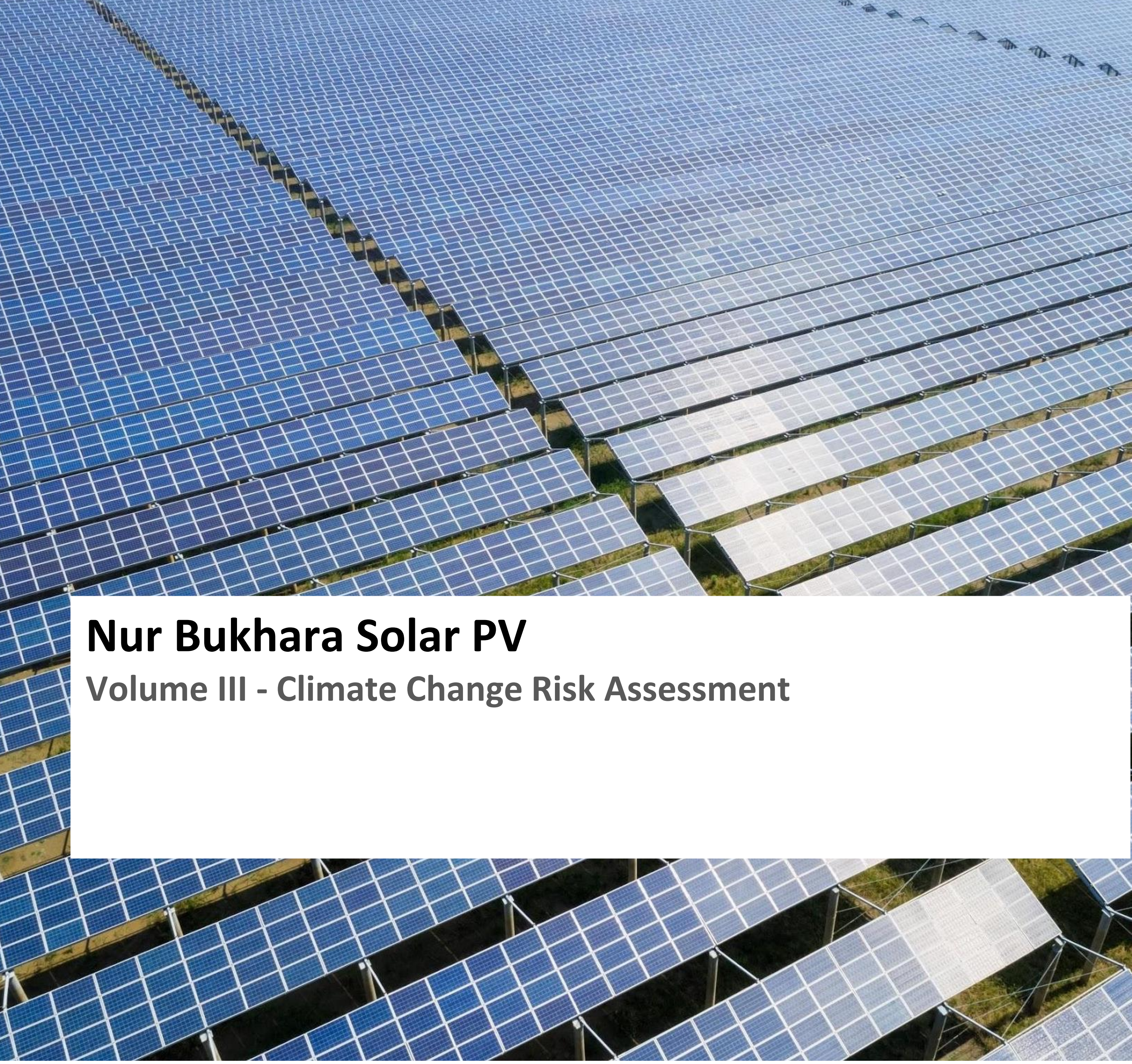

Nur Bukhara Solar PV

Volume III - Climate Change Risk Assessment

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Disclaimer

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Abbreviations

Acronym	Definition
AoI	Area of Influence
BESS	Battery Energy Storage System
CCKP	Climate Change Knowledge Porta
CNTIC	Chinese National Technical Import and Export Corporation
EBRD	European Bank of Reconstruction and Development
EP4	Equator Principles 4
EPFIs	Equator Principles Equator Principles Financial Institutions
ESIA	Environmental and Social Impact Assessment
ESP	Environmental and Social Policy
GoU	Government of Uzbekistan
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
JE	Juru Energy
KPIs	Key Performance Indicators
RCP	Representative Concentration Pathways
TCFD	Task Force on Climate-related Financial Disclosures
OHS	Occupational Health and Safety
PPA	Power Purchase Agreement

1 Introduction

1.1 Overview and Project background

Abu Dhabi Future Energy Company PJSC ("Masdar" or the "Developer") has been awarded by the Ministry of Energy, Government of Uzbekistan, to design, build, finance, construct, commission and operate, maintain and transfer the Nur Bukhara Solar photovoltaic (PV) Project with a capacity of 250 MWA and 63 MW/126 MWh Battery Energy Storage System (BESS) ("Project"). The Project will be designed to meet national regulations and international standards. The Project will be implemented through a long-term, i.e., 25 years power purchase agreement (a "PPA") between Nur Bukhara Solar PV LLC Foreign Enterprise (the Project Company or the Company) and JSC National Electric Grid of Uzbekistan ("NEGU") as the off-taker.

The Project will support Uzbekistan to:

- Reduce energy dependence on carbon-based fuels.
- Meet renewable energy targets.
- Reduce greenhouse gas emission rates.

Masdar has appointed Juru Energy Ltd. (JE or the ESIA Consultant) to perform an Environmental and Social Impact Assessment (ESIA) for the Project. The ESIA will be developed following the requirements of the International Finance Corporation (IFC) Performance Standards (PSs) and with reference to EBRD Environmental and Social Policy 2019 (ESP 2019) Performance Requirements (PRs) and the Equator Principles.

This document is the Climate Change Risk Assessment (CCRA) and has been prepared on behalf of Masdar. The purpose of this document is to present a climate change risk analysis following the requirements of the Equator Principles 4 2020[1] (EP4) for the Project. In line with that guidance, the scope of work is to include consideration of climate-related 'Physical Risks' as defined by the Task Force on Climate-Related Financial Disclosure (TCFD)[2]. This document will be submitted as part of Nur Bukhara ESIA - Volume III.

1.2 Objectives

This CCRA aims to identify the likelihood of future climate hazards and their potential impacts on the operation of the Project, Project workers and neighbouring communities. This is fundamental for informing the prioritization of climate action and adaption and resilience management requirements for the Project.

1.3 Structure

The CCRA is set out as follows:

- Section 2.0 - Project Description

1 https://equator-principles.com/app/uploads/The-Equator-Principles_EP4_July2020.pdf
2 https://www.fsb-tcfd.org/

- Section 3.0 - Applicable Framework (Policy / Lender)
- Section 4.0 - Approach and Methodology
- Section 5.0 - Climate Risk Assessment
- Section 6.0 - Summary of alignment with the Paris Agreement

2 Project Description

The PV Project comprises a 250 MWA and 63 MW/126 MWh Battery Energy Storage System (BESS). The Project ESIA: Volume II, June 2023, provides a full project description. In summary, the Project is located on 645 ha of land in the Alat District of the Bukhara region, a region in the southwest of the Republic of Uzbekistan. It is located 24 km southeast of Alat City, close to the border with Turkmenistan. The proposed Site is flat and is surrounded by the Amu-Bukhara Irrigation System (ABIS) canal to the North, South and East, national road R78 to the north and drainage channels and ponds located approximately one kilometre to the West of the Project area. The Project location and layout are presented in Figure 1, Figure 2, and Figure 3.

Assets included in the Project scope include:

- PV Panels and tracking system including control system including inverters (dry cleaning).
- Trackers.
- Low and medium voltage electrical installation.
- Battery energy storage system (Li-Io) located in self-contained enclosures.
- 220kV substation (including three transformers, indoor GIS switchgear and officer.
- 300m 220kV overhead line (OHTL) connection to an existing OHTL, "Karaku'l 500 SS" - "Hamza-2 SS" requiring one new tower and approximately 200m of new conductor wire).
- Access from the existing R-78 regional road.
- Perimeter drainage system and ditch-shaped internal drainage network on the side of the interior roads where runoff water is collected (Drainage design will be sized for 1: 100-year storms and consider future climate change predictions in sizing).
- Construction laydown.
- Worker's accommodation camp (to be confirmed).
- Supporting infrastructure, e.g., onsite buildings, diesel generator, guard house, drainage system and emergency response infrastructure).
- Security system.

A summary of the PV and BESS systems is provided in Table 1 below.

Table 1: PV plant and BESS configuration

Elements	Parameter	Unit	
PV plant Configuration	Peak Power of Modules	MWp	290,043
	Apparent Power of Inverters (at 45 ºC)	MVA	285,516
	Access Capacity	MW	250.0

Elements	Parameter	Unit	
	DC/AC Ratio (installed P. /. Access C.)	-	1.01 / 1.16
	Number of inverters	Ud.	927
	Number of modules	Ud.	513,352
	Number of strings	Ud.	~18,000
	Number of structures 1P x 84/56	Ud.	6,153
	Number of modules per string	Ud.	28
	Pitch	m	9
BESS System Configuration	AC power	kW	63,000
	AC Installed Power	kWh	126,000

Construction phase water will be sourced from the municipal water supply source and delivered to the Site by tanker for short-term storage and use. During operation, water needs at the Site will be low. The tanker will supply clean water and water for general needs to the Project site and be stored in an onsite tank sized to the needs of the workforce and operations. Potable water will be bottled.

The Project construction phase will last from 12 to 16 months. The works will be led by an engineering, procurement and construction (EPC) contractor who will have subcontracts with suppliers and sub-contractors for the following activities:

- Transportation contractor
- Civil works /balance of plant contractor
- Electrical contractor (PV site) (low voltage)
- Electrical contractor (medium and high voltage)
- Service suppliers (accommodation, geotechnical surveys, road construction, security, catering)

The total workforce required during the peak construction period is approximately 250-500 workers (skilled and non-skilled). The PV and BESS Plant will be maintained and operated by skilled personnel, ensuring that the system is in optimal condition and that all parts are fully serviced and functional. The permanent workforce is not expected to exceed ten persons; not all persons will be permanently based on the Site. During maintenance works, the number of people on Site may increase, but this will be intermittent (up to twice per year) and limited to a short duration (two to three weeks or less). An overview of the project activities for each phase is presented below.

- Mobilization phase

- Transportation of civil construction materials to the Site
    - Storing of materials
    - Recruitment of local workforce/services
    - Identification of local materials
- Site set up
    - Preparation of accommodation facility
    - Procurement
    - Construction phase - civil works
    - Secure Site
    - Construct internal access road
- Site clearance/excavations
    - Foundation works (including delivery of cement)
    - Cabling excavations
    - Transportation of abnormal loads of materials to the Site
    - Construction of operations building stores and maintenance yard
    - Enabling work
- Construction phase - mechanical and electrical works
    - PV/BESS infrastructure installation
    - Excavation for placement of tracking system
    - Construction of SS
    - Installation of SS equipment
    - LILO connection
    - Commissioning
- Operation phase
    - Operation of PV / BESS project.
    - Day-to-day maintenance
    - Periodic/planned maintenance
    - Monitoring
- Decommissioning phase (construction)
    - Reinstatement of excavated areas
    - Removal of construction materials
    - Rehabilitation of temporary storage and accommodation areas

The PV and BESS transportation from the factory will combine sea and land freight. The primary and alternative routing solutions are as follows:

- Direct Rail Route traditional route from China via Kazakhstan up to Tashkent hub;
- Sea Rail Route via Turkey alternative route, by sea to Mersin port in Turkey and further by rail to destination;

Sea Rail Route via Baltic Sea alternative route, by deep sea to Baltic ports, and by rail to the Site. The construction duration is expected to be one year, from September 2023 to August 2024, with an operational lifetime of 25 years (2024 to 2049), which may be extended following refurbishment or replacement.

Figure 1: Project Area

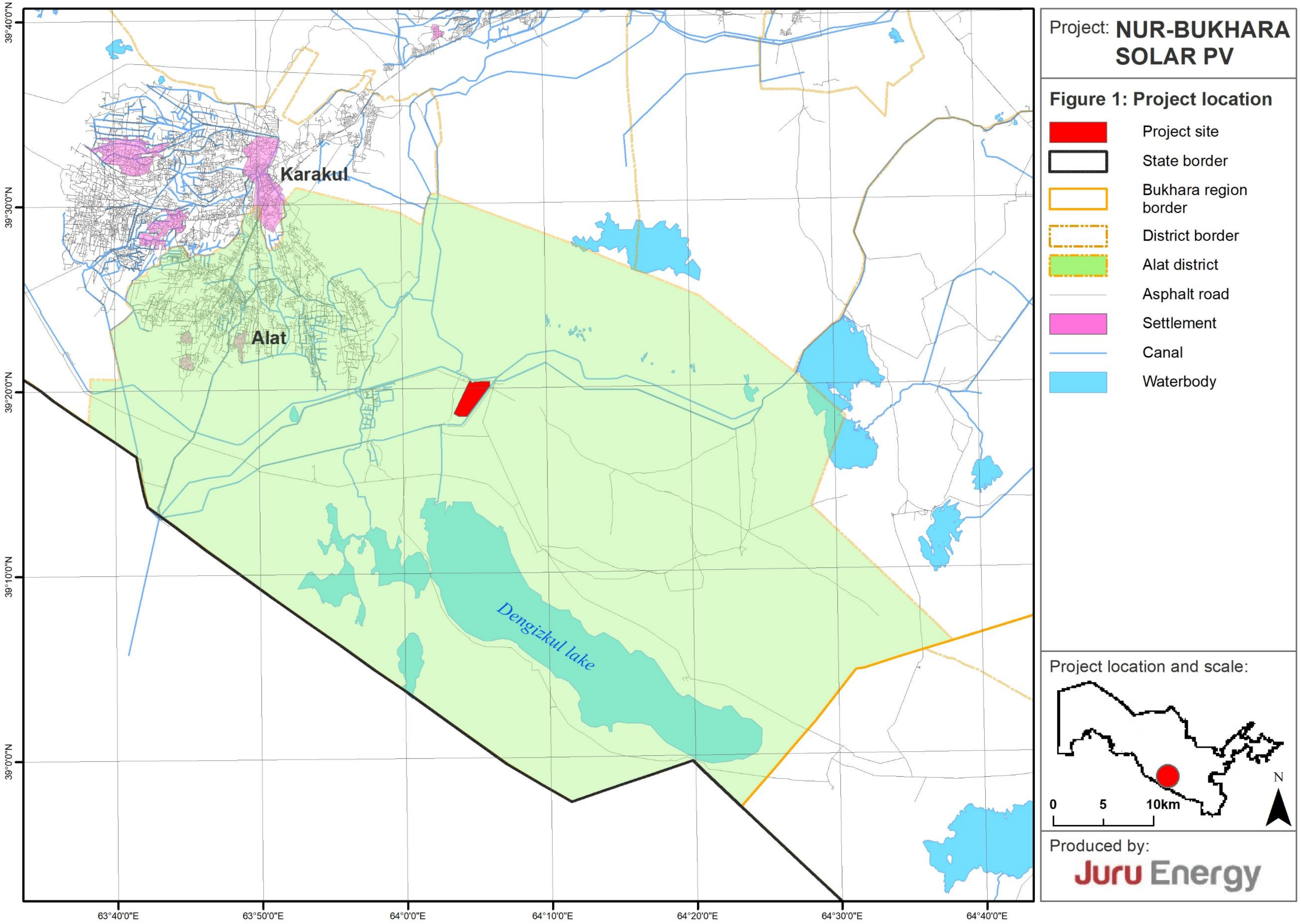


Figure 2: Project setting (map view)

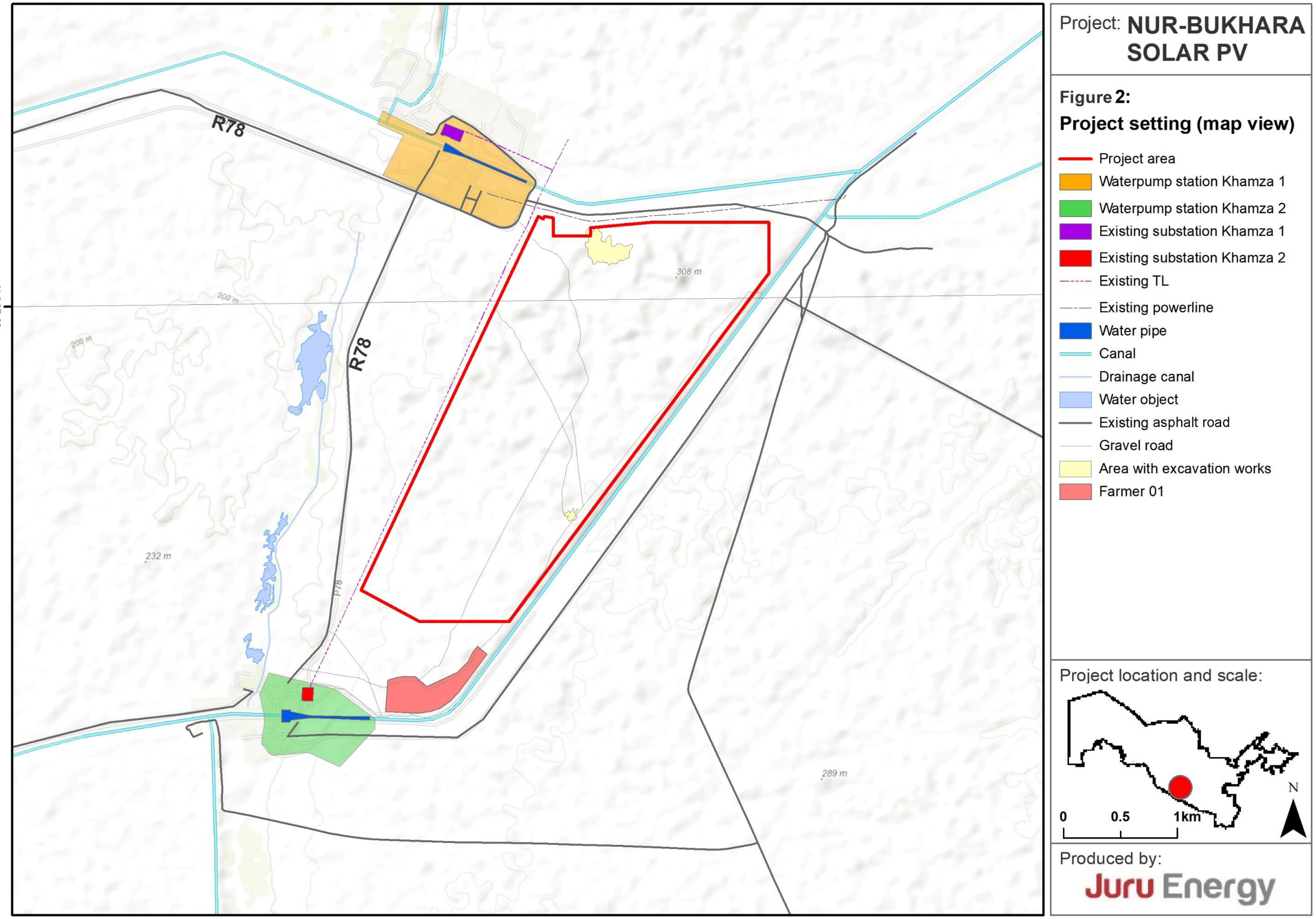
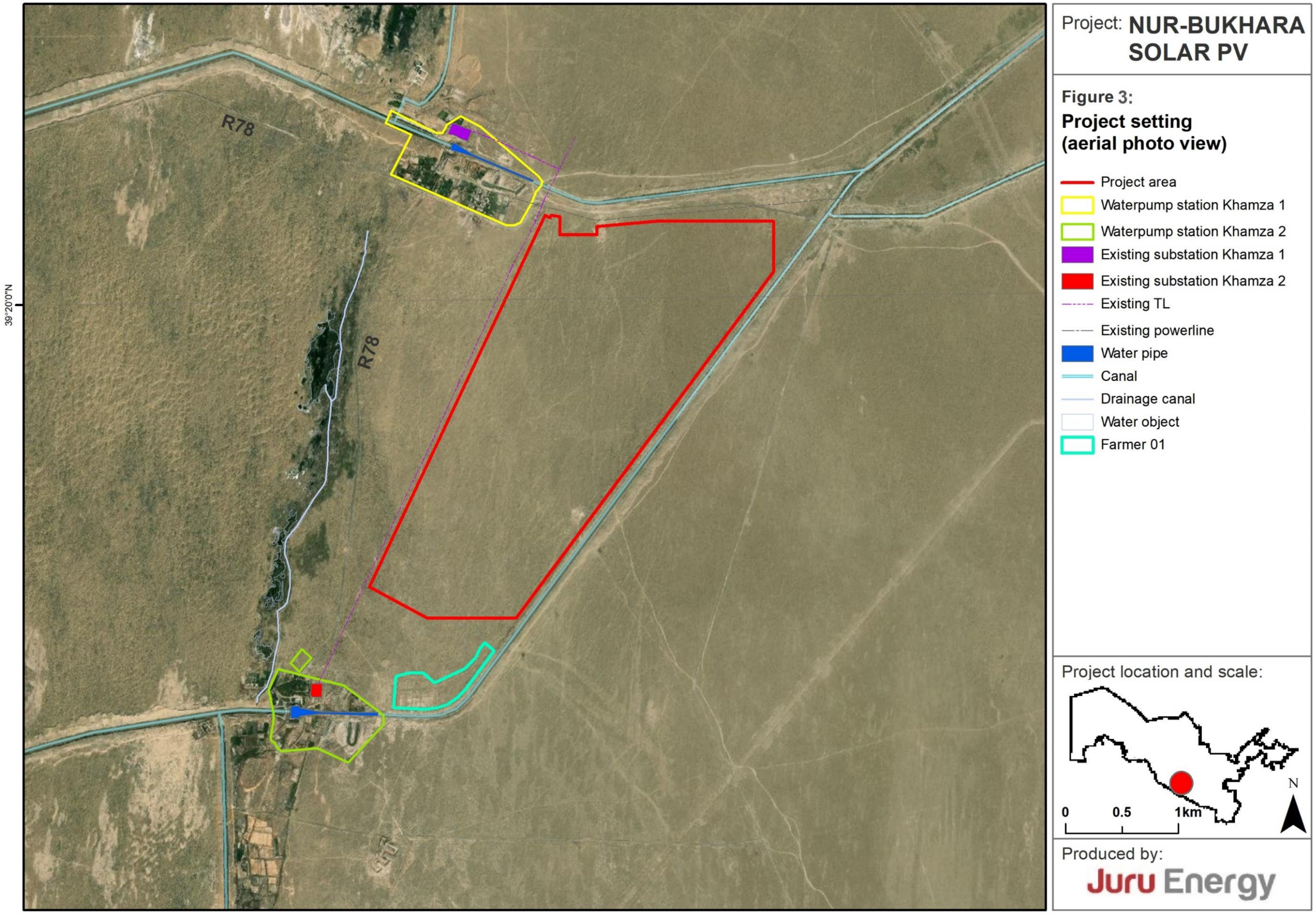


Figure 3: Project setting (aerial photo view)



3 Legal and Institutional Framework

3.1 National Policy Overview

Uzbekistan is committed to a low GHG development pathway and has adopted policies and strategies that support this goal. Fundamental legal and regulatory laws include:

- Law of the Republic of Uzbekistan "On Ratification of the Paris Agreement" (No.ZRU-491 dated 02.10.2018).

Under this law, Uzbekistan submitted its Third National Communication to the UNFCCC, ratifying the Paris Agreement in November 2018, bringing its Intended Nationally Determined Contribution (INDC) into effect for the period up to 2030[3] (see section 3.2). This envisages international and financial support, ensuring access to advanced energy-saving and environmentally sound technologies and resource allocation for climate financing. The ratification of the Paris Climate Agreement committed Uzbekistan to transition to a green economy and adoption of the following normative documents:

- Law of the Republic of Uzbekistan "On the Use of Renewable Energy Sources" (ZRU-539 dated 21.05.2019).
- Decree of the President of the Republic of Uzbekistan. № PD-4477, dated October 4, 2019, "On approval of the Strategy on transition of the Republic of Uzbekistan to the "green" economy for the period 2019-2030".
- Decree of the President of the Republic of Uzbekistan, № PD-5863, dated October 30, 2019, "On approval of the Concept of environmental protection of the Republic of Uzbekistan until 2030".

Priority areas of "The Strategy on the Transition of the Republic of Uzbekistan to the "Green" Economy for 2019-2030" relevant to the electricity-producing industry are:

- Reconstruction and modernization of generating capacities of existing power plants with highly efficient technologies based on combined cycle gas and gas turbine units.
- Improve configurations and modernization of main power networks to increase the stability of the power system.
- Implementation of organizational and technical measures, including optimization of modes.
- Increasing the level of automatization of technological processes.

3 https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf

3.2 Intended Nationally Determined Contribution (INDC)

Uzbekistan shares the opinion of the world community regarding the necessity to apply efforts to control global climate change following the capabilities and responsibility of each country on a reasonable and equitable basis. According to the decision of the 20th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)4, 1/CP.20, and following the national circumstances and sustainable development goals, considering the transition of the country to a resource-efficient development model, the Republic of Uzbekistan has identified. It presents its INDC for the period up to 2030.[5, 6] The original mid-term objective of the Uzbekistan 2017 INDC was to decrease specific emissions of greenhouse gases per unit of GDP by 10% by 2030 from the 2010 level. In October 2021, the country submitted a revised version of its INDC to the UNFCCC (updated NDC). The updated NDC sets a target for reducing GHG emissions per unit of GDP by 35% below 2010 levels by 2030. Other key policy commitments include:

- Decrease in GDP energy consumption by approximately two times as a result of the introduction of advanced energy saving technologies.
- Further development of renewable energy sources to bring their share to 25% of the total power generation.
- Ensure access to modern, affordable and reliable energy supply for up to 100% of the population and sectors of the economy.
- Upgrade the infrastructure of industrial enterprises and ensure their sustainability by increasing energy efficiency by at least 20% and by wider use of clean and environmentally friendly technologies and industrial processes.
- Expand the production and use of motor fuels and vehicles with improved energy efficiency and environmental performance, as well as develop electric transport.
- Significantly increase water use efficiency in all sectors of the economy, introduce drip irrigation technologies on up to 1 million hectares of land and increase crop yield by up to 20-40%.
- Achieve Land Degradation Neutrality; − increase the average productivity of basic agricultural products by 20-25%.

3.3 National Adaptation Plan (NAP)

In January 2020, with financing from the Green Climate Fund, Uzbekistan launched a project to develop a National Action Plan (NAP) and integrate climate change adaptation into national and subnational planning and budgeting processes. As part of the development of the NAP, in 2020, the Ministry of Energy of Uzbekistan launched a national Low-carbon Energy Strategy aimed at developing

4 1/CP.20 "Lima Call for Climate Action". It contains invitation to all Parties to communicate their intended nationally determined contributions (INDCs) well in advance.

5 Third National Communication of the Republic of Uzbekistan to the UNFCCC (2016) (UNFCC - Uzbekistan 3rd national Communication)
6 Intended Nationally Determined Contribution (2017) (https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/nationally-determined-contributions-ndcs) / 2021
https://unfccc.int/sites/default/files/NDC/2022-06/Uzbekistan_Updated%20NDC_2021_EN.pdf

alternative energy sources, including solar, hydro and wind, to produce electricity with low-carbon emissions. Priority actions in the plan include modernizing and reconstructing existing power plants and constructing new generating assets using energy-efficient power production technologies. Additionally, Uzbekistan adopted its first statute providing regulation of its renewable sector through the Renewable Energy Law enacted on 22nd May 2019. This law seeks to help Uzbekistan diversify its economy and reduce its reliance on fossil fuels by developing and regulating renewable energy.

Uzbekistan also implements measures for adaptation to and mitigation of climate change impacts, including the implementation of Clean Development Mechanism (CDM) Projects within the framework of the Kyoto Protocol. Over the entire period of the CDM project activities in Uzbekistan, it has put into circulation 15,229,536 tons of Certified Emission Reductions in CO2-equivalent (CERs). and attracted foreign private investments in the amount of USD 24.4 million.

3.4 International Finance Corporation

According to the IFC's Performance Standard 1, the client must "*establish and maintain a process for identifying the environmental and social risks and impacts of a project*." As part of this process, *"the risks and impacts identification process will consider the emissions of greenhouse gases (GHGs), the relevant risks associated with a changing climate and the adaptation opportunities, and potential transboundary effects, such as pollution of air, or use or pollution of international waterways*". For projects expected to generate more than 25,000 tonnes of CO2 equivalent (tCO2e) per year of GHG emissions, quantifying the direct and indirect emissions within the Project boundaries shall also be carried out in line with an internationally recognized methodology.

3.5 Equator Principles

The Equator Principles is a voluntary set of principles institutions, called Equator Principles Financial Institutions (EPFIs), sign on to, in order to show their commitment to assess and manage the environmental and social risks of their projects. Equator Principles 4 (EP4) also sets out obligations for climate change risk analysis (CCRA) in line with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). Following the EP4 guidance note on CCRA,[7] a CCRA is required in the following instances:

- For Category A and, as appropriate, Category B projects. For these projects the CCRA is to include consideration of relevant climate-related 'Physical Risks' as defined by the Task Force on Climate-Related Financial Disclosure (TCFD).
- For all projects, in all locations, when combined Scope 1 (direct) and Scope 2 (indirect electricity) emissions are expected to be more than 100,000 (tCO2e) per year. For these

7 https://equator-principles.com/app/uploads/CCRA_Guidance_Note_Sept2020.pdf

projects the CCRA is to include consideration of climate-related 'Transition Risks' (as defined by the TCFD).[8]

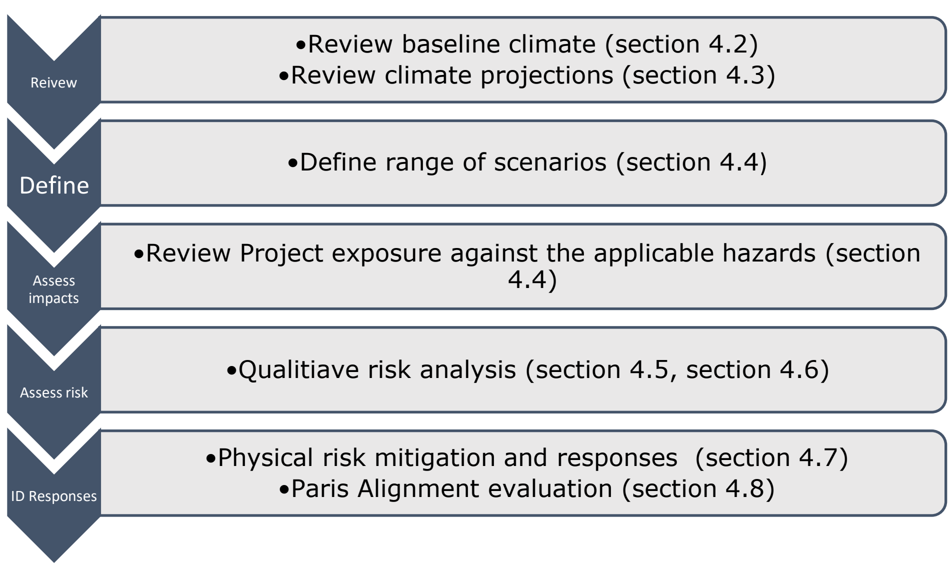
The Project is expected to be categorized as a Category B project under EP4, and combined Scope 1 and Scope 2 emissions are not expected to be greater than 100,000 (tCO2e) per year; therefore, a consideration of physical climate-related risks only has been performed. Transition risks, typically considered policy risks, technology risks, market risks and reputational risks, are not relevant for the development of a solar PV Project in Uzbekistan as the development of solar PV is aligned with country policy in this area. EP4 also states that for Projects that have combined Scope 1 and Scope 2 emissions greater than 100,000 (tCO2e) per year, the CCRA must also include a completed "climate change alternatives analysis", which evaluates lower greenhouse gas (GHG) intensive alternatives. As noted above, Scope 1 and Scope 2 emissions are not expected to be greater than 100,000 tonnes; therefore, a climate change alternatives analysis has not been performed.

4 Climate Change Risk Assessment

4.1 Approach and Methodology

Figure 4 outlines the main steps to complete a qualitative assessment for physical risks aligned with the TCFD process for applying scenario analysis of climate related risks and opportunities suitable for solar PV projects[9]. The findings from this analysis will be disclosed on the Project website. Regular reporting and analysis will be ongoing throughout the lifetime of the Project.

Figure 4: Process for climate change risk assessment



8 The TCFD sets out a process for scenario risk to climate related risks and opportunities to support the integration of scenario analysis into strategic planning and project risk management.
9 June 2017, TCFD recommendations report

4.2 Baseline Climate Overview

Uzbekistan has an arid and continental climate characterized by large variations in temperature within days and between seasons. Large parts of the country (79% by area) feature flat topography either in the form of semi-desert steppes or desert zones, including desert areas in the far West that have formed due to the drying of the Aral Sea.

The majority of the territory of Uzbekistan is attributed to a moderate climate zone. According to the criteria of the UNESCO world map of desertification and the UN Convention to combat desertification, the country has an aridity index from 0.03 to 0.20, categorizing it as an arid region subject to intensive desertification and droughts. The southern part of the country is located in the arid subtropical climate zone. In the West, the climate is sharply continental with dry, hot summers, relatively cold snowless winters, and a moisture deficit, with a significant excess of evaporation over precipitation. The remaining south-eastern areas have a continental climate, including the area covering the largest cities of Tashkent and Samarkand, and contain high mountains forming part of the Tien-Shan and Gissar-Alai Ranges[10]. In general, temperature ranges vary across the country. Uzbekistan's desert regions can reach maximum temperatures of 45-49°C, while minimum temperatures in the southern parts of the country can drop as low as -25°C [11].

Alat district has a mid-latitude desert climate (Classification: BWk), characterized as cold and semi-arid. The district's yearly temperature is 20.19ºC, which is 2.52 % higher than Uzbekistan's averages. Alat typically receives about 11.91 millimetres (0.47 inches) of precipitation and has 27.79 rainy days (7.61% of the time) annually[12].

The TYPSA scoping report provides data on the project site's climatology obtained from the stations located close to the Site. The climate data was obtained from the Central Asia Temperature and Precipitation Data, which was operated by the National Snow and Ice Data Centre https://nsidc.org/data/G02174/versions/1)[14]. This data is presented below.

10]https://climateknowledgeportal.worldbank.org/sites/default/files/2021-09/15838-Uzbekistan%20Country%20Profile-WEB.pdf
11 https://tcktcktck.org/uzbekistan/bukhara/dzhankel-dy
12 Alat, Bukhara, UZ Climate Zone, Monthly Averages, Historical Weather Data (tcktcktck.org)
13 IFC, Typsa, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project
14 IFC, Typsa, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project

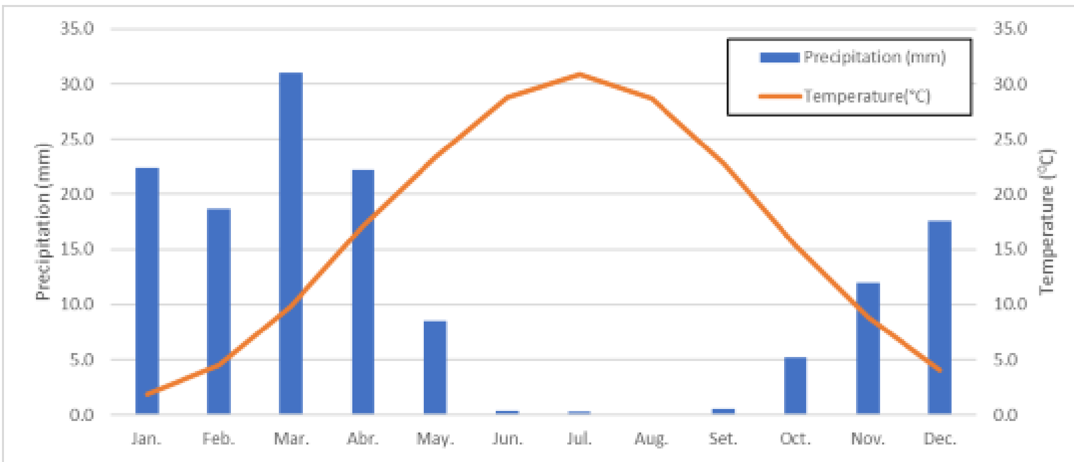
Figure 5: Average monthly statistics of air temperature and precipitation

Parameter	Jan.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Aug.	Set.	Oct.	Nov.	Dec.	Year
Temperature(°C)	1.9	4.5	9.8	17.2	23.3	28.8	30.9	28.7	22.8	15.4	8.8	4.1	16.4
Precipitation (mm)	22.4	18.7	31.0	22.2	8.5	0.4	0.3	0.1	0.6	5.2	12.0	17.6	139.1

Source: IFC, TYPSA, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project

The bar chart below shows monthly precipitation and temperature variability for the project site[15].

Figure 6: Average monthly precipitation and temperature variability at the project Site

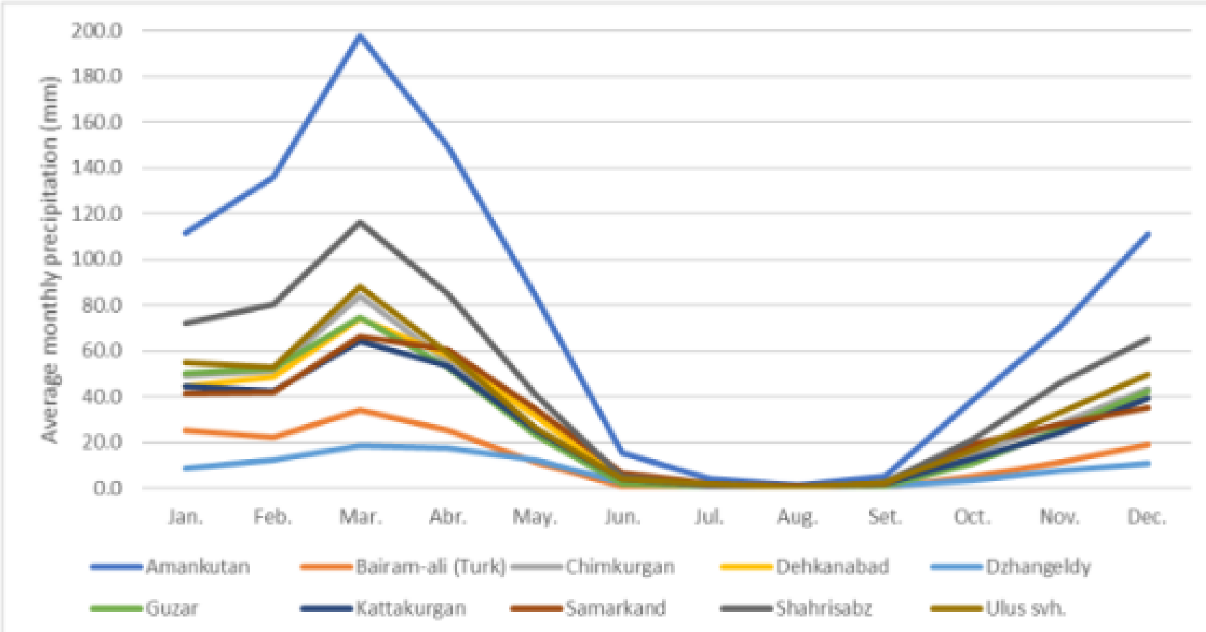


Source: IFC, TYPSA, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project

Precipitation data for ten meteorological stations is shown in the next graph depicting very dry summers with most of the precipitation occurring between December and May[16].

15 TYPSA Hydrology and Hydraulic Report.
16 IFC, Typsa, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project

Figure 7: Average monthly precipitation for ten stations.



Source: IFC, TYPSA, 2022. Environmental and Social Scoping Report – Bukhara Solar PV Project

4.3 Climate Change Trends and Projections

The primary data source for the World Bank Group's Climate Change Knowledge Portal (CCKP), which has been used as the primary source for identifying projections in this section, is the Coupled Model Inter-comparison Project Phase 5 (CMIP5) models, which are utilized within the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), providing estimates of future temperature and precipitation[17] .

In that portal, the future climate projections have been developed with GHG emission projections, which are Representative Concentration Pathways (RCP) 2.6, RCP4.5, RCP6.0 and RCP8.5 for medium and long terms by CMIP5 and CMIP6 approaches.

The RCP4.5 and RCP8.0 will be used for this assessment to determine future trends and apply these to the Project:

- RCP 4.5 is described by the IPC as an intermediate scenario and assumes that with policy interventions to lower emissions over time with emission peaking around 2040 and then declining. Implied warming is up to 2.6°C by the end of the 21st century. According to the IPCC, RCP4.5 requires that carbon dioxide (CO_2) emissions start declining by approximately 2045 to

17 https://climateknowledgeportal.worldbank.org/country/uzbekistan/climate-data-projections

reach roughly half of the levels of 2050 by 2100. This is the scenario which is alignment with the Paris Agreement.

- RCP 8.5 describes a 'business-as-usual' scenario, where global emissions continue to rise throughout the 21st century. Implied warming is up to 4.8°C by the end of the 21st century – the upper end of the pathway - with many physical climate risks changing (e.g., cyclones).

The period for the assessment is 2040 and 2059, approximately aligned with the expected operational duration (25 years from 2025 to 2050) and 2080–2099 (which coincides with a potential extended operation period from 2050 to 2080).

4.3.1 Temperature

Under all emissions pathways, average temperatures in Uzbekistan are expected to rise significantly by the 2090s relative to their 1986–2005 baseline. The rate of warming for Uzbekistan exceeds the projected global average temperature rise. Both maximum and minimum temperatures are expected to rise more quickly than daily mean temperatures, with an increase of 5.6°C expected by the 2090s, under RCP8.5 for both indicators. The model ensemble projects the most significant increases to occur during the summer months (June to September), with a rise as high as 6°C by the end of the 21st century under the RCP8.5 pathway. Additionally, the July daily maxima are expected to exceed 35°C in many parts of Uzbekistan, with warming of this magnitude likely to have a severe socio-economic impact on the country as summer temperatures reach hazardous levels. Notably, the lowest level of warming is suggested for the central province of Bukhara (5.1°C−5.2°C) under the RCP 8.5 pathway by the 2090s. [18] The above trends are is summarised in Table 2 below.

Table 2: Projected anomaly (changes °C) for maximum, minimum, and average daily temperatures in Uzbekistan for 2040–2059 and 2080–2099, from the reference period of 1986–2005 for RCP 4.5 and RCP 8.5. The table shows the median of the CCKP model ensemble and the 10–90th percentiles in brackets1920

Scenario	Average Daily Maximum Temperature		Average Daily Temperature		Average Daily Minimum Temperature Scenario	
	2040-2059	2080–2099	2040-2059	2080–2099	2040-2059	2080–2099
RCP4.5	1.9 (0.1, 4.1)	2.7 (0.7, 4.9)	1.8 (0.2, 3.7)	2.6 (0.7, 4.6)	1.9 (0.0, 3.9)	2.5 (0.4, 4.7)
RCP8.5	2.5 (0.5, 4.8)	5.4 (3.2, 7.8)	2.5 (0.7, 4.5)	5.3 (3.3, 7.4)	2.5 (0.6, 4.6)	5.2 (3.1, 7.5)

18 Climate Risk Country Profile: Uzbekistan (2021): The World Bank Group and the Asian Development Bank
19 WBG Climate Change Knowledge Portal (CCKP, 2020). Climate Data: Projections. URL: https://climateknowledgeportal.worldbank.org/country/uzbekistan/climate-data-projections; reproduced from Climate Risk Country Profile: Uzbekistan (2021): The World Bank Group and the Asian Development Bank.

20 Monthly/annual average temperatures are most commonly used for general estimation of climate change, but the daily maximum and minimum can explain more about how daily life might change in a region, affecting key variables such as the viability of ecosystems, health impacts, productivity of labor, and the yield of crops, which are often disproportionately influenced by temperature extremes

4.3.1 Precipitation

The trends for precipitation are less consistent than for temperature varying between reductions in total annual precipitation to increases. The anticipated change in total annual precipitation ranges from a decrease of three per cent to an increase of 12 % by 2030 and a decrease of 6 % to an increase of 18 % by 2085, with most projections showing an increase. Nevertheless, it is likely that there will be increased precipitation between November and April, with precipitation in other months remaining stable or decreasing slightly. It is also expected that current dry spells will grow longer by up to four days by 2085, leading to an overall increase in arid conditions due to changing precipitation patterns and increased temperatures. It is also possible that Uzbekistan will witness an increase in the intensity of heavy rain events by 3 to 11 % and frequency by 7 to 36 % by 2030, and intensity by 7 to 23 % and frequency by 12 to 74 % by 2085. [21,22]

4.3.1 Climate-related natural hazards

Uzbekistan's Climate Risk Country Profile Report has performed disaster risk ratings for climate-related natural hazards, as summarised in Table 3 below.

Table 3: Climate-Related Natural Hazards[23]

Flood (0 - 10)	Tropical Cyclone (0-10)	Drought (0- 10)	Vulnerability (0-10)	Overall Risk Level (0-10)	Rank (1-191) (1st is the most at risk)
6.3 [4.5]	0 [1.7]	6.6 [3.2]	1.9 [3.6]	3.1 [4.5]	112 [3.8]

Overall, weather conditions in the country are expected to become hotter and drier, with more frequent and more intense heatwaves, droughts and modifications in precipitation patterns leading to increased related extreme weather events such as heavy rains, floods and mudflows.

4.3.2 Heatwaves

Uzbekistan regularly experiences high maximum temperatures, with an average monthly maximum of around 18.5°C but with an average July maximum of 34.9°C. The current median probability of a heat wave (defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentile of daily mean temperature) for Uzbekistan is around 2%. The frequency of heat waves has already risen, with the sharpest increase observed in the northwestern areas surrounding the Aral Sea and the lower Amu Darya.13 This has led to a rise in the number of very hot days (>40°C), which have been shown to amplify the effects of ischemic heart disease in Uzbekistan.

21 Climate Service Center Germany. 2016 (https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en)
22 Tashkent. 2016. Third National Communication of the Republic of Uzbekistan Under the UN Framework Convention on Climate Change.
23 Selected indicators from the INFORM 2019 Index for Risk Management for Uzbekistan. For the sub-categories of risk (e.g. "Flood") higher scores represent greater risks. Conversely the most at-risk country is ranked 1st. Global average scores are shown in brackets

The daily probability of a heatwave is projected to increase in Uzbekistan under all emissions pathways. This increase in heat wave probability is expected to occur as soon as the 2030s, even under the lowest emissions (RCP2.6) pathway. Primarily, increases in heatwave probability simply reflect the general increase in ambient temperatures, which constantly move away from the baseline (1986–2005) against which heat wave is measured. Another lens through which to view extreme heat is the annual frequency of days in which temperatures breach 35°C. [24]

4.3.1 Drought

Uzbekistan's arid climate and regular high temperatures make drought an increasingly regular occurrence, with one drought every five years on average during the 1980s and 1990s and four episodes between 2000 and 2012.[25] Three kinds of drought occur in the country: hydrological drought (water shortages from January to March due to low precipitation in the upper watershed of key rivers), meteorological drought (usually associated with a precipitation deficit and typically occurring in spring or summer), and agricultural drought (a lack of moisture in the soil that inhibits crop growth). Hydrological drought has been occurring with increasing frequency and severity in the western areas of Uzbekistan in the past two decades, whereas the central and southern provinces have experienced the highest frequency of meteorological drought. The CCKP model ensemble suggests that the annual probability of experiencing a severe meteorological drought in Uzbekistan could increase significantly by the 2090s under all but the lowest emissions pathway.[26]

4.3.1 Flood and mudflow[27]

The majority of Uzbekistan is at high risk of both river flooding and flash flooding. As of 2010, assuming protection for up to a 1 in 25-year event, the population annually affected by flooding in Uzbekistan is estimated at 61,000 people. The climate change component can be isolated and, by the 2030s, is expected to increase the annually affected population by 13,000 people and GDP impact by $143 million under the RCP8.5 emissions pathway (AQUEDUCT Scenario B). Flash flooding and mudflows pose an increasing threat to southern and eastern parts of Uzbekistan, with 3,300 such events occurring between 1900 and 2013. These phenomena typically occur between the months of March and July, fed by precipitation and potentially by melting snow. The potential increase in the intensity of precipitation during extreme rainfall periods flags the importance of further study.

4.4 Overview of Potential Hazards and Risks

Climate physical risks result from climate change, which involves event-driven (acute) or longer-term shifts (chronic) in climate patterns. Acute physical risks refer to those that are event-driven, including increased severity of extreme weather events such as cyclones, hurricanes, or floods. Chronic physical

24 Climate Risk Country Profile: Uzbekistan (2021): The World Bank Group and the Asian Development Bank
25 FAO (2017). Drought characteristics and management in Central Asia and Turkey. FAO Water Reports 44. URL: http://www.fao.org/3/a-i6738e.pdf
26 Climate Risk Country Profile: Uzbekistan (2021): The World Bank Group and the Asian Development Bank
27 Climate Risk Country Profile: Uzbekistan (2021): The World Bank Group and the Asian Development Bank

risks refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves. With reference to the TCFD list of potential climate hazards, a review of the physical hazards to identify those with the potential to impact the workforce and physical infrastructure has been performed. The results of the hazard screening are presented in Table 4. The baseline hazards were evaluated based on the review of recognized global and national-level open-source databases/literature, as summarised in section 4.3 above. Those hazards considered relevant (medium and high) are evaluated in more detail in the following section.

Table 4: Hazard risk review (High/medium – relevant hazards, low – scoped out)

Climate-related hazard	Sensitivity	Risk /Relevance to the Project
Temperature increase (mean)	High	An increase in mean temperature is projected to increase in Uzbekistan under all emissions pathways and will affect the Project area, infrastructure and project workers (during construction and operation). This may be heightened for any extended operations period (post-2050).
Prolonged periods of extreme heat (heat waves)28	High	The daily probability of a heatwave is projected to increase in Uzbekistan under all emissions pathways and will affect the Project area, infrastructure operability and project workers (during construction and operation). This may be heightened for any extended operations period (post-2050).
Extreme cold	Low	This Project is located in a region with limited evidence that extreme cold would impact a project of this nature.
Precipitation increases, in particular, an increase in extreme rain events	Medium	This Project is located in a region where extreme precipitation may occur under all emissions pathways. This may be heightened for any extended operations period (post-2050).
Flooding (pluvial, fluvial, groundwater)	Medium	The proximity of the ABIS canals (albeit regulated) makes localized flooding a potential risk and relevant to the Project.
Coastal flooding	Low	The Project is located inland and is not at risk from coastal flooding.
Precipitation decreases	Medium	The Project does not heavily rely on water; however, Uzbekistan does suffer from water resource constraints, and the Alat region typically only receives about 11.91 millimetres (0.47 inches) of precipitation and has 27.79 rainy days (7.61% of the time) annually therefore even small changes may be significant and relevant for the Project.
Water availability (stress and drought)	Medium	The Project does not heavily rely on water; however, Uzbekistan does suffer from water resource constraints where even small changes may be significant (see above). The Project will source its water from the municipal water supply that originates from the Amu-Bukhara River. The sustainability of this source may decrease over time and is therefore relevant to the Project.
Cyclones	Low	The Project is not located in a cyclone-prone area.

28 Defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentile of daily mean temperature OR days in which temperatures breach 35°C. (15383 Uzbekistan Country Profile)

Climate-related hazard	Sensitivity	Risk /Relevance to the Project
Landslides	Low	The Project is located across relatively flat terrain. No significant slopes are noted near the Project. Landslides are not considered a risk.
Wind speed increase, / storms more frequent dust storms/ thunderstorms, tornadoes,	Medium	It is suggested that storms are assessed because of the potential impacts of the event, and the likelihood of dust storms is relevant.
Wildfires (increased frequency)	Low	The Project is located in a region with limited evidence that wildfires have previously impacted this type of Project.
Earthquake (increased frequency)	High	The Site is located within a high-risk seismic zone.

4.5 Impact Evaluation – Approach

The physical risk analysis approach follows the ESIA impact assessment approach adopted for the EISA (Nur Bukhara ESIA, Volume II). It considers the sensitivity (or vulnerability) of the receptor (i.e., the Project or the workforce) and the magnitude of the impact (or the exposure to climate risk) for each relevant hazard identified in Table 4 above. RCP8.5 scenarios have been qualitatively considered for impact magnitude to apply a conservative approach.

Table 5: Significance evaluation

Significance		**Magnitude**					
		Negative			Positive		
		Low	**Medium**	**High**	**Low**	**Medium**	**High**
Receptor sensitivity	**Low**	Neutral	Minor	Moderate	Neutral	Minor	Moderate
	Medium	Minor	Moderate	Major	Minor	Moderate	Major
	High	Moderate	Major	Critical	Moderate	Major	Critical

4.6 Receptor Sensitivity

The sensitivity represents whether the climate change parameter will affect the project operation, while the exposure represents the changes in future scenarios. The sensitivity (or vulnerability) rating is assessed as summarized in Table 6.

Table 6: Sensitivity Results

Climate-related hazard	Sensitivity
Mean Temperature increase, °C	High
Extreme Temperature (Number of Hot Days >40°C or prolonged periods), °C	High
Days with Precipitation > 20 mm	Low
Flooding	Medium
Precipitation decreases	Low
Water availability (stress and drought)	Low
Increased wind speed	High
Earthquake	Medium

4.7 Climate Risk

The projected magnitude of the climate change impact based on the descriptions provided in section 4.3 and their specific relevance to the Project are summarized in Table 7.

Table 7: Project impact magnitude

Climate Drivers	Projected Impact		Description of impact
	2040 and 2059	2080–2099	
Mean Temperatures	Medium	High	Decrease in capacity and generation efficiency and battery capacity Decrease in capacity for cooling of batteries
Extreme Temperature, °C / Number of Hot Days >40°C	Medium	High	Decrease in capacity and generation efficiency Loss in generation efficiency for cooling of batteries Increases heat-related illnesses of personnel Increases life-cycle costs of buildings
Days with Precipitation > 20 mm / Flooding	No consistent projections, but it is expected to increase (Medium)		Damage to infrastructure and supply chain disruption due to flash floods. Reduced access to the Site for construction and maintenance (operation phase) (from flooding along the ABIS canal)

Climate Drivers	Projected Impact		Description of impact
	2040 and 2059	2080–2099	
			Affect the health and safety of personnel.
Precipitation decreases /water scarcity	No consistent projections, but it is expected to increase (Medium)		Affect water availability for general works (construction and operation) and sanitary and potable water use.
Increased wind speed (dust storms)	Medium	High	Damage to infrastructure (grid system and PV) Affect the health and safety of personnel

4.8 Minimization of Physical Risks

While climate change impacts are not anticipated to be significant over the design life of the Project (25 years), project outputs sensitive to climate change were identified along with climate change risk response (mitigation) measures. Several measures are represented in Table 8 below, with a summary of the physical risk chapter and residual impact analysis. Recommendations include adequate engineering design of sites (e.g., project siting away from the ABIS canal, suitable stormwater drainage systems and foundations, all-weather road pavement and drainage on the access road and internal roads, high design standard transmission line, and regular maintenance.

The critical climate-vulnerable project components (e.g. transmission line, transformers, BESS, OV panels) will be subject to further analysis during the Project's detailed engineering design to ensure they take account of projected increases in flooding; measures that will permanently become part of the solar park infrastructure will be included within the main civil work contract costs. Measures to protect worker health and safety are also noted. These have been fed back into the ESIA for implementation as part of the construction environmental and social management system.

Table 8: Summary Table of the Climate-Related Physical Risks, Adaptation Measures and Residual Risks

Climate Drivers	Projected Impact		Hazard	Risk		Preliminary Scoping of Adaptation Measures	Initial Assessment for Residual Risks	
	2040	2065		2040	2065		2040	2100
Mean Temperatures	Medium	High	Decrease in capacity and generation efficiency and battery capacity Decrease in capacity for cooling of batteries	Minor	Medium	• Impact of high ambient temperature on the plant. • Plant for shading around the battery containers and operational offices. • Build concrete-sided buildings instead of metal. • Change the shift hours in line with the cooler hours. • Construct resting rooms/areas with adequate ventilation at optimum temperature. • Erect temporary shade at all work fronts for all workers.	Neutral	Neutral
Extreme Temperature, °C / Number of Hot Days >40°C	Medium	High	Decrease in capacity and generation efficiency Loss in generation efficiency for cooling of batteries Increases heat-related illnesses of personnel	Minor	Medium	• Impact of high ambient temperature on the plant. • Plant for shading around the battery containers and operational offices. • Build concrete-sided buildings instead of metal. • Change the shift hours in line with the cooler hours (e.g., take an extended lunch period during the day (construction) and ensure regular breaks). • Erect temporary shade at all work fronts for all workers.	Minor (Moderate worker health)	Moderate

Climate Drivers	Projected Impact		Hazard	Risk		Preliminary Scoping of Adaptation Measures	Initial Assessment for Residual Risks	
	2040	2065		2040	2065		2040	2100
			Increases life-cycle costs of buildings			• Construct resting rooms/areas with adequate ventilation at optimum temperature. • Suspend work out on the Site during extreme heat days (>40°C).		
Days with Precipitation > 20 mm / Flooding	Medium		Damage to infrastructure and supply chain disruption due to flash floods. Reduced access to the Site for construction and maintenance (operation phase) (from flooding along the ABIS canal) Affect the health and safety of personnel	Minor	Medium	• Site critical infrastructure away from the ABIS canal. • Ensure a suitable stormwater drainage system for a 1:100-year storm. • Design foundations (PV panels and tower foundations for extreme rain events. • Reduce dependency on the supply chain with storage of materials and equipment. • Construct shelters away from flood sources (i.e. ABIS canal) for use in heavy precipitation.	Minor	Minor
Precipitation decreases /water scarcity	Medium		Affect water availability for general works (construction and operation) and sanitary and	Negligible	Minor	• The plant is planned for dry cleaning panels, so there are limited operational phase water needs. • The plant is equipped with a zero liquid discharge	Minor	Minor

Climate Drivers	Projected Impact		Hazard	Risk		Preliminary Scoping of Adaptation Measures	Initial Assessment for Residual Risks	
	2040	2065		2040	2065		2040	2100
			potable water use.			• Water to be sourced for the municipal supply system reducing the potential for competition issues. • Install rainwater storage tanks to use any rainwater in the plant operation, if necessary, in the future.		
Increased wind speed (dust storms)	Medium	High	Damage to infrastructure (grid system and PV) Affect the health and safety of personnel	Minor	Medium	• Design for maximum wind speeds. • Consider more frequent cleaning. • Construct resting rooms/areas with adequate ventilation for high wind/dust periods. • Suspend work out on the Site during high winds.	Minor	Minor

5 Summary of Alignment with the Paris Agreement

Following MDB Paris Alignment Note, [29] a Project needs to be aligned with both mitigation (BB1) and adaptation and resilience (BB2) parts of the framework to be considered "Paris-aligned." A summary of project risks and mitigation factors, as discussed above, against the BB1 and BB2 screening criteria for MDBs is provided in Table 9. Individual Lenders must satisfy their internal policies on Paris Alignment.

Table 9: Summary of project factors against BB1 and BB2 screening criteria

Uniform Assessment Criteria	Proposed finding	Project Response
BB1 – UC1 - Is the Project included in the "universally aligned list' with activities that have a positive or negligible impact on the climate[30]?	Yes	Yes. Renewable energy generation (e.g., from wind, solar, wave power, etc.) with negligible lifecycle GHG emissions is considered an eligible operation type. Electricity transmission and distribution, including energy access, energy storage, and demand-side management, is considered an eligible operation type. ALIGNED.
BB2 – is the project aligned with the overall adaptation goals of the Paris Agreement?	Yes	Project climate risk and vulnerability context have been described as per EP4 requirements, and measures to reduce material physical climate risk and build climate resilience have been described in section 5.7. The operation is consistent with relevant national policies/strategies and national climate adaptation and resilience priorities. ALIGNED.

29 World Bank. Joint MDB Methodological Principles for Assessment of Paris Agreement Alignment of New Operations : Direct Investment Lending Operations - List of Activities Considered Universally Aligned with the Paris Agreement's Mitigation Goals or Not Aligned (English). Washington, D.C. : World Bank Group. http://documents.worldbank.org/curated/en/099220306162369703/IDU00ef11f9807471044870b9c6041d5dda75c78

30 List of Activities Considered Universally Aligned with the Paris Agreement's Mitigation Goals or Not Aligned with the Mitigation Goals (version 1.0, June 2023) https://documents1.worldbank.org/curated/en/099220306162369703/pdf/IDU00ef11f9807471044870b9c6041d5dda75c78.pdf