 	Not significant/negligible
2- Ambient Noise			
<ul style="list-style-type: none"> Machinery and equipment Earth works 	Minor on community.	<ul style="list-style-type: none"> Equipment and machinery will be maintained in good working conditions, Workers will be provided with the suitable PPEs/ear protectors Use of further reduction measures (e.g. mufflers, noise protection) may be assessed. If necessary a grievance mechanism will be adopted for assessing complaints associated with construction noise, if any. 	Not significant/negligible
3- Soil			
<ul style="list-style-type: none"> Septic tanks Solid and hazardous waste Oil leaks and fuel spills 	Moderate	<ul style="list-style-type: none"> Proper, sewage and waste management Proper management of fuels used on to minimize release to soils Emergency response plan to include response to spill scenarios. At decommissioning develop a re-instatement plan 	Not significant

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Summary	Residual Impact
4- Biological Environment			
<ul style="list-style-type: none"> Terrestrial biodiversity 	Not significant	<ul style="list-style-type: none"> Implement and update a solid and liquid waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin 	Not Significant
5- Labor and workplace health and safety			
<ul style="list-style-type: none"> Work environment health and safety 	Moderate	<ul style="list-style-type: none"> A health and safety policy will be applied throughout the project and among all project contractors. Abide by all national occupational health and safety regulations, Law 12/2003 Provision of suitable PPE, training and ongoing safety checks Equipment periodic maintenance according to manufacturers' schedule 	Not Significant
6- Socio-economic			
<ul style="list-style-type: none"> Employment 	Positive	<ul style="list-style-type: none"> work opportunities for local communities mostly during construction phase 	Positive
<ul style="list-style-type: none"> Local communities (including indirect job opportunities) 	Not significant	<ul style="list-style-type: none"> To be assessed in additional ESIA initiated by the Developers' Association 	Not Significant
<ul style="list-style-type: none"> Water resources used during construction activities at project site 	Moderate	<ul style="list-style-type: none"> Develop water management plan Purchase water from a selected water facility 	Not Significant
<ul style="list-style-type: none"> Traffic: Impacts resulting from increased traffic movements 	Moderate for single project	<ul style="list-style-type: none"> Transportation for individual project is estimated to be 30 vehicles/day in total during peak construction (SESA 2016). However, the cumulative assessment to be addressed through the facility management 	Minor for single project
<ul style="list-style-type: none"> Site security and presence of security personnel 	Minor for single project	<ul style="list-style-type: none"> To be assessed in additional ESIA initiated by the Developers' Association 	Not significant for single project

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Summary	Residual Impact
Operation Phase			
1-Ambient Air Quality			
<ul style="list-style-type: none"> Fuel combustion emissions from transport vehicles 	Negligible	<ul style="list-style-type: none"> Maintaining machinery and vehicles 	Negligible
2-Ambient Noise Impacts			
<ul style="list-style-type: none"> Machinery and equipment 	Negligible	<ul style="list-style-type: none"> Potential noise generating machines and equipment are designed to meet statutory regulations concerning noise. Acoustic enclosures are installed for noise generating equipment, wherever possible such as inverters and transformers Workers at noise generating machinery and equipment will be provided with the suitable personal protective equipment (PPEs). If necessary a grievance mechanism will be adopted for assessing complaints associated with operation noise, if any. 	Negligible
Soil			
<ul style="list-style-type: none"> Septic tanks Oil leaks 	Minor	<ul style="list-style-type: none"> Proper domestic wastewater and waste management Proper management of fuels used on to minimize release to soils At decommissioning develop a re-instatement plan Septic tank integrity checking Good house-keeping measures; and, Emergency response plan to include response to spill scenarios. 	Not significant

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Summary	Residual Impact
3- Impact on Biological Environment			
<ul style="list-style-type: none"> Terrestrial biodiversity 	<ul style="list-style-type: none"> Minor 	<ul style="list-style-type: none"> Implement and update a solid and liquid waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin 	Negligible
4- Socio-economic conditions			
<ul style="list-style-type: none"> Employment 	<ul style="list-style-type: none"> Positive 	<ul style="list-style-type: none"> work opportunities for local communities mostly during construction phase 	Positive
<ul style="list-style-type: none"> Workers influx and accommodation 	<ul style="list-style-type: none"> Minor for single project 	<ul style="list-style-type: none"> To be assessed in additional ESIA initiated by the Developers' Association 	Not significant for single project
<ul style="list-style-type: none"> Traffic: Impacts resulting from increased traffic movements 	<ul style="list-style-type: none"> Minor for single project 	<ul style="list-style-type: none"> Transportation for individual project is estimated to be 10 vehicles/day during normal operation (SESA 2016). However, the results of cumulative assessment, once made available by Scatec, is to be incorporated in this ESIA 	Not significant for single project
<ul style="list-style-type: none"> Water resources used for panel cleaning activities and domestic use for O&M personnel 	<ul style="list-style-type: none"> Negligible for single project 	<ul style="list-style-type: none"> To be assessed in additional ESIA initiated by the Developers' Association 	Negligible for single project
5- Labor and workplace health and safety			
<ul style="list-style-type: none"> Work environment health and safety 	<ul style="list-style-type: none"> Minor 	<ul style="list-style-type: none"> A health and safety policy will be applied throughout the project and among all project contractors. Abide by all national occupational health and safety regulations, Law 12/2003 Provision of suitable PPE, training and ongoing safety checks Installing fire detection and fighting system Equipment periodic maintenance according to manufacturers' schedule 	Not significant

7.2 Institutional Arrangements

According to the requirements of the Ministerial Decree 134/2003 of the Ministry of Labour and Manpower implementing law 12/2003, ISO 14001, OHSAS 18001 standards, and Scatec Solar commitment to the protection of persons and environment, a HSE policy will be developed for the facility. Scatec Solar, the contractor and all sub-contractors will at all times comply with National HSE Regulations, Equator Principles and IFC Environmental, Health and Safety Guidelines. The outline of the HSE policy requirements for the PV project is summarized as follows:

- Carry out Environmental Impact Assessment and management plans
- Apply an HSE plan, which will act as the reference document for the project.
- Provide HSE training for all staff on safety and emergency plans and procedures.
- Apply HSE requirements for Contractors

7.2.1 Health and Safety Policy

In order to comply with the company's responsibilities in the field of health, safety and the environment (HSE) and to successfully manage HSE issues, clear and formalized working practices are defined for the project, in accordance with the guidelines of the HSE management system (HSE-MS). These practices will be verified through implementation to ensure they are updated to the current operational risks and regulations.

HSE issues will receive the same priority as other aspects of the project and/or operations e.g. cost, timeline, environment etc. The contractor will develop a specific HSE plan and conduct a risk analysis before construction start, complying with the requirements set out in section 2.4.2.

According to Scatec Solar, the contractor shall develop the specific HSE plan and related plans such as Security Plan, Risk Management Plan, Emergency Preparedness Plan, Waste Management Plan, etc. prior to construction commencement. The plans shall be approved by Employer (Scatec Solar). The contractor is responsible for the implementation of the plans for the duration of the project.

In this context, the following section outlines the HSE plan.

HSE Plan

The HSE Plan ensures that the project's working processes and rules make provisions for:

- Scatec Solar- HSE procedures and guidelines mentioned in section 2.2
- Local regulations for safety and environmental pollution prevention measures
- HSE organization and staff proficiency management, training
- Project management and change management
- HSE management of contractors and the procurement of goods and services
- Analysis of accidents and feedback

- Management of emergency situations
- Verification of the HSE management system and management review

The HSE Audit

The contractor will conduct monthly health, safety and environmental audits of the works including site and office activities. The employer or representatives are entitled to perform audits at any convenient time. Audits to ensure compliance with legal requirements will be performed by an external party annually and audit records will be kept on file on site. Any deviations will be discussed, recorded and rectified immediately

The HSE audit protocol applies to the activities and to the project-specific level of risk. The HSE audit system is used to:

- Verify that HSE management procedures comply with defined requirements, have been successfully introduced and are efficient.
- Pinpoint working processes that require improvement or corrective action
- Define appropriate action plans and assess progress over time.

7.2.2 Human Resources Policy

Under the human resources policy, Scatec Solar is to inform the employees regarding their rights under national labor and employment law, including their rights related to wages and benefits as per the national labour law as well as Scatec Solar HR policies. This policy will be clear and understandable to employees and available in the main language spoken by the workforce. Scatec Solar will not employ children or forced labour.

Thus, the HR policy is to cover the following topics:

- Entitlement to and payment of wages; permissible wage deductions;
- Overtime compensation; hours of work and any legal maximums;
- Entitlement to leave for holidays, vacation, illness, injury, and maternity and other reasons;
- Entitlement to benefits;
- The employees' right to form and join workers' organizations of their choosing without any interference or employment consequences and to bargain collectively with the employer;
- Rights to privacy and data protection;
- Disciplinary and termination procedures and rights;
- Conditions of work;
- Occupational safety, hygiene and emergency preparedness;
- Promotion requirements and procedures;
- Vocational training opportunities;
- Child labor and equal opportunity.
- Retrenchment plans

With respect to contracted workers, Scatec Solar will ensure that the third parties who engage these workers abide by the project's environmental and health and safety management requirements through a contractor management plan. This is to be included in the contractor's scope of work (contract). This is to include ensuring proper housing and accommodation conditions for workers

during construction and/or operation, as relevant¹. In this context, Scatec Solar will establish policies and procedures for managing and monitoring the performance of third party performance.

7.3 Management Plans

Within its commitment to ensure environmental protection and maintain efficient environmental performance as well as social integrity, the project will develop various environmental and social management plans addressing the different environmental and social aspects. These environmental dimensions will be incorporated throughout the project phases. In this regard, the environmental plans to be developed will address:

- Hazardous and solid waste management
- Water and wastewater management
- Preventative and corrective maintenance
- Module Cleaning Philosophy
- Housekeeping
- Fire Fighting and emergency response
- Emergency Response Plan
- Risk management approach
- Training and awareness
- Contractor management
- Community Safety and site security
- Information disclosure and Stakeholder Engagement
- Project Decommissioning Plans

It is worth mentioning that Scatec Solar intend to subcontract the following services to suitable qualified local companies:

- Security of the plant
- Construction works
- Waste management
- Vehicles rental
- General cleaning services
- Inverter and transformer maintenance

The following sections provide details of the various environmental management plans.

¹ Workers' accommodation: processes and standards A guidance note by IFC and the EBRD, 2009

7.3.1 Hazardous Waste (HW) Management

HW at the project site is expected to mainly consist of used machinery oils. Used oils will be collected and temporarily stored until transferred off site. According to the national used oil management system, used oils are collected by Petrotrade or the supplier. The used oils will then be sent for recycling by a specialized oil recycling company.

7.3.2 Solid Waste Management

Main source to solid waste is domestic activities from workers, as municipal solid waste will be generated from the warehouse, offices and catering. In addition, it includes wooden pallets and PV panels plastic packaging materials.

Solid waste would also include damaged PV modules which could be disposed of as solid waste or sold or return to the supplier for recycling for recycling as they contain substances such as glass, aluminum and semiconductor materials that can be successfully recovered and reused in other relevant products. Other waste including cloths from panel cleaning will be disposed of with the domestic solid waste by authorized waste contracts.

Solid waste will be stored on-site until authorized solid waste contractor collects it for final disposal. If possible, when waste disposal is transferred offsite and/or collected by third parties, Scatec Solar will obtain chain of custody documentation to the final destination and will use contractors that are reputable and legitimate enterprises licensed by the relevant regulatory agencies.

Damaged panel management for recycling to be included in the plans overall of the Benban Developers Association (BDA).

7.3.3 Water and wastewater management

Drinking Water

Depending on the source of drinking water the quality of water will be monitored to ensure it is meeting the regulatory requirements as described in section 2.2.5.

Wastewater

The sewage and sludge in the septic tank is to be collected and disposed of through an authorized contractor. The contracts with the authorized wastewater contractors are to be maintained in the site's Environmental Register. Information will also include quantities of wastewater disposed of.

7.3.4 Preventative and Corrective Maintenance

The main objective of the plant maintenance is to maximize equipment availability at an operating condition.

Planned maintenance

Maintenance will be carried out in accordance with:

- Equipment manufacturers' suggested requirements.
- Scheduled inspections according to good maintenance practices.
- Maintenance programs and procedures developed by Scatec Solar, based on their experience in the field.

Preventive Maintenance

The preventive maintenance guidelines are based on:

- A general maintenance plan according to which all maintenance activities are scheduled.
- Regular visual inspections will be conducted for inspecting modules, inverters, structures, electric system, weather stations, monitoring system and security system to detect existing and potential defects. It is particularly important to inspect all plant equipment exposed to the weather.

The main tasks proposed as a minimum maintenance scope are:

- **Modules.** All modules will be cleaned periodically because of the soiling due to dust, leaves or bird droppings. Also performance / power measurements will be taken randomly.
- **Inverters.** At least include; thermal inspections, ventilation and event log checks, earthing connection and efficiency measurements and filter replacement.
- **Structures.** Tightness of bolts and functionality of tracker system will be regularly checked.
- **Electric system.** The maintenance staff will perform measurements of earth resistance, thermal inspection of connection boxes and switches, protection triggering tests and cabling insulation controls.
- **Electronic and Electro-Mechanical equipment** .will include lubricating hinges, bearings and other movable parts such as tracker motors; adjusting torques of bolts and studs of electrical connections and transformers.
- **Metering.** Power metering and quality controls will be checked.
- **Weather station.** Calibration of sensors and sensor cleaning will be undertaken to keep the weather stations in an optimal state.
- **Monitoring system.** All the meters will be checked and recalibrated according to specification.
- **Security system.** Alarm tests will have a periodical test according to the local laws and best practices
- **Enclosures.** Includes cleaning, painting and inspection and repair of the lighting system.
- **Soil, roads and fences:** road, curb and perimeter fencing checking and repairs and weeding clearance are considered.

Corrective Maintenance Plan and Response Times

Preventive maintenance reduces the frequency of breakdowns but cannot avoid them. Unplanned maintenance involves corrective maintenance and emergency repairs resulting from equipment problems, required as a result of equipment breakdowns or deficiencies. Once a problem occurs, the plant maintenance staff is enough trained to carry out the repairs in a quick response time in order to return to the normal operation levels. Corrective maintenance may involve the participation of specialized maintenance contractors.

7.3.5 Module Cleaning

A cleaning strategy is required in order to maintain the production level up to the expected level. Initially and due to the characteristics of this project, semi-automatic dry cleaning will be adopted.

Since the dust deposition on the modules will have a seasonal behavior, the cleaning frequency of the plant will be adapted to keep the optimum production levels during such periods (estimated cleaning frequency will be minimum fortnightly with approx. 25 cleaning cycles per year).

7.3.6 Housekeeping

Regarding housekeeping of the plant, periodic inspection will be carried out to ensure proper housekeeping. Good housekeeping practices will be followed such as:

- Optimizing the use of water.
- Performing noise measurement in the related places within the project area.
- Dust removal

7.3.7 Fire Fighting Plan

Fire hazards may arise from electric equipment, wires and cables. A well designed Electrical Safety Program will protect employees as well as the project. Basic components of the safety program will include:

- Perform an electrical hazard assessment.
- Inform and train employees of the potential hazards and the application of Lockout/tag-out devices and warning labels
- Test and verify that employees are “qualified” to work- on specific equipment.
- Selection and provision of proper personal protective equipment for employees.
- Provide fire alarms
- Installment of fixed and semi-fixed dry chemical fire extinguishing equipment

7.3.8 Emergency Response Plan

Scatec Solar recognizes the importance of an emergency response plan and will adopt a strategic approach to engage potential stakeholders in the project’s success.

Emergency Situations

Emergency situations are those implying collective danger to persons, material goods or the environment. Emergency situations may take place on specific working areas, may be classified from minor to major depending on their importance as follows:

- **Partial emergency:** this emergency situation cannot be solved as quickly as an attempt and forces the personnel to request help from a group of experts who have more material and human resources.
- **General emergency:** this emergency situation exceeds human, firefighting and emergency resources capacity on site, forcing the alteration of all the organization of the company. It has to be replaced by another emergency organization requested from the exterior.

7.3.9 Emergency management plan

Scatec Solar will identify and assess major-accident hazards, and will take all measures necessary to prevent major accidents or limit their adverse impacts on workers, affected communities and the environment, with a view to ensuring high levels of protection to people and the environment in a consistent and effective manner.

Such measures will be identified in a major-accident prevention/emergency preparedness policy and an appropriate management plan, integrated into the overall ESMS. This plan will include organisational structures, responsibilities, procedures, communication, training, resources and other aspects required to implement such policy to ensure that Scatec Solar has the capacity to respond effectively to emergencies associated with project hazards, with the overall objective to:

- Prevent, contain and control incidents so as to minimise the effects, and to limit damage to people, the environment and property
- Implement measures necessary to protect people and the environment from the effects of major accidents
- Communicate the necessary information to relevant emergency services or authorities, as well as to the potentially affected workers and public
- Provide for the restoration and clean-up of the environment following a major accident.

Emergency control

All emergencies should be reported to the Scatec Solar safety department who will contact the relevant emergency services and personnel to deal with the operational side of an emergency.

Generally, Scatec Solar will set basic principles for safety and emergency management systems including the establishment of a major accident prevention policy, the preparation of safety reports, the development of safety management systems and the drawing-up of internal and external emergency plans, as well as, the creation of systems so as to ensure that those plans are tested, revised and implemented.

7.3.10 Risk management approach

Scatec Solar's approach to managing risk on a project is summarized as follows.

- Identify – Identify risks acting on the project
- Analyze – the nature, likelihood, consequence and timing of the risk
- Quantify – (where possible) the consequence and probability of the risk
- Control – Determine the response to risk – accept, track, mitigate, or transfer
- Monitor – Document and communicate risk management strategy, plan and procedures
- Improve – Continuous improvement in risk identification, analysis, quantification, control and monitoring

Mitigating & managing risks

The risks identified in the Risk Register will be evaluated and allocated a risk management strategy:

- Accepted – Risk is deemed acceptable
- Mitigate: Put in place internal and external systems to reduce either the likelihood or consequence of the risk
- Transfer – Transfer the risk to a third party that is better able to manage the risk

7.3.11 Training and Awareness

Employees training and awareness

In order to ensure the competence of the project personnel in undertaking the environmental management procedures and plans, training will be conducted for the personnel according to the particular responsibility.

Training programmes will involve training staff on safe handling of equipment and wastes and on the use of equipment. They will be informed of any potentially harmful health effects related to the PV plant operations. Moreover, they will also be trained on the use of fire reel hose and fire extinguishers. Training plans will be put in place to:

- Ensure that all visitors and site personnel undergo a site specific HSE Induction training session
- Ensure that all records of attendance are kept on file
- Ensure that all visitors and personnel are issued with an access card as proof of site induction
- Provide a list of site specific hazards identified
- Train, inform, communicate and instruct all workers regarding the hazards and risks before any work commences and thereafter at regular intervals as the risks change and as new risks develop. This training will be carried out in the form of the risk assessment and toolbox talks. A record of attendance will be kept on file
- Ensure that Sub-Contractors will conduct their own task specific risk assessments and keep records in the Health and Safety file

Contractor Training and Awareness

Contractors and vendors that perform work on site will be required to show evidence of appropriate health, safety and emergency response training. Environment, health and safety requirements will be incorporated within the individual contractors' contracts. The project will undertake an induction program to advise contractors and site visitors of basic health, safety, and emergency procedures such as emergency signals and evacuation routes. Contractors and vendors on short-term assignments that do not have safety and emergency response training will work under the supervision of the Company staff.

7.3.12 Community Safety

In the course of ensuring that operation assets and personnel are secured and safeguarded in a legitimate manner, the project will follow the instructions of the additional ESIA regarding risks and impacts upon workers, local society and communities in and surrounding the project area of influence resulting from the use of arrangements provided by security personnel, whether privately outsourced or publicly provided . This will be in line with additional ESIA and PV Park security plans

The Project will ensure safe access and security of the site, and ensure the safety of all Employees and visitors to the site .

A “Restricted Access Policy” will be enforced throughout the site. Access of all Employees and visitors will be controlled through the establishment of a registration procedure (e.g. fingerprint or ID registration, tag system, together with the details of the person entering the site). The access to the site construction area shall be via a secure administration office/laydown area.

The Project shall construct and maintain a perimeter and fence in accordance with the Contract. The Project shall implement a site Specific induction procedure – encompassing all Employees, staff and visitors.

For security measures, the Project will contract a company to provide security services. The security company will provide security guards on site, exchanging shifts. The guards will be mainly located at the premises of the site.

Security personnel will have not been implicated in past abuses, appropriate conduct toward workers and community and to act within the applicable law. Furthermore, the grievance mechanism will allow the potentially affected party to express concerns about the security arrangements and acts of security personnel. Scatec Solar will investigate any allegations of unlawful or abusive acts of security personnel, take action (or urge appropriate parties to take action) to prevent recurrence, and report unlawful and abusive acts to public authorities.

7.3.13 Community Development

Community service is a key component for the ESIA. It is understandable that community needs could not all be addressed by one investor/project but should be addressed through collaborative efforts of the different developers. A number of potential opportunities for community development exist and these can be categorized into:

- Training
- Health services
- Infrastructure

Training: This can include training courses for potential employment candidates as well as technical training for university students.

Health services: This can include providing ambulance services and improving local health units.

Infrastructure: this can include the construction of schools, roads and associated facilities.

It is of utmost importance that the means of community development is chosen and undertaken in full coordination with the governorate and local government entities.

Based on the SESA results preliminary areas for potential community development aspects have been identified. In this respect, a detailed needs assessment need to be performed by the Developers Association to focus on development aspects that would ensure sustainability of the community support. The SESA has summarized the proposed areas of support in table below:

Table 7- 2: Priority Community needs and budget

Initiative	Detailed activities	Responsible entities	Estimated
Building capacity of community young people	Mobilize young people who are willing to work in the project; Provide vocational training for young graduates and other young people; Monitor the results of training	NREA; Developers association Vocational secondary schools Training centers in Aswan	Advertising for the trainings+ curriculum preparation + training provision: Total annual cost in the order of 10,000
Upgrading infrastructure in New Fares	The electricity supply system needs upgrading;	NREA; Developers association; Electricity company; The governorate of Aswan	The cost of new cables would be covered by electricity company; the developers association and NREA should initiate this upgrading project
Termites combating	Hire a specialized company in order eliminate termites	Developers association; Agriculture Directorate; Private companies	5,000 \$ annually
Enhancement of health service	Provision of health care personnel that will serve the community and the Benban PV project workers	The developer association Health Directorate	No cost as the health directorate would provide staff. The developers could provide health facilities for their workers which could also serve community people
Upgrading the ambulance unit	Reconstruct the collapsed near the highway; the Ambulance department proposed to furnish the ambulance unit	The Ambulance Department in Aswan and the Developers Association	Construction will cost about 3,000 \$
Street lighting	Provision of solar panel and lamps	Developers Association; Electricity Company	300 \$ per each column

7.3.14 Cultural Heritage

As indicated in Chapter 2 above as well as in the SESA NTS, The Antiquities Authority confirmed that no archaeological finds have been reported on the site and thus issued a "No objection for the Benban Solar Park. However, archaeological/antiquities chance finds remain a possibility. As per the antiquities law, and the IFC PS 8, procedures in case of chance finds should be developed for the site as a whole and for individual investors.

7.3.15 Information Disclosure and Stakeholder Engagement

To ensure the correct level of engagement is being achieved by each stakeholder, the Project will develop a Communication Plan and strategies to communicate project related information to key stakeholders in a proactive and timely manner. The project's plan is to be in line with the overall plan developed by the facility management for the whole PV park. Stakeholders' engagement usually involves the following:

- the disclosure of (NTS) information,
- consultation with affected communities, and
- the establishment of a grievance mechanism.

The receipt of community contacts through a well-functioning system addresses one part of the communication to be maintained with the community.

In this respect, the Project will implement a Stakeholder Engagement Plan (SEP) in line with the overall SEP to be developed by the facility management company for the whole PV park, during construction and operation of the project, which will include but might not be limited to the following components:

- Description of the regulatory and/or Scatec Solar's requirements for consultation and disclosure
- Description of resources and responsibilities for implementing stakeholder engagement activities
- Description of how stakeholder engagement activities will be incorporated into the promoter's environmental and social management system (ESMS).
- Regular liaison with neighbouring villages, district councils and the municipal authority to keep them advised of the project programme, progress and planned activities;
- Timely and appropriate disclosure of information about planned activities to neighbours and the local community prior to and during construction including, in particular, information about any disruptive activities such as transport of abnormal loads or noisy activities;
- Timely and appropriate disclosure of information regarding any significant changes in any activities, as relevant
- Timely and appropriate information about any non-routine activities during operation that could cause disruption, for example major maintenance or repair works;
- Clear information about Emergency Planning arrangements for the local community. Information will be disseminated to stakeholders in a

culturally appropriate manner and will be freely accessible through forms of communication adequate to the relevant community.

The SESA report has provided a number of recommendations that can be taken into consideration by the BDA to ensure proper development and implementation of the Stakeholder Engagement Plan; these recommendations are summarized as follows:

- **Recommendation 1:** assigning a Community Liaison Officer to be responsible for communication with the community as well as a social Development Officer should also be assigned to handle the grievance and redress mechanism.
- **Recommendation 2:** Community Liaison Officer to cooperate with Community Advisory Committee (CAC) to share information and respond to inquiries in monthly meetings while having an active channel with the NREA.
- **Recommendation 3:** conduct separate focus group meetings with women, young people and vulnerable groups. Women-oriented NGOs should be engaged in order to cooperate with them to pass information in simple dialect to poor marginalized women. Young people could be reached via informal meetings in the Youth Center.
- **Recommendation 4:** form a project management unit (PMU), which responsibility would include, but not limited to, raising the workers awareness regarding environmental management aspects on-site, be responsible for establishing information sharing channels with stakeholders as well as implementation of workers grievance mechanism.

The SESA has also proposed a framework for the disclosure of information.

Grievance mechanism

In addition, the Project will develop a Grievance Mechanism that allows the stakeholders to address its comments, worries and complaints that should be accessible. An example of a basic structure for such system is shown in the figure below.

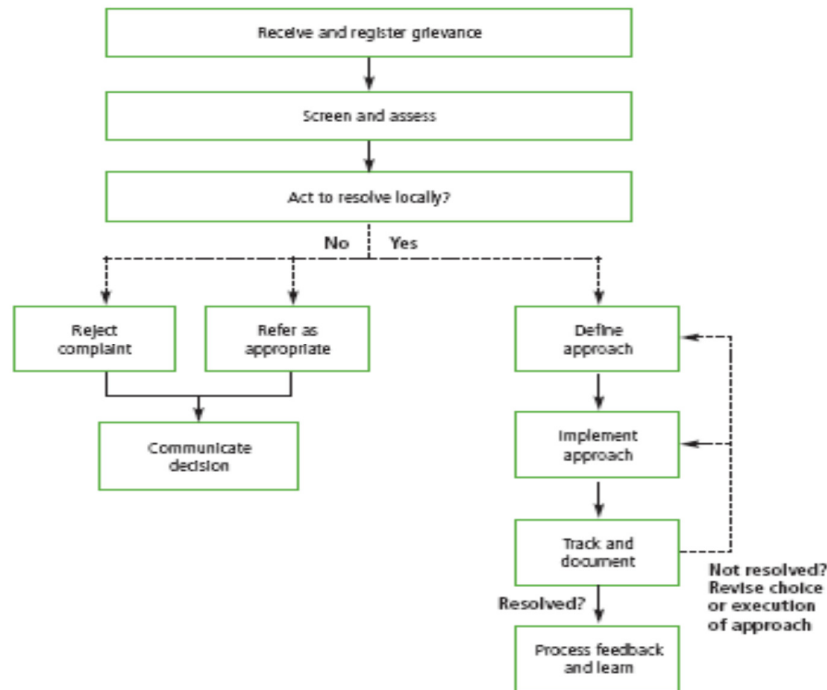


Figure (7-1): Example of Grievance Mechanism Structure

(Source: A Guide to Designing and Implementing Grievance Mechanisms for Development Projects, The Office of the Compliance Advisor/Ombudsman for the International Finance Corporation (IFC), 2008)

All employees shall be informed of this mechanism at the time of recruitment or no later than before start of any work on site. The grievance mechanism shall also include an anonymous communication channel such as a “suggestion box.” The mechanism involves the site management and will address issues and concerns promptly. All issues raised will be addressed using a transparent process that provides timely feedback where applicable, without retribution.

The procedure for the grievance mechanism for both workers and local community is described below.

- A concern is raised, either anonymous or with known name and source. All issues raised are tracked in the projects “Issue Log”, and a responsible person for the issue is identified. The Project / Site Manager is ultimately responsible for all issues, but a concern/issue may be delegated to the Site Manager, HSSE Manager or QA Manager as required .
- Any concern indicating danger for human life, significant environmental damage or corruption will demand an immediate shut down until the concern has been investigated.
- Identified concerns are investigated. All concerns will be evaluated and corresponding reply within 72 hours

For all community related issues the agreed action is added to any planned agenda for information meetings or report. For all workers related issues the agreed action is communicated through the suppliers foreman to all relevant

personnel at first convenience. Such activities have to be in line with additional ESIA and SEP.

- Once agreed actions are completed the issue is closed and final notification is given.

Any concern related to possible corruption, significant security or safety breaches or other potential major concerns gives anyone on site the right and duty to stop work and report to Project / Site Manager.

All concerns and corresponding actions are included in reporting to management as defined in the project charter and relevant reporting templates.

7.3.16 Project Decommissioning Plans

Decommissioning is defined as the close down of operations, the removal of process equipment, buildings and structures and carryout site cleanup and remediation if required. The expected lifetime of the project ranges between 25 to 30 years that will be renewable as long as the proper predictive maintenance measures are taken and all the necessary revamps and upgrades are done. Following are the main issues addressed by the facility's decommissioning plan:

- Development of the decommissioning plan according to international and best practices guidelines.
- Removal procedures for all above ground structures
- Disassemble the PV Modules: The components of the plant will be disassembled and removed. Thereafter they will be reused, recycled (where possible) or disposed of in accordance with regulatory requirements.
- Moreover, the PV modules could be sent for recycling through the PV Cycle Scheme².

7.4 Monitoring Plan

Scatec Solar will adopt rigorous procedures for monitoring and reporting the risks identified in the risk matrices. Monitoring will normally include recording information to track performance and comparing this against the previously established benchmarks or requirements in the management program.

Scatec Solar will document monitoring results and identify and reflect the necessary corrective and preventive actions in the amended management program and plans.

² PV CYCLE applies so-called “Best Available Techniques Not Entailing Excessive Costs” (BATNEEC) that allow our take-back and recycling system to be effective and cost-efficient, PV module recycling enables the recovery of various raw materials and thus helps conserve our valuable natural resources. By increasing resource efficiency and decreasing waste, PV CYCLE contributes to the European Union’s environmental targets. PV CYCLE organizes the recycling of all PV technologies that are commercially available today, whether they are silicon or non-silicon based technologies. <http://www.pvcycle.org/pv-recycling/>

Scatec Solar, in collaboration with appropriate and relevant third parties, will implement these corrective and preventive actions, and follow up on these actions in upcoming monitoring cycles to ensure their effectiveness. Thus, the risk matrices will be re-evaluated on a periodic basis. Any change in the probability or consequence of a risk is documented and the risk management strategy reviewed in light of these changes.

Monitoring results will be fed into the decision making process as a trigger for the implementation of corrective actions, in order to maintain compliance with environmental laws and regulations, ensure environmental protection and workplace safety, as well as to ensure appropriate operation of the mitigation measures and actions stated in management plans. Senior management in Scatec Solar organization will receive periodic performance reviews of the effectiveness of the ESMS, based on systematic data collection and analysis.

Based on results within these performance reviews, senior management will take the necessary and appropriate steps to ensure the intent of Scatec Solar's policy is met, that procedures, practices, and plans are being implemented, and are seen to be effective. Finally, Revised Risk Management Plans are re-issued if necessary.

7.4.1 Monitoring Air Quality

During Construction

Workplace air monitoring of equipment exhaust will be performed quarterly. Emissions are generated from exhaust from construction equipment and motor vehicles and particulates during site works. Monitoring results will be compared with the allowable limits of Law 4/1994 provided in Chapter (2) of this study.

The following parameters shall be measured:

- Carbon monoxide, CO
- Sulfur dioxide, SO₂
- Nitrogen oxides, NO_x
- PM₁₀

7.4.2 Workplace Monitoring

Labour Audit

A Labour Audit is the most widespread spot-check mechanism used nowadays to monitor labour standards (during construction and operation phase). Essentially, it's a tool used to ensure and support the application of the labour standards; it amounts to the thorough formal examination of the labour practices of a particular workplace or company, based on corroborated evidence.

Thus, an audit aims to check these practices against a defined standard and may well extend to supply chains.

In addition, monitoring will cover grievances received from workers and external stakeholders, and how they were resolved.

Workplace Noise

During Construction

During construction, the facility will ensure that the noise level from all operating equipment would not exceed the allowable limit set by Law 4/ 1994 for 8 hours duration shift (90 dB). In case the noise levels exceeded this limit, the exposure periods will be carried out according to those indicated in Annex (7) of Law 4/1994. Moreover, ear plugs will be provided for the workers at the locations generating increased noise levels. Noise level measurement will be carried out quarterly.

During Operation

Sources of noise inside the plant result mainly from transformers and inverters. The measured noise levels will be compared to the levels set in Annex (7) of Law 4/1994. In case the noise exceeded the maximum limit of 90 dB, exposure periods will be proceeded as stipulated in Law 4/1994. Table (7.4) shows the noise monitoring locations and frequencies and the estimated monitoring cost. Regular checks will be carried out twice a year for areas of direct exposure to equipment. Moreover, proper PPEs will be provided for the workers at the given locations.

7.4.3 Solid and Hazardous Wastes

Non-hazardous solid wastes will be recorded in the Environmental register of the plant. On the other hand according to Law 4/1994, a register will be prepared for hazardous wastes. Information of the HW register should include types and quantities of hazardous wastes, storage means and disposal.

7.4.4 Approximate Monitoring Costs

An independent consultant would be hired for carrying out the monitoring activities. The following table (7-3) provides approximate monitoring costs for guidance purposes only. The costs only cover analysis and field measurements. However, they do not include specific sample collection costs.

Table (7-3) Approximate costs for Environmental Monitoring

(Parameter	Description	Approximate annual cost (L.E)
<i>Construction Phase</i>		
Noise level	Measurement at two locations quarterly	1200
Air quality (SO ₂ , NO ₂ , CO, PM ₁₀)	Measurement at 2 locations quarterly	1800
<i>Operation phase</i>		
Workplace noise	Measurement at 2 locations twice a year	800

Table 7- 4: ESMP Summary

Aspect	Issues of concern	Actions	Party Implementing the Action	Indicator of completion	Estimated Cost	Required completion Date
Construction Phase						
Air Quality	Dust emissions	-Water Spraying using low water consuming suppression equipment -Implementing a speed limit for construction vehicles	Construction contractor	-Monitoring plan -Air quality measurements	1800 L.E	Throughout the construction phase period
	working conditions of machinery	-Ensure good working conditions through frequent inspection of all construction equipment	Construction contractor	Maintenance logs	Cost of maintenance	
Noise Level	working conditions of machinery	-Ensure good working conditions through machinery maintenance	Construction contractor	Noise measurements and Maintenance logs	1800 L.E and cost of maintenance	Throughout the construction phase period
	Provision of PPEs	-Providing necessary PPEs for workers	Construction contractor			
Soil	housekeeping practices	-Develop and implement site management plan and a solid waste management plan	Construction contractor Developers (include provisions in the construction contracts. Developers to ensure contractors	-Solid/hazardous waste and wastewater management contract -Contractor follow up documents	-Part of construction activities management -Cost of transportation and disposal	Throughout the construction phase period
	Waste/wastewater management					

Aspect	Issues of concern	Actions	Party Implementing the Action	Indicator of completion	Estimated Cost	Required completion Date
Construction Phase						
			compliance)			
Occupational Health and Safety	Site Staff and Workplace Safety	-Developing HSE procedures according to national requirements and IFC standards	Contractor	HSE provisions in the construction contracts	Construction cost	Before construction activities
Emergency Response plans	Site Staff and Workplace Safety	-Develop procedures for emergency control	Contractor	Emergency response plan		Before project commissioning
Biological Environment	native floral species, if relevant	-Use, as much as possible, native floral species for landscaping, if relevant	Construction contractor			
	waste management	-Developing a solid waste management plan	Construction contractor	Solid waste management contract	Cost of transportation and disposal	Throughout the construction phase period
Cultural heritage	Chance find	-Halt activities and immediately notify the concerned authorities	Construction contractor	Procedures for chance find		Throughout the construction phase period

Aspect	Issues of concern	Actions	Party Implementing the Action	Indicator of completion	Estimated Cost	Required completion Date
Operation Phase						
Water Resources consumption	Water consumption for of cleaning process	- Workers training - Use of efficient cleaning equipment	Developer	Workers training on utilization of cleaning equipment plans and selection of cleaning equipment	Operation cost	Throughout the project lifetime
Labour rights and welfare	working conditions	Develop Human Resources policy	Developer	Contracts (with workers)	Operation cost	Throughout the project lifetime
Training and Awareness	competence of the project personnel	training for the personnel according to the particular responsibility	Developer	Training plans		Throughout the project lifetime
Occupational Health and Safety	Site Staff and Workplace Safety	- Developing HSE procedures according to national requirements and IFC standards	Developer	Development of HSE policies	Operation cost	Before project commissioning
Emergency Preparedness and Response	Operation risk management	- adopt a probabilistic risk assessment framework	Developers	Emergency response plan	Operation cost	
Cumulative Aspects						
Traffic (construction)	traffic during peak construction periods	Develop common traffic management plan for all developers	All developers	Common traffic plan		During construction

Labour rights and welfare (construction)	workers accommodation and working conditions	Include provisions in contractors scope of work (contracts)	Developer (through contracts with construction contractors) and Contractor	Contracts (with contractors)	Construction cost	During construction phase
Stakeholders Engagement	Distribute Traffic	-Distributed over several side roads leading to the site location	Contractors			
	Community liaison activities	-Develop Grievance mechanism -Endorse the SESA Master Disclosure and Engagement plans	Developers	-Develop SEP -Grievance mechanism developed -% resolution of grievances within stipulated timeframes	Projects operation cost	Throughout the project lifetime
Community health, safety and site security	- risk of road traffic accidents -Site security	-Endorse the common site security and safety plans developed jointly by all developers	Developers	-		Throughout the project lifetime