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Rogun Hydropower Project – Updated Environmental And Social Impact Assessment

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10 Climate Resilience

10.1 Introduction

10.1.1. This Chapter considers climate change in two ways; an assessment of the Project's vulnerability to the physical risks of climate change and an assessment of the risks from transitioning to a lower-carbon economy.

10.1.2. A Climate Risk and Vulnerability Assessment (CRVA) has assessed the physical risks of climate change and the potential impacts on Rogun Hydropower Plant (HPP) (the Project) during its lifetime. The CRVA considered the vulnerability of the Project to climate variables identified in the future baseline, assessed the impacts with consideration to the design adaptation measures which improve the resilience of the Project to the impacts of climate change.

10.1.3. Transition risks in the context of climate change arise during the transition to a lower carbon economy. The changes required to facilitate the transition will give rise to a range of risks including policy and market changes, technological advances and reputational risks around higher emitting operations and a lack of resilience to climate impacts and future climate projections.

10.2 Climate Risk and Vulnerability Assessment

10.2.1. The scope of the CRVA is to assess physical climate change impacts on the current, partially constructed, Project (existing and proposed assets), across its future operational lifetime (up to and including the 2090s). Hydropower generation is sensitive to weather, particularly weather events that impact on hydrological conditions such as precipitation and temperature, and it is imperative that climate change is considered in the planning and management of the Project[1].

Standards and Guidelines

10.2.2. World Bank Environmental & Social Standards (ESS) - ESS1 Assessment and Management of Environmental and Social Risks and Impacts sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through Investment Project Financing (IPF), in order to achieve environmental and social outcomes consistent with the Environmental and Social Standards (ESSs). The ESS1 guidance note states that – "the environmental and social assessment will consider potentially significant project related transboundary and global risks and impacts, such as impacts from effluents and emissions, increased use or contamination of international waterways, emissions of short- and long-lived climate pollutants, climate change mitigation, adaptation and resilience issues, and impacts on threatened or depleted migratory species and their habitats".

10.2.3. The European Investment Bank (EIB) Standard 5 – Climate Change (EIB5) sets out the requirement for projects to assess, manage and monitor project-related physical climate risks. The standard aims for the CRVA to build resilience and adaptive capacity in response to current and future climate change-induced impacts.

10.2.4. The CRVA aligns with the EU Taxonomy 'Do No Significant Harm' (DNSH) principle to climate change adaptation objectives for investment decisions. This regulation sets out the definition of

[1] World Bank (2020). Climate Change in Tajikistan (Online). Available from: https://zoinet.org/wp-content/uploads/2018/01/TJK-climate-summary-en.pdf (Accessed: July 2023).

sustainable investment by applying good governance practice and ensuring the principle of DNSH for both environmental and social objectives. The CRVA methodology aligns to DNSH.

10.2.5. EIB Climate Strategy[2] sets out EIB's commitment to building resilience to climate change through use of CRVAs.

10.2.6. IEMA EIA Guide to Climate Change Resilience and Adaptation sets out how to address climate change resilience in environmental impact assessments[3]. This has been adapted for use as guidance for international ESIAs.

10.2.7. The International Hydropower Association (IHA) have produced a Climate Resilience Guide for the Hydropower Sector[4] which has been used to identify and assess climate change risks and suggest adaptation measures for the Project.

Existing Assessment

Environmental and Social Impact Assessment, 2014

10.2.8. Volume I Main Report of the 2014 Environmental and Social Impact Assessment (ESIA) provided sectoral studies of the Project, of which climate data was reported as part of the study on the physical environment. Section 7 of the 2014 ESIA focussed on the effects of the Project on the local climate, in addition to how the changes in water availability with climate change may affect the operation of the Hydropower Plant (HPP). Section 20 developed the climate projections for the project area, indicating the importance of snow and glacier melting on future water resources and flooding and mudflows. The hydrological and glaciological projections as part of this section assess the impact of the disappearance of glaciers and the water balance of the basins. It also assesses the impact of the Project on the local climate, and environment due to climate change, such as downstream sedimentation. The assessment concluded that there are no significant adverse climate change risk affecting the operation of Rogun HPP in terms of water availability.

10.2.9. The ESIA did not include detailed studies on changes to hydrology from climate change, including Glacial Lake Outburst Floods (GLOF), changes in flows due to local glacier retreat or expansion, changes in sedimentation, or other effects of climate change (e.g., increasing temperatures) that would increase the risk to the operation of Rogun HPP.

10.2.10. An assessment of climate change and its effects on Rogun HPP was excluded from the Volume II technical annexes.

Techno-economic assessment study, 2014

10.2.11. Chapter 5 of the Techno-Economic Assessment Study (TEAS) is a comprehensive review of the existing climate documentation to assess the quality of the data, review the inflows assessment, estimate flood return periods and Maximum Probability Flood, and review the existing climate change projections.

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[2] European Investment Bank (EIB) (2020) Climate Strategy (Online). Available from: https://www.eib.org/attachments/strategies/eib_climate_strategy_en.pdf (Accessed on: July 2023)

[3] IEMA (2020) EIA Guide to Climate Change Resilience and Adaptation. Available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020

[4] IHA (2019) Hydropower Sector Climate Resilience Guide (Online). Available at: https://assets-global.website-files.com/5f749e4b9399c80b5e421384/5fa7e38ce92a9c6b44e63414_hydropower_sector_climate_resilience_guide.pdf (Accessed: June 2023)

10.2.12. The study analysed trends in precipitation and temperature but concluded that a critical review of climate change models is required to reduce the uncertainties inherent in downscaled climate change projections, to allow for the level of accuracy required when designing HPPs. It is currently not accurate to understand the local impact of climate change on Rogun HPP, and therefore derived climate adaptation measures would be inappropriate. However, the study reiterates that adaptation must be incorporated into the planning of Rogun HPP. The study suggests that even a robust and conservative design should allow some flexibility to be resilient to drastic climatic changes. Adaptive capacity could be built in the form of monitoring systems e.g., early warning systems to improve preparedness to extreme phenomena.

Environmental and Social Panel of Experts, 2014

10.2.13. Recommendations from the Environmental and Social Panel of Experts (ESPoE) include that coverage of climate change and adaptation needs to be improved, using the EIB Standard 5 as a guide.

Review of Environmental and Social Aspects of Rogun Hydropower Plant, 2021

10.2.14. This review concluded that the Environmental and Social assessment should consider the impacts of climate change such as climate change adaptation and resilience issues. It is also recommended that the structural design should take into account climate change considerations.

Dam Safety Panel of Experts, Second Report, 2023

10.2.15. Recommendations from the Dam Safety Panel of Experts (PoE) suggests that the TEAS Climate change impacts and risk assessments should be updated. This includes factoring in climate change into Reservoir Operation Simulation Studies and flood assessments.

Environmental and Social Panel of Experts, Second Report 2023

10.2.16. The second report from the ESPoE reiterates that resilience, vulnerability, and adaptation need to be addressed in line with both World Bank and EIB guidelines.

Climate and Hydrology studies

10.2.17. It is noted that further studies around climate and hydrology to support the planning of the Rogun HPP will be undertaken. This includes climate change impact assessment and adaptation studies, including hydrology, sedimentation modelling and management, and flood-wave hazard such as GLOFs and landslides.

10.2.18. At the time of writing, these studies have not been commissioned and therefore the outcomes from these studies have not informed this assessment. The outcomes will inform the future climate change adaptation management of the Project.

Baseline – Current Conditions

Current Baseline

10.2.19. Tajikistan is the smallest country in Central Asia; 93% of its territory is mountainous regions and 6% is occupied by glaciers. Tajikistan is located in the temperate continental climate zone and with moderate climate variables typical of Central Asia. Climate variability is linked with its geological sub-state, which includes coastal, plain areas and mountains. Tajikistan is prone to natural disasters;

typically avalanches in winter, flash floods in the spring, and high temperatures and dust storms in the summer[5].

10.2.20. The glaciers are important in regulating the climate whilst retaining water and controlling flows[6]. Climate change impacts are already observed in Tajikistan, with 20 billion cubic metres of ice volume within glaciers already lost during the 20th century (about 2.5%), likely to be accelerated by increasing temperatures. It is estimated that total glacial area will decline by up to 20% within the next 30-40 years, depleting water resources and increasing the risk of mudflows and floods[7].

10.2.21. The climate change data below focuses on trends in precipitation, temperature, sea level rise, wind and the impacts on land across the operational design life. Detailed hydrological data and trends affecting the operation of the Project can be found in Annex A05: Water.

10.2.22. Information on the current climate (current baseline) of Tajikistan has been obtained from the World Bank Climate Change Knowledge Portal[8]. Region of Republican Subordination (referred to as Tadzhikistan Territories in the World Bank Climate Change Knowledge Portal) is located across central and west Tajikistan, in which the Project is located. Baseline climate information for the sub-region of Region of Republican Subordination is presented as representative of the climate of the Project.

Temperature

10.2.23. The temperatures experienced across Tajikistan are dictated by the mountainous terrains. Average monthly temperatures in Region of Republican Subordination are slightly warmer in comparison to the rest of Tajikistan as presented in **Figure 10-1**. The coldest month is January, with July and August being the warmest months.

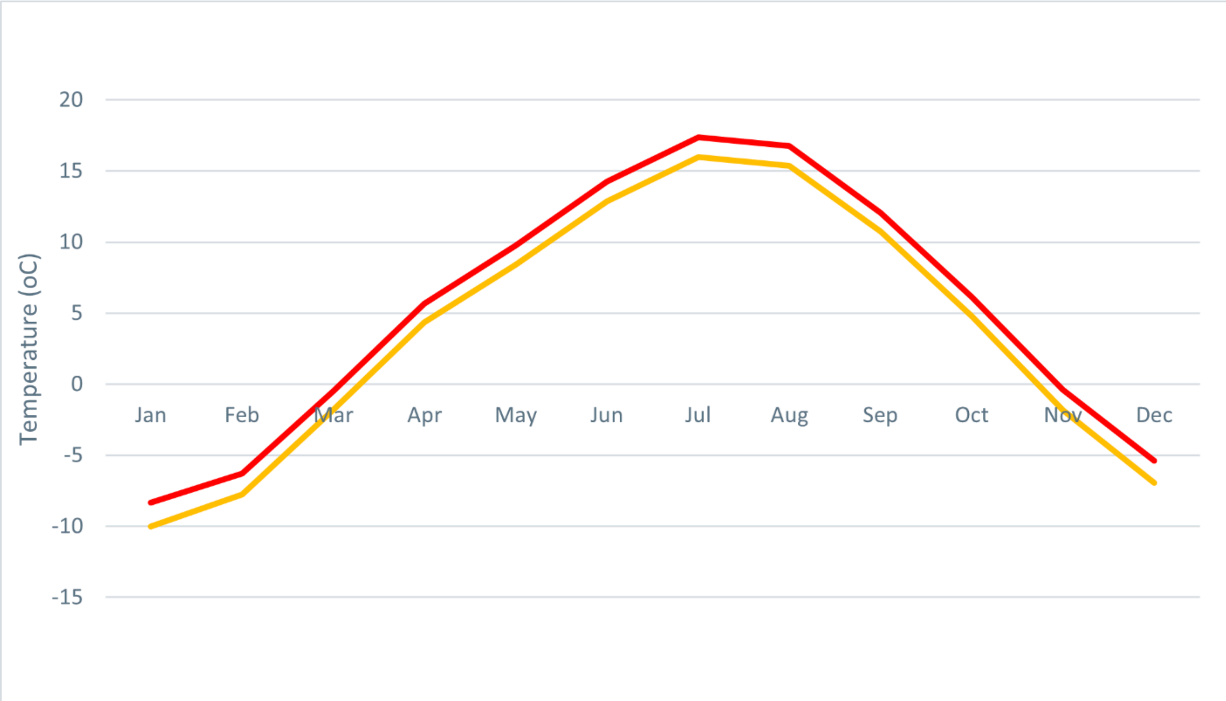
[5] World Bank (2020). Climate Change in Tajikistan (Online). Available from: https://zoinet.org/wp-content/uploads/2018/01/TJK-climate-summary-en.pdf (Accessed: July 2023).

[6] UNDP (n.d.) Tajikistan Climate Change Adaptation. Available at: https://www.adaptation-undp.org/explore/central-asia/tajikistan (Accessed: June 2023)

[7] Global Support Programme (n.d.) Supporting Tajikistan to advance their NAP process. Available at: https://www.globalsupportprogramme.org/projects/supporting-tajikistan-advance-their-nap-process (Accessed: June 2023)

[8] World Bank (2020). Climate Change Knowledge Portal. Available at: https://climateknowledgeportal.worldbank.org/

Figure 10-1 - Average Monthly Temperature for Region of Republican Subordination (red) and Tajikistan (orange) (1991-2021)



10.2.24. Temperature records spanning 1901-2021 indicate that there have been increases in the annual average temperature of Region of Republican Subordination (**Table 10-1**), consistent with climate projections. **Table 10-1** shows that from 1991-2021, the average annual temperature in Region of Republican Subordination has been approximately 0.7°C higher than the average for 1961-1990. 2016 was the warmest year since 1900 in Tajikistan with an average temperature of 4.53°C, closely followed by 2021 with an average annual temperature of 4.52°C.

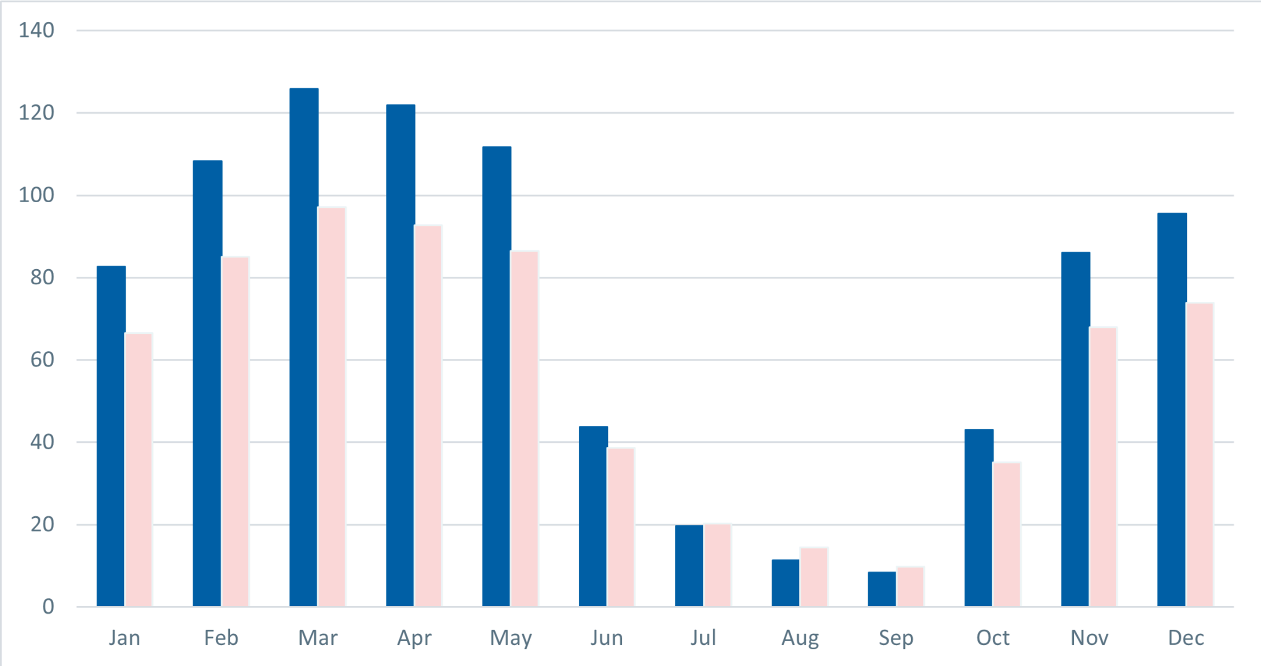
Table 10-1 – Region of Republican Subordination Annual Average Temperature (1901-2021)

Year	Average Annual Temperature (°C)
1901-1930	2.7
1931-1960	2.7
1961-1990	3.1
1991-2021	3.8

Precipitation

10.2.25. Average monthly precipitation in Region of Republican Subordination is generally higher in comparison to the rest of Tajikistan as presented in **Figure 10-2**. The wettest month is March, with July, August and September being the driest months.

Figure 10-2 - Average Monthly Precipitation for Region of Republican Subordination (blue) and Tajikistan (pink) (1991-2021)



10.2.26. Precipitation records spanning 1901-2021 indicate that there have been increases in the annual average precipitation of Region of Republican Subordination (shown in **Table 10-2**). **Table 10-2** shows that from 1991-2021, the average annual precipitation in Region of Republican Subordination has been approximately 55mm higher than the average for 1961-1990.

Table 10-2 – Region of Republican Subordination Annual Average Precipitation from 1901-2021

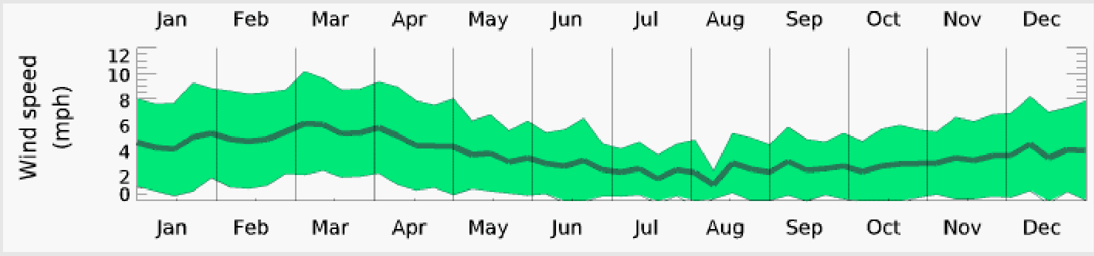
Year	Average Annual Precipitation (mm)
1901-1930	740.5
1931-1960	764.4
1961-1990	793.3
1991-2021	848.3

Wind

10.2.27. Wind speed data (which is being affected by the energy levels being affected by a warmer climate) is not available from the World Bank Climate Change Knowledge Portal. However, Meteoblue presents observed climate data for the Region of Republican Subordination region[9] (Meteoblue, 2020). Data obtained approximately 72km away from Project site shown in **Figure 10-3**. Wind speeds are typically lowest in July and August, and highest in March.

[9] Meteoblue (2020). Climate observed Cernavoda. Available at: https://www.meteoblue.com/en/weather/historyclimate/climateobserved/roghun_tajikistan_1220701

Figure 10-3 - Average Monthly Wind Speed (mph) for Region of Republican Subordination 2022



10.2.28. Dust storms are common in Tajikistan due to the aridity of the region situated in the 'global dust belt'. Dust storms are typical between April and November however are primarily associated with lowland areas[10].

Solid Mass

10.2.29. Mudflow and landslides within mountainous and foothill regions are unpredictable and result from melting glaciers leading to flash floods or glacier lake outburst floods (GLOF). Avalanches are where large amounts of uncompacted fresh snow are set into motion. Most avalanches are observed in February and March.

Future Baseline (Climate Projections)

10.2.30. Climate projections have been derived from the World Bank Climate Change Knowledge Portal for the Project area[11]. Projections have been presented for Region of Republican Subordination. Projections have been provided for SSP2-4.5 (middle of the road, equivalent to 2-degree warming) and SSP5-8.5 (fossil fuel development, equivalent to a 4-degree warming), the latter has been used to provide a 'worst case' scenario[12] against which to assess the resilience of the Project. This follows the precautionary principle. The projections have been assessed for the 2030s, 2050s and 2090s (20-year periods) using CMIP6 data.

10.2.31. As stated in **Section 0**, further studies will be undertaken to support climate change impact studies, including the impacts of the future climate to glaciers in the region, using climate change data from the glacial regions.

[10] Abdullaev, S. F., and Sokolik, I. N. (2019). Main Characteristics of Dust Storm sand Their Radiative Impacts: With a Focus on Tajikistan. Journal of Atmospheric Science Research Volume 02(02). (Accessed on: July 2023).

[11] World Bank (2020c). Tajikistan Climate Data – Projections. Available at: https://climateknowledgeportal.worldbank.org/country/tajikistan/climate-data-projections

[12] It is acknowledged that climate modelling can produce scenarios against greater degrees of warming, the SSP5-8.5 projections represent a scenario which is commonly available and accepted to represent a 'worst case' in the context of Environmental and Social Impact Assessments.

Temperature

10.2.32. The projected change in seasonal temperature for Region of Republican Subordination for the 2030s, 2050s and 2090s under SSP2-4.5 and SSP5-8.5, compared to the baseline of 1995-2014 is presented in **Table 10-3**. For SSP2-4.5 this shows an increase in temperature in the range of 1.01°C (2030s winter) to 3.13°C (2090s summer) for the 50% percentile 'central estimate' (taken as the median value of predicted change). For SSP5-8.5 this shows an increase in temperature in the range of 1.24°C (2030s summer) to 6.10°C (2090s summer).

10.2.33. The projections for temperature rise are greatest in summer. During winter, air temperatures are also expected to increase, though with less intensity.

Table 10-3 - Region of Republican Subordination Projected Change in Season Temperature (°C) under SSP2 and SSP5 for the 2030s, 2050s and 2090s (baseline period 1995-2014)

Year		SSP2-4.2	SSP5-8.5
2030s	Summer	+1.15	+1.24
	Winter	+1.01	+1.37
2050s	Summer	+1.87	+2.54
	Winter	+1.92	+2.54
2090s	Summer	+3.13	+6.10
	Winter	+2.99	+5.66

10.2.34. As well as an increase in average temperatures, projections indicate an increase in extreme temperatures (i.e., the temperature experienced during heatwaves). Table 10-4 shows the mean maximum of daily maximum temperature for summer and winter in each of future time slices relative to the reference period (1995-2014) for Region of Republican Subordination. **Table 10-4** shows that the hottest day in the 2090s period is projected to be 40.2°C, 6°C degrees hotter than the hottest day in 1995-2014.

10.2.35. Periods of extreme temperature can increase the risk of fire outbreak, with high temperatures, low humidity and dry conditions conducive to fire weather[13] (Jones et al., 2020).

[13] Jones et al., (2020) Climate Change Increases the Risk of Wildfires. Available at: https://tyndall.ac.uk/working-papers/climate-change-increases-the-risk-of-wildfires/

Table 10-4 - Region of Republican Subordination Projected Mean Maximum of Daily Max-Temperature (°C) under SSP2 and SSP5 for the 2030s, 2050s and 2090s (baseline period 1995-2014)

Year		SSP2-4.2	SSP5-8.5
Baseline period	Summer	34.2	34.2
	Winter	10.0	10.0
2030s	Summer	35.2	35.4
	Winter	11.3	11.4
2050s	Summer	36.1	36.6
	Winter	12.1	12.6
2090s	Summer	37.2	40.2
	Winter	13.4	15.9

Precipitation

10.2.36. An increase in annual precipitation is predicted in Region of Republican Subordination for all time periods and scenarios. This is due to winter precipitation increases far outweighing summer precipitation decreases. The projected change in annual precipitation for Region of Republican Subordination for the 2030s, 2050s and 2090s under SSP2-4.5 and SSP5-8.5 compared to the baseline of 1995-2014 for the 50th percentile is presented in **Table 10-5**. This shows an increase in annual precipitation in the range of 4.3mm to 61.2mm.

Table 10-5 - Region of Republican Subordination Projected Change in Annual Precipitation (mm) under SSP2 and SSP5 for the 2030s, 2050s and 2090s (baseline period 1995-2014)

Year	SSP2-4.2	SSP5-8.5
2030s	+17.4	+4.3
2050s	+28.0	+26.8
2090s	+39.5	+61.2

10.2.37. It is anticipated that there will be seasonal changes as more precipitation will fall as rain and less as snow which will increase annual and inter-annual variability. These changes may lead to greater average flow volumes and greater variability.

10.2.38. As the country's mountain glaciers melt at increasing rates, in the short to medium term this could lead to excess waterflows and cause severe flooding and associated hazards such as landslides and mudslides. This will occur for several decades whilst the glaciers deplete. In the longer term, reduced glaciers are likely to reduce the regularity of waterflows, where annual flow volumes will decrease due to extensive glacier recession and may result in the drying of some watersheds.

Wind

10.2.39. There is low confidence in the accuracy of the results from existing models of future wind conditions under climate change. The site of the Project is identified as having a 'very low' storm hazard risk[14].

10.2.40. The retreat of glaciers can increase the incidence of dust storms however these are concentrated within the lowland areas.

Solid Mass

10.2.41. Projected increases in extreme precipitation events combined with warm spells could increase avalanching and landslides with climate change (World Bank, 2021a, 2021b).

Scoping

10.2.42. The CRVA methodology aligns to EIB Standard 5 and the Do No Significant Harm (DNSH) framework criteria. As such, a scoping assessment is not required here. The methodology ensures a proportionate assessment with a focus on key climate change risks. This is undertaken through a screening process (Step 1) which identifies only relevant climate hazards impacting the project, and a vulnerability assessment (Step 3) to bring forward only those receptors (project assets) considered vulnerable to the climate change trends for further assessment as part of the CRVA.

Assessment Methodology

10.2.43. The assessment of climate risk and vulnerability follows the criteria for climate change adaptation as set out in the DNSH framework and involves the following steps.

Step 1: Screening of Climate Hazards

10.2.44. The DNSH criteria identifies chronic and acute climate hazards, relevant to temperature, wind, water and solid mass. The location and type of Project are taken into consideration to identify which climate hazards are applicable and should be taken forward to the vulnerability assessment. Climate hazards which are not relevant to the Project are screened out.

Step 2: Current and Future Climate Baseline

10.2.45. For the in-scope climate hazards, the current climate conditions and future climate projections are described. The current and future climate baseline contained in this Chapter has been obtained from the World Bank Climate Change Knowledge Portal (World Bank, 2020b).

10.2.46. Aligning to the IEMA EIA Guide to Climate Change Resilience and Adaptation the baseline considers:

- The current climate baseline (defined by historic climate conditions) to provide an indication of past vulnerability; and
- The future climate baseline (short-term extremes and long-term variation) to assess a project's vulnerability to climate change.

10.2.47. Climate projections have been presented for Region of Republican Subordination. Projections have been provided for SSP2-4.5 (middle of the road, equivalent to 2-degree warming) and SSP5-8.5 (fossil fuel development, equivalent to a 4-degree warming), the latter has been used to provide a

[14] Swiss Re (2020) CatNet – the online natural hazard atlas

‘worst case’ scenario[12] against which to assess the resilience of the Project. This follows the precautionary principle. The projections have been assessed for the 2030s, 2050s and 2090s (20-year periods) using CMIP6 data.

Step 3: Vulnerability Assessment

10.2.48. The in-scope climate hazards are assessed to identify their vulnerability to climate hazards. The assessment is determined by a function of sensitivity and exposure:

- The typical sensitivity of receptors to climate variables – based on literature review and professional judgement and rated as high, moderate or low; and
- The exposure of receptors to projected change in climate variables – based on the baseline information and rated as high, medium or low.

10.2.49. The valued components of the CRVA are the project assets, known as the receptors. The vulnerability of receptors to climate variables is determined from the combination of the sensitivity and exposure ratings, using the matrix shown in **Table 10-6**.

10.2.50. The outcome of this stage of the assessment is a list of climate variables for each Project element to take forward for further assessment. ‘Low’ vulnerabilities are not considered further and scoped out at this stage. ‘High’ and ‘Moderate’ vulnerabilities are scoped in and assessed further on Step 4 to identify their significance and materiality.

Table 10-6 – Vulnerability Matrix

	Exposure		
Sensitivity	Low	Medium	High
Low	Low vulnerability	Low vulnerability	Low vulnerability
Moderate	Low vulnerability	Medium vulnerability	Medium vulnerability
High	Low vulnerability	Medium vulnerability	High vulnerability

Step 4: Materiality (Significance) Assessment

10.2.51. The materiality of the physical risks on the economic activity of the Project is assessed though the likelihood and consequence of the climate change impact, taking into account design control measures which mitigate climate impacts. Design control measures have been identified through existing Project information and include a combination of measures which have been and will be incorporated into the design. This provides an initial risk assessment of the assets and operations of the Project and identifies which impacts are significant, or material to the Project.

10.2.52. Likelihood and consequence were qualitatively assessed using the descriptions in

10.2.53. **Table** 10-7 and **Table 10-8** respectively. These descriptions have been developed using experience and professional judgement, informed by relevant guidance.

Table 10-7 – Definitions of Likelihood

Measure of Likelihood	Description
Very high	The event occurs multiple times during the lifetime of the project, e.g., usually annually.
High	The event occurs several times during the lifetime of the project, e.g., approximately once every five years.
Medium	The event occurs limited times during the lifetime of the project, e.g., approximately once every 15 years.
Low	The event occurs occasionally during the lifetime of the project, e.g., once in 60 years.
Very low	The event may occur once during the lifetime of the project.

Table 10-8 – Definitions of Consequences

Measure of Consequence	Description
Negligible	No facility/infrastructure damage, minimal adverse effects on health, safety and the environment. Facility doesn't shut down. No financial loss.
Minor Adverse	Localised facility/infrastructure disruption. No permanent damage, minor restoration work required: Facility closure lasting less than one day. Slight adverse health or environmental effects. Repairs cost 2% of facility reconstruction cost.
Moderate Adverse	Limited facility/infrastructure damage with damage recoverable by maintenance or minor repair. Facility/infrastructure disruption lasting more than one but less than three days. Adverse effects on health and/or the environment. Repairs cost 25% of facility reconstruction cost.
Large Adverse	Extensive facility/infrastructure damage. Facility/infrastructure disruption lasting more than three but less than ten days. Early renewal of 50-90% of infrastructure. Permanent physical injuries and/or fatalities. Significant effect on the environment, requiring remediation. Repairs cost 50% of facility reconstruction cost.
Very Large Adverse	Permanent damage. Facility/infrastructure disruption lasting more than ten days. Early renewal of facility/infrastructure >90%. Severe health effects and/or fatalities. Very significant loss to the environment requiring remediation and restoration. Repairs cost 100% of facility reconstruction cost.

10.2.54. The likelihood and consequence ratings were combined to assess the significance and materiality of the climate impacts on the Project receptors. The significance and materiality are considered in relation to the impact of the climate hazard on the receptor and the materiality of that impact on the economic activity.

10.2.55. **Table** 10-9 presents the significance matrix. Where impacts are considered significant, they are considered to have a material effect on the Project. The assessment is qualitative and based on expert judgment and knowledge of similar projects. It also includes engagement with the wider Project Team and a review of Project documentation.

Table 10-9 – Significance Rating Matrix

Likelihood	Consequence of Hazard Occurring Negligible	Minor adverse	Moderate adverse	Large adverse	Very large adverse
Very High	Not Significant	Significant	Significant	Significant	Significant
High	Not Significant	Significant	Significant	Significant	Significant
Medium	Not Significant	Not Significant	Significant	Significant	Significant
Low	Not Significant	Not Significant	Not Significant	Significant	Significant
Very Low	Not Significant	Not Significant	Not Significant	Significant	Significant

Step 5: Identification of Adaptation Solutions

10.2.56. Where Significant (material) risks have been identified, additional adaptation measures are presented that can reduce the physical climate risk.

Step 6: Residual Risk Assessment

10.2.57. The assessment of residual risk takes into account the additional adaptation solutions and uses the likelihood and consequence criteria (defined in Step 4) to re-assess the impact of climate change on the Project.

10.3 CRVA Impact Assessment

10.3.1. The six steps presented above have been used in this Section to inform the CRVA for the Project.

Step 1: Screening of climate hazards

10.3.2. **Table 10-10** identifies the climate hazards as detailed in the DNSH criteria and provides justification where climate hazards have been screened out, based on the location and nature of the Project. All climate hazards with a potential to create a climate change impact to HPPs will be screened in and taken forward within the assessment, where design control measures as part of the Rogun HPP will be considered in the risk assessment. This ensures a robust assessment and consideration of all theoretical climate hazards.

10.3.3. Where climate hazards have been screened out, they have not been considered further in the assessment.

Table 10-10 – Screening of DNSH climate hazards

Climate Hazard			Screened in	Screened out	Justification (where screened out)
Chronic	Temperature related	Changing temperature (air, freshwater, marine water)	✔		
		Heat Stress	✔		
		Temperature variability	✔		
		Permafrost thawing		✔	Permafrost is not present in the location of the Project.
	Wind related	Changing wind patterns	✔		
	Water related	Changing precipitation patterns and types (rain, hail, snow/ice)	✔		
		Precipitation or hydrological variability	✔		
		Ocean acidification		✔	The Project is located approximately 1000km from the Arabian Sea at an elevation of approximately 1000m. As such, climate risks associated with the sea will not impact the Project.
		Saline intrusion		✔	
		Sea level rise		✔	
		Water stress	✔		
	Solid mass related	Coastal erosion		✔	The Project is located approximately 1000km from the Arabian Sea at an elevation of approximately 1000m. As such, climate risks associated with the coast will not impact the Project.
		Soil degradation	✔		
		Soil erosion	✔		
		Solifluction	✔		
Acute	Temperature related	Heat wave	✔		
		Cold wave / frost	✔		

Climate Hazard			Screened in	Screened out	Justification (where screened out)
		Wildfire	✔		
	Wind related	Cyclone, hurricane, typhoon	✔		
		Storm (including blizzards, dust and sandstorms)	✔		
		Tornado		✔	Tornados are not typical in central Asia and therefore the risk associated with tornadoes are not considered further.
	Water related	Drought	✔		
		Heavy precipitation (rain, hail, snow/ice)	✔		
		Flood (coastal, fluvial, pluvial, ground water)	✔		
		Glacial lake outburst	✔		
	Solid mass related	Avalanche	✔		
		Landslide	✔		
		Subsidence	✔		

Step 2: Current and Future Baseline

10.3.4. Baseline for the CRVA has been described in Section 10.2 above.

Step 3: Vulnerability Assessment

10.3.5. The sensitivity of the Project to climate hazards and the exposure of the Project to climate hazard are outlined within this section. The assessment of receptor sensitivity is based on literature and studies of HPPs, whereas the exposure scoring considers Rogun specific exposure to the climate hazard.

Sensitivity

10.3.6. HPPs are sensitive to water-related climate hazards due to water stress causing changes in levels and load factors affecting the energy generation capacity. Other water-related climate hazards resulting from changing precipitation patterns and hydrological variability make the Project sensitive to impacts from flooding (including Glacial Lake Outburst Floods) and associated damage to dam components, debris and instability of slopes. In particular, Mechanical and Electrical (M&E) equipment, offices and roads are sensitive to the impacts of flooding[15].

10.3.7. HPPs are sensitive to hazards such as precipitation, drought and wind conditions that could lead to soil erosion, soil degradation and potential solifluction of reservoir banks as a result of climate change as this will increase the sediment load from the catchment, resulting in loss of storage more rapidly than would occur without the increased hazard due to climate change. HPP are also sensitive to more acute solid-mass related climate hazards such as avalanches and landslides, as this could cause direct damage to dam components, particularly spillways and tunnels, and could cause displacement waves in the reservoir.

10.3.8. HPP are sensitive to changing wind patterns which could cause additional loading on dam structures or damage from storms and wind events, particularly overhead transmission lines.

10.3.9. HPPs can be sensitive to increasing temperatures, particularly transmission lines which could overheat. M&E equipment is typically located underground and less sensitive to overheating. Other components that are sensitive to high temperatures such as increased evaporation from the reservoir itself, issues with material durability and damage from wildfire. Staff associated with construction, operation and maintenance of HPPs are also sensitive to high temperatures as this can lead to heat stress although the fact that most workplaces will be underground will reduce the risk during operation. HPPs are also impacted by low temperatures and cold snaps / frost due to damage from snow loading.

10.3.10. The sensitivity of the current and proposed project elements to climate hazards has been assessed within **Table 10-11**.

[15] IHA (2019) Hydropower Sector Climate Resilience Guide (Online). Available at: https://assets-global.website-files.com/5f749e4b9399c80b5e421384/5fa7e38ce92a9c6b44e63414_hydropower_sector_climate_resilience_guide.pdf (Accessed: June 2023)

Table 10-11 – Sensitivity of Project Elements to Climate Hazards

Climate hazard	Project Element									
	Construction	Temporary works	Energy generation	Dam and reservoir	Spillway and ancillary	Tunnels	Powerhouse, turbines and generators, all M&E	Access roads and replacement bridges	Permanent offices and maintenance facilities	Transmission and utilities	Human health
Water-related	Moderate	Moderate	Moderate	High	Moderate	Moderate	High	High	High	Moderate	Moderate
Temperature-related	Moderate	Moderate	Low	Low	Low	Low	Low	Moderate	Moderate	High	Moderate
Wind-related	Low	Low	Low	Low	Low	Low	Low	Low	Low	Moderate	Low
Solid-mass related	Moderate	Moderate	Moderate	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Exposure

10.3.11. The exposure of the Project to climate change variables have been scored across the lifetime of the Project in **Table 10-12**. The timeframes represent a 20-year periods aligning to the baseline presented within **Section 10.2**.

Table 10-12 – Exposure of Project to Climate Change Variables Across the Lifetime

Climate Hazard	Climate change variables	2030s (Construction)	2050s, 2090s (Operation)
Water-related	Changes in precipitation patterns and types	Low	Medium
	Heavy precipitation and flood / Increase in extreme precipitation events and flooding	Low	Medium
	Glacial Lake Outburst Floods (GLOF)	Low	Medium
	Precipitation or hydrological variability including changes in glacial melt and snowmelt patterns	Low	High
	Water stress	Low	Medium
	Drought	Low	Low
Temperature-related	Changing temperature and temperature variability / Increase in annual average temperatures and extreme temperatures i.e. heatwaves and heat stress	Low	Medium
	Cold wave / frost	Low	Low
	Increase incidences of wildfire	Low	Medium
Wind-related	Changing wind patterns	Low	Low
	Cyclone, hurricane, typhoon, increase in storm conditions	Low	Low
Solid-mass related	Soil degradation, soil erosion and solifluction	Low	Low
	Increase incidences of landslide, avalanche and subsidence.	Low	High

Vulnerability Assessment

10.3.12. Utilising the results of the sensitivity and exposure scoring in **Table 10-11** and **Table 10-12**, this has enabled scoring of vulnerability for the construction period and the operational lifetime, allowing for low vulnerability assets to be scoped out of further assessment. Vulnerability of construction phase assets are shown in **Table 10-13**, and operational phase in **Table 10-14**.

Construction

Table 10-13 – Assessment of Vulnerability of the Project During the Construction Phase

Climate variables	Project Element	Vulnerability	Scoped in	Scoped out	Justification
Water related	Construction assets	Low		a	Exposure of the current project to water-related climate hazards is considered low for the construction period based on minimal change from baseline.
Temperature-related	Construction assets	Low		a	Exposure of the current project to temperature-related climate hazards is considered low for the construction period based on minimal change from baseline.
Wind-related	Construction assets	Low		a	Exposure of the current project to wind-related climate hazards is considered low for the construction period based on minimal change from baseline.
Solid mass-related	Construction assets	Low		a	Exposure of the current project to land-related climate hazards is considered low for the construction period based on minimal change from baseline.

Operation

Table 10-14 – Assessment of Vulnerability of the Project During the Operational Phase

Climate hazard	Climate change variables	Project Element	Vulnerability	Scoped in	Scoped out	Justification
Water-related	Changing precipitation patterns and types (rain, hail, snow/ice)	**Operation:** All assets	Medium	a		The project assets are sensitive to water-related hazards, particularly the reservoir itself. Climate change is expected to increase the exposure of the assets to water-related hazards.
	Heavy precipitation events and an increase in extreme precipitation events and flooding	**Operation:** All assets	Medium	a		
	Glacial Lake Outburst Floods (GLOF)	**Operation:** All assets	Medium	a		
	Precipitation or hydrological variability due to changes in glacial melt and snowmelt patterns	**Operation:** Energy generation capacity Spillways Tunnels Transmission and utilities Human health	Medium	a		
		Operation: Dam and reservoir Roads and bridges Offices and maintenance facilities	High	a		
	Water stress	**Operation:** All assets	Medium	a		

Climate hazard	Climate change variables	Project Element	Vulnerability	Scoped in	Scoped out	Justification
	Drought	**Operation:** All assets	Low		a	The project will have low exposure to the impact of drought conditions in the project area.
Temperature-related	Changing temperature and temperature variability / Increase in annual average temperatures and extreme temperatures i.e. heatwaves and heat stress	**Operation:** Energy generation Dam and reservoir Spillway and ancillary Tunnels Powerhouse, turbines, MEP	Low		a	An increase in the exposure of the project to increasing temperatures is likely, however the sensitivity of these assets to variations in temperature is low, especially for the below-ground assets.
		Operation: Roads and bridges Offices and maintenance Human health	Medium	a		An increase in the exposure of the project to increasing temperatures is likely, increasing the vulnerability of the assets.
		Operation: Transmission and utilities	High	a		Above-ground electrical transmission and equipment is particularly sensitive to increasing temperatures.
	Cold waves / Frost	**Operation:** All assets	Low		a	Temperatures are projected to increase, reducing the occurrence of cold waves and frosts. Although these events may still occur it is anticipated that they will

Climate hazard	Climate change variables	Project Element	Vulnerability	Scoped in	Scoped out	Justification
						be similar to existing events.
	Increased incidence of wildfire	**Operation:** Roads and bridges Permanent offices and maintenance facilities Transmission and utilities Human health	Medium	a		An increase in the exposure of the project to increasing incidences of wildfire, increasing the vulnerability of the above ground assets.
		Operation: Energy generation Dam and reservoir Spillway and ancillary Tunnels Powerhouse, turbines, MEP	Low		a	Although an increase in the exposure of incidences of wildfire could occur, some of the project assets are located below ground and therefore are of low sensitivity to impacts related to wildfire
Wind-related	Changing wind patterns	**Operation:** All assets	Low		a	Changes to wind patterns are not anticipated to have any adverse impact on the project, therefore any changes will not increase exposure.
	Cyclone, hurricane, typhoon / Increase in storm conditions and wind/dust events	**Operation:** All assets	Low		a	A significant increase in storm conditions and wind speeds is not anticipated with climate change projections, therefore exposure remains low.

Climate hazard	Climate change variables	Project Element	Vulnerability	Scoped in	Scoped out	Justification
Solid-mass related	Soil degradation, soil erosion and solifluction	**Operation:** All assets	Low		a	The project is not sensitive to the impacts of surrounding soils and its exposure to this climate change variable is not anticipated to change.
	Increase incidences of landslide, avalanche and subsidence.	**Operation:** Energy generation Powerhouse, turbines Roads and bridges Offices and Maintenance Tunnels Transmission and utilities Human health	Medium	a		The project is particularly sensitive to landslides, especially the reservoir and spillways, due to being within a seismic region and areas of unstable slopes. Climate change could increase incidences of landslide/rock avalanche due to changing precipitation patterns.
		Operation: Dam and reservoir Spillway and ancillary	High	a		

Step 4: Materiality (Significance) Assessment

10.3.13. The following section presents the identified potential physical climate impacts during operation and maintenance where the initial risk has been assessed, considering of design control measures which mitigate climate impacts.

Direct Construction Impacts

10.3.14. Construction impacts have been scoped out of the assessment due to the vulnerability analysis showing low vulnerability of construction activities and assets to the climate change variables. The vulnerability assessment considers the sensitivity of the receptors to climate variables, and the exposure of the receptors to the projected change in climate. Exposure to projected climate trends will increase over time and given the construction phase is due to be completed in 2029, the exposure, and therefore vulnerability has been assessed as low.

Direct Operational Impacts

10.3.15. The assessment of the climate change risk builds on the vulnerability assessment (presented in **Table 10-14**). The climate change risk assessment (presented in **Table 10-15**) takes into account control measures which have been included in the design or will be developed as part of the operation and management of the Project, which will reduce the risk climate change poses to the Project assets. The climate change risk assessment concludes with assigning the significance (materiality) of the climate change impacts, The significance and materiality are considered in relation to the impact of the climate hazard on the receptor and the materiality of that impact on the economic activity.. This assessment is contained in **Table 10-15**.

10.3.16. The design and management control measures have been identified through review of existing Project information. This includes, but is not limited to design criteria, management plans, operating plans and ESIA. It is noted that some of the Project elements are already in construction and therefore there is a reduced potential for further influence on the design. It is also expected that where control measures are included in existing management plans, these measures will be adopted by any newly developed or updated management plans. In the event the materiality (significance) assessment identifies any significant risk, this is considered to have a potentially material impact on the operation of the Project during its lifetime and therefore would require adaptation measures to reduce the residual risk.

Table 10-15 – Direct Operational Impacts Assessment

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
Water-related	The dam and reservoir, roads and bridges, and offices and maintenance facilities were assessed to have **high vulnerability** to precipitation or hydrological variability due to changes in glacial melt and snowmelt patterns. All assets were assessed as having **medium vulnerability** to: ▪ Changing precipitation patterns and types (rain, hail, snow/ice) ▪ Heavy precipitation events and an increase in extreme precipitation events and flooding ▪ Glacial Lake Outburst Floods (GLOF) and water stress ▪ Water stress The energy generation capacity, spillways,	Changes in precipitation patterns, types of precipitation and water stress leading to changes to flows available affecting increased/decreased generation, including a shift in seasonal peak and load factors.	▪ Cascade Dam and Reservoir Operating Plan. ▪ Further optimization studies for energy generation. ▪ Further detailed hydrology studies to inform energy generation capacity. ▪ Hydrology estimates updated regularly using latest climate change data and projections. Additional studies for Climate Change and Hydrology will be completed at the recommendation of the new Dam Safety Panel of Experts.	Medium	Minor	Not significant
		Changes in downstream water release and lower minimum environmental flows, damaging habitats and causing flooding.	▪ Modelling of the operational discharge regime will be part of the Cascade Dam and Reservoir Operating Plan, including flood routing. ▪ The volume of water transferred from summer to winter shall remain unchanged.	Low	Minor	Not significant
		Heavy precipitation, flooding, GLOF events and glacial melt leading to flooding of assets and/or exceeding of flood design levels and drainage systems, culverts and crossings leading to damage or overtopping.	▪ The dam crest hight will be increased from 1,110 meters above sea level (masl) to 1,300 masl by 2029. ▪ The reservoir full supply level will increase from 1,065 masl to 1,290 masl by 2036. ▪ Designed for the 1 in 10,000 year flood event and the Probable Maximum Flood (PMF) level.	Low	Minor	Not significant

[16] Likelihood and consequence take into account control measures.

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
	tunnels, transmission and utilities, and human health project elements were assessed to have **medium vulnerability** to precipitation or hydrological variability due to changes in glacial melt and snowmelt patterns. The impacts from drought on all project assess was assessed as low vulnerability and has been scoped out.	This could lead to needing to draw down the reservoir in periods of high flow events and potential safety issues.	■ Dry freeboard includes for the allowance for permanent settlement, wave run up and GLOF. ■ Additional freeboard has been taken into consideration for the risk of GLOFs. ■ Rapid drawdown should not affect the safety of the dam. ■ The Emergency Preparedness Plan includes a GLOF monitoring program in the catchment to complement any flood forecasting system. ■ The Emergency Preparedness Plan requires that GLOFs or PMF changes in peak flows will be regularly updated using the latest climate change data and projections for the region. ■ The Emergency Preparedness Plan states that the current design of the orifice spillways provides 60% of the discharge capacity. ■ Backup power supply (diesel generator) is in place to ensure continued operation of gates in the event of a power failure related to flooding of powerhouse.			
		Flooding causing erosion of dam and damage to spillways.	■ Designed and built in such a way that erosion damage caused by sediments running along it can be easily repaired by isolating part of the spillway. ■ Spillways to protect dam and allow safe passage of water up to the PMF level. Concrete slabs or lining for strength and surface finishing for water flow of high speeds (up to 30 m/s).	Medium	Minor	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
			Concrete surface treatment to prevent cavitation (due to high speed flow), and erosion (due to sediment flow). Above 30 m/s, additional mitigation such as aeration devices will be provided. ■ Steel lining or other anti-erosion materials in place. ■ The Emergency Preparedness Plan sates that regular inspections of tunnel lining for evidence of cavitation and other types of damage will take place. ■ The Emergency Preparedness Plan requires scouring impacts to be verified during operation and stabilise or infill where necessary if there are changes to original design assumptions.			
		Flooding damaging roads and restricting access for maintenance.	■ The drainage design for roads includes an allowance for climate change. ■ Critical operation equipment - access to that equipment have alternative access/egress routes for emergency situations. ■ The Emergency Preparedness Plan requires regular monitoring and inspections of the key slopes adjacent to roads, with protection/maintenance measures where necessary.	Medium	Minor	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
		Increased sediment load and deposition resulting in loss of storage/depleted peaking energy leading to decreased capacity, outlet blockages, upstream flooding, and corrosion of gates and turbines and M&E. This will lead to increased maintenance requirements.	■ Reservoir Sedimentation Management and Monitoring Plan will consider the need for dredging and other measures to reduce the impact of sedimentation. ■ Watershed Management Plan will include measures to reduce erosion and sedimentation into the reservoir from the catchment. ■ Effective operation conditions of the reservoir can help to control the overall sedimentation, adjusting the operation rule of the reservoir to the sedimentation patterns. ■ Ongoing emptying of sediment traps and monitoring deposition. ■ Tactical dredging of key areas including power intakes and spillway intakes will help reduce the sedimentation in the reservoir. For Rogun HPP, this will only be applicable after several decades of when the sedimentation has accumulated, however, given high annual sediment loads. ■ Corrosive resistant turbine blades. ■ Additional sediment management facilities. ■ Additional dredging as required to ensure key areas (power intakes, spill ways) remain clear. ■ Regular inspection in the vicinity of key slopes and after large rainfall and flooding events.	Medium	Minor	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
		Increased debris in reservoir from increased runoff, leading to increased risk of blocking intakes.	■ Operation and maintenance procedures including debris clearance, will be adjusted based on need.	High	Negligible	Not significant
Temperature-related	The transmission and utilities project elements were assessed as having **high vulnerability** to changing temperature and temperature variability / Increase in annual average temperatures and extreme temperatures i.e. heatwaves and heat stress.	High temperatures and heatwaves causing heat stress for personnel.	■ Health and Safety procedures in place to manage current heat stress for personnel, procedures will be updated in response to changing environmental conditions. Workers are largely below ground.	Medium	Minor	Not significant
		Increased temperatures stimulate plant growth in reservoir with negative impacts on intakes and increased maintenance requirements to maintain ground clearance.	■ Oligotrophic system at full supply level therefore unlikely to result in the stimulation of plant growth	Low	Minor	Not significant
	The roads and bridges, offices and maintenance, and human health project elements were assessed as having **medium vulnerability** to changing temperature and temperature variability / Increase in annual average temperatures and extreme temperatures i.e. heatwaves and heat stress.	High temperatures causing material durability issues of above ground assets (utilities, offices, maintenance buildings, bridges), such as expansion, contraction, corrosion, or reduced ratings leading to damage and/or instability and increased maintenance requirements.	■ Materials selected according to strength and durability characteristics. ■ Design criteria includes anti-erosion and corrosion protection.	Low	Moderate	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
	The roads and bridges, permanent offices and maintenance facilities, transmission and utilities, and human health project elements were assessed as having **medium vulnerability** to increased incidence of wildfire The impacts from cold waves / frost on all project assets was assessed as low vulnerability and has been scoped out. The impacts from changing temperature and temperature variability / Increase in annual average temperatures and extreme temperatures i.e. heatwaves and heat stress on energy generation, dam and reservoir, spillway and ancillary, tunnels, powerhouse, turbines, MEP project elements was assessed as low	Lightning risk to transmission lines.	■ Lightning protection on assets vulnerable to lightning strikes	Very low	Minor	Not significant
		Increased frequency, distribution and severity of wildfires, damaging assets.	■ Increased maintenance requirements for above ground infrastructure if needed	Low	Moderate	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
	vulnerability and has been scoped out. Impacts from increased incidents of wildfire for energy generation, dam and reservoir, spillway and ancillary, tunnels, powerhouse, turbines and MEP project elements has been assessed as low vulnerability and are scoped out.					
Solid-mass related	The dam and reservoir, spillway and ancillary project elements were assessed as having **high vulnerability** to increased incidences of landslide, avalanche and subsidence. The energy generation, powerhouse, turbines, roads and bridges, offices and maintenance, tunnels, transmission and utilities and human health project elements were assessed as having **medium vulnerability** to increased incidences of	Increased slope instability from surface runoff causing damage to assets from rockfalls and mudslides, or displacement waves in the reservoir. Higher sedimentation rate from upstream landslides could lead to earlier blockage.	■ Landslide Management and Monitoring Plan which will be developed to support the ESIA will include slope stability risk assessment and monitoring to minimize risk. ■ The design criteria have taken into consideration the effects of landslides by lowering impoundment rates. ■ The Reservoir Landslides Annex includes engineering measures to stabilize susceptible slopes and improve resilience of infrastructure to landslide movement. ■ Anti-seepage measures e.g. grout curtain to ensure seepage in acceptable limits, reducing possible instability. ■ The Watershed Management Plan includes measures to reduce erosion and sedimentation upstream of the dam.	Low	Moderate	Not significant

Climate variable	Vulnerability summary (from Table 10-14)	Climate impact	Control measures	Likelihood[16]	Consequence[16]	Risk
	landslide, avalanche and subsidence. The impacts from soil degradation, soil erosion and solifluction on all project assets was assessed as low vulnerability and has been scoped out.					

INDIRECT EFFECTS

10.3.17. No indirect effects have been identified.

TRANSBOUNDARY EFFECTS

10.3.18. The CRVA considers the effects of climate change (the environment) on the project assets, and not the effect of the project on the environment, and therefore there are no transboundary effects on the transboundary environment.

10.4 CRVA Mitigation and Management

10.4.1. There are a number of forthcoming key studies, all recommended by the Dam Safety PoE, to be undertaken to inform the climate change impact assessment and adaptation of Rogun HPP including hydrology, sedimentation modelling and management, and flood-wave hazards such as GLOFS and landslides. The outcome of these studies will help define the need for further mitigation measures for future operation of Rogun HPP.

10.4.2. A Reservoir Sedimentation Management and Monitoring Plan, Watershed Management Plan, and Landslide Management and Monitoring Plan will be developed for the Project by April 2024. The cascade emergency response plan is reviewed at each stage of the dam construction and a final will be produced for the full height of the dam. The cascade operating plan currently covers the temporary turbines, and will be updated as the Project progresses.

10.4.3. To manage the impacts of climate risk on the Project, Rogun JSC as operators of Rogun HPP will need to undertake regular monitoring of the effects of extreme weather events. The monitoring record will detail the type of extreme weather event and any impact that was realised, such as damage to equipment requiring repair works, impacts on the employees, impacts on the HPP output. The record can be used to evaluate the actual impacts affecting the Project to develop an understanding of the tolerance and thresholds of the Project assets. An understanding of this will aid implementation of planned and preventative maintenance requirement for the Project and allow adaptive management of Project operations.

10.4.4. Rogun JSC, as operator of Rogun HPP will need to review climate projection data as it is updated. Changes to climate projection data may influence operational planned and preventative maintenance schedules and information incorporated into management plans. When necessary (dependant on the updated climate data) the maintenance schedules and management plans should be updated to reflect the impacts of climate and weather related risks.

RESIDUAL EFFECTS

10.4.5. There are no reported residual significant climate physical change effects.

10.5 Climate Transition Risk

Introduction

10.5.1. The scope of the transition risk assessment is to assess climate risks arising from the transition to a lower carbon economy on the current, partially constructed, HPP Project (existing and proposed assets), under a high and a low emission scenario.

10.5.2. A current scenario is based on the ongoing construction of the Project, focusing on the climate impacts during 2023. The future scenarios assess the transition risks against a high and low emission scenario when the Project is in full operation (2030s).

10.5.3. In line with the EIB, it is imperative to understand the aspects of the financial risk that can occur following a rapid decarbonisation of the industry.

'With all new operations being Paris-aligned as of 2020, the transition risks of new operations will be further reduced'.

10.5.4. The EIB outlines the requirement to understand and model transition risks for all countries where the EIB operates.

Standards and Guidelines

10.5.5. The key standard used for this is the European Investment Bank (EIB) Standard 5 – Climate Change (EIB5) which sets out the requirement for projects to assess, manage and monitor project-related transition climate risks. EIB5 aims for the Transition Risk Assessment to build resilience and adaptive capacity in response to current and future climate change-induced impacts.

10.5.6. The EIB defines transition risks in line with the Taskforce for Climate-related Financial Disclosure Framework (TCFD). TCFD outlines the disclosures to be considered and the themes of a transition risk assessment, namely; policy, technology and market changes used to facilitate the change to a lower carbon economy. Transition risks may pose varying levels of financial and reputation risks on the Project.

Scoping

10.5.7. The risks identified in the Transition Risk Assessment have been scoped in and adapted according to relevance to Rogun HPP. The transition risks identified in the TCFD Implementation Guidance, as referenced in the EIB Roadmap, which are not relevant to Rogun HPP have not been included in the assessment.

Assessment Methodology

10.5.8. The assessment of transition risks follows the criteria set out by the TCFD Framework and involves the following steps:

- Screening of the relevant policy, technological and market risks relevant to the Project.
- Assessment of relevant scenarios for the Project, a scenario of 2023 has been assigned for the current baseline, and future scenarios include a 2030 high emission, and a 2030s low emission scenario.

- A likelihood and impact rating are assigned to each relevant risk, giving a final risk rating of low medium or high. The likelihood of the risk is based on the likelihood of the risks occurring to Tajikistan or the renewable energy industry. The impact is based on an assessment of relevant datasets including IEA and the World Bank which provide context on the exposure of the Project to the transition risks.

10.6 Transition Risk Impact Assessment

10.6.1. There are a number of transition risks relevant to the Rogun HPP which have been outlined below. The transition risks have been identified as policy and legal, technology and market risks in line with the EIB (and subsequent TCFD) guidance.

10.6.2. The following subsections have been set out as follows:

- **Risk**: in line with EIB guidance
- **Impact**: specific impact on the Rogun HPP
- **Context**: review of data received on aspects and process of the construction, operation and maintenance of the Rogun HPP
- **Current scenario**: the risk rating for the 2023 construction period
- **Future scenario**: the risk rating for the 2030 operation period
- **Summary**: outlining the requirements for management.

Policy and legal changes

Risk

- Enhanced GHG and climate reporting obligations and monitoring for future reporting obligations.

Impact on Rogun HPP

- Resources will be needed to record full GHG emissions from construction, operation and maintenance, including recording offset emissions of the Rogun HPP; as well as monitoring and understanding future reporting obligations.

Context

10.6.3. Tajikistan is part of the IEA's EU4Energy Programme, a collaborative programme design to support countries in implementing sustainable energy policies and energy sector development. The programme is made up of five components to assist Eastern and Central Asian countries in reporting on energy sources and demand.

10.6.4. (Component 1): enhanced energy data management and (Component 3) generate an improved energy legislative and regulatory framework and implemented policy recommendations as well as to promote investments in key energy infrastructure strategic projects suggest a higher reporting standard on energy use / carbon will be required. The FP040 project by the Green Climate Fund

(2023) aims to protect Tajikistan's hydropower from climate risks. There are three elements to the project: adopting best international practices, re-training Tajik hydropower operators and assessing and managing climate risks. The funds show progress for Tajikistan to develop a framework for efficient management of hydropower projects.

10.6.5. This implies reporting on carbon will become more stringent, whilst also being influenced by surrounding countries following commitments to reduce overall national emissions. It is likely that Tajikistan's requirement to report at a country level will feed down to a project level, and reporting requirements will increase under the low emission scenario. The regulatory landscape for climate and carbon in Tajikistan is not considered to be a leader in policy frameworks, therefore the risk remains low for the high emission scenario.

Current Scenario

2023		
Current Scenario		
Likelihood	**Impact**	**Risk**
Low	Low	**Low**

Future Scenario

2030s					
Low Emissions Scenario			**High Emissions Scenario**		
Likelihood	**Impact**	**Risk**	**Likelihood**	**Impact**	**Risk**
High	Low	**Low**	Medium	Low	**Low**

Summary

10.6.6. The assessment of enhanced GHG and climate reporting obligations and monitoring for future reporting obligations has revealed low risks in both scenarios. Rogun JSC as operators of Rogun HPP will need to monitor GHG emissions ensure relevant County and Local policies and regulations are monitored to ensure any reporting requirements are caried out.

Risk

- Exposure to litigation and mandates on existing services.

Impact on Rogun HPP

- Resources will be required for monitoring / horizon scanning to understand projects exposure to environmental litigation; carbon, climate resilience, water, land use; and social impacts on local community and employees. These are considered to be relatively minor in relation to the overall resources required for Rogun HPP construction and operation.

Context

10.6.7. The Project has a high exposure to regulations on water and biodiversity, given the position of the Project within the Vakhsh River. The financial risk is that more rigorous / precise measures will be required following updates to regulations, particularly under a low emission scenario, where protection of water resources and biodiversity is likely to be more stringent.

"The Water Codex of the Republic of Tajikistan contains provisions for particular uses of water for which there is a charge and for compensation of damage to water sources (Tajikistan Ministry of Justice 2020)".

"The Law of the Republic of Tajikistan on Protection and Using of Flora defines principles of protection and rational use of flora, determines the legal, economic and social basis in this area and is directed on preserving and protecting flora (Tajikistan Ministry of Justice 2018)".

10.6.8. The Programme for Reforming the Water Sector of Tajikistan for 2016-2025 contains adaptation measures through the development of a long-term strategy for the use and protection of water resources, development of seasonal and annual plans for the distribution and management of water resources in river basins, restoration of irrigation infrastructure and improvement of conditions for its maintenance and operation, and introduction of new water-saving technologies (Tajikistan Ministry of Justice 2015).

10.6.9. On the basis of the recommendations provide in the Biodiversity assessment (summarised in Section 8.11 of this report) are implemented, it is understood that all residual impacts to biodiversity will all be reduced to a maximum of Minor (Not Significant) effects. The exception is the creation of altering the Vakhsh River into a deep lake which remains a moderate impact. The transition risk is therefore assessed as medium under the 2030 low emissions scenario and low under the 2030 high emissions scenario.

Current Scenario

2023		
Current Scenario		
Likelihood	Impact	Risk
Low	Low	**Low**

Future Scenarios

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	Impact	Risk	Likelihood	Impact	Risk
Medium	Medium	**Medium**	Medium	Low	**Low**

Summary

10.6.10. The assessment of exposure to litigation and mandates on existing services has revealed medium risk in the low emission scenario and low risk in the high emission scenario. Rogun JSC as operators of Rogun HPP will need to monitor changes to regulatory requirements as they are published and ensure compliance is maintained.

Risk

- Policy changes causing higher compliance costs, requirements on offsetting activities.

Impact on Rogun HPP

- Increased operating costs.

Context

10.6.11. As the Project will be producing hydropower energy and will be 100% self-sufficient, the risks from increased operating costs will remain low for both the high and low emissions scenarios.

Current Scenario

2023		
Current Scenario		
Likelihood	**Impact**	**Risk**
Low	Low	**Low**

Future Scenarios

2030s					
Low Emissions Scenario			**High Emissions Scenario**		
Likelihood	**Impact**	**Risk**	**Likelihood**	**Impact**	**Risk**
Low	Low	**Low**	Low	Low	**Low**

Summary

10.6.12. The assessment of policy changes causing higher compliance costs, requirements on offsetting activities has revealed low risks in both scenarios. Rogun JSC as operators of Rogun HPP will be required to monitor policy changes as they are implemented to minimise the impact on operating costs.

Risk

- Policy changes associated with write-offs, asset impairment, and early retirement of existing assets due to policy changes.

Impact on Rogun HPP

- An increase in the requirement for the replacement of assets, plant and machinery and other equipment with lower carbon options.

Context

10.6.13. The number of vehicles during operation is likely to be relatively low, with access required only for maintenance and servicing. The majority of these will be light vehicles with HGVs only required if components need replacing.

10.6.14. WeBuild, the current contractor for Lot 3 are currently working on modernisation / reconstruction / and completion of the Diversion tunnels (DT), it is assumed there will be equivalent practices for any assets, plant and machinery and other equipment which need modernizing or reconstructing for lower carbon options.

10.6.15. Under a low emission scenario there may be a requirement to replace operational plant and machinery with lower carbon alternatives or electric vehicle options, however due to the low volume of vehicles, the risk remains low in both the High and Low emission scenarios.

Current Scenario

2023		
Current Scenario		
Likelihood	Impact	Risk
Low	Low	**Low**

Future Scenario

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	Impact	Risk	Likelihood	Impact	Risk
Medium	Low	**Low**	Low	Low	**Low**

Summary

10.6.16. The assessment of policy changes associated with write-offs, asset impairment, and early retirement of existing assets due to policy changes has revealed low risks in both scenarios. Rogun JSC as operators of Rogun HPP will be required to monitor policy changes to allow any required replacement of assets can be factored into planned replacement regimes.

Technology changes

Risk

- Technological advances causing existing products to become obsolete and substituted with lower emissions options.

Impact

- Costs of replacing assets plant and machinery and other equipment.
- Extra resource needed for replacing assets plant and machinery and other equipment.

Context

10.6.17. There are a number of energy dependant assets within the Project, namely; the power house, turbines, power supplies, permanent maintenance facilities and site offices, as well as several transmission lines, where new lines and sub-stations are under construction.

Construction

10.6.18. The largest contractor is currently working to replace diesel engines used during construction with electrical engines. Five new electrical engines were commissioned for the construction of the Rogun HPP in 2021.

Operation

10.6.19. The entirety of these assets will be powered by the Project; however, there will be 2 diesel back-up generators on standby should supply shortages impact the HPP.

10.6.20. The opportunity to substitute to lower emission assets is low, making the overall risks under each of the future scenarios also as low.

10.6.21. Under a high emission scenario, the risk to transition to a lower carbon back-up may be required. However, this is expected to be minimal in comparison to the power generated by HPP, as such the risk is considered to be low for each future scenario.

Current Scenario

2023		
Current Scenario		
Likelihood	Impact	Risk
Low	Low	**Low**

Future Scenario

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	Impact	Risk	Likelihood	Impact	Risk
Low	Low	**Low**	Low	Low	**Low**

Summary

10.6.22. The assessment of technological advances causing existing products to become obsolete and substituted with lower emissions options, has revealed low risks in both scenarios. Rogun JSC as operators of Rogun HPP should ensure replacement of assets with lower emission options can be factored into planned replacement regimes.

Risk

- Investment in successful and unsuccessful new technologies.

Impact

- Unsuccessful investments will cause loss of finance and impact supply and demand of the energy generated.

- Successful investments will impact current processes and incur costs to revenue, or energy capacity from process changes in the management of the Rogun HPP Scheme.

Context

10.6.23. According to the IEA, the Tajikistan Strategy (Tajikistan Ministry of Justice, 2030), highlights the most significant problems faced by the energy sector are, amongst others, environmental pollution and high production losses in electricity generation, and insufficient electricity supply during the autumn and winter due to reduced water flow.

10.6.24. The physical risk assessment projects the increase in temperatures and extreme weather events, which can in turn lead to water stress affecting power generation. However the design control measures and hydrology studies will serve to mitigate any significant risk. Therefore the impact and risk are considered low for both emission scenarios.

Current Scenario

2023		
Current Scenario		
Likelihood	Impact	Risk
Low	Low	**Low**

Future Scenarios

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	Impact	Risk	Likelihood	Impact	Risk
High	Low	**Low**	Medium	Low	**Low**

Summary

10.6.25. The assessment of investment in successful and unsuccessful new technologies has revealed low risks in both scenarios. Rogun JSC as operators of Rogun HPP should undertake sufficient research into any replacement equipment to ensure investments are, to the best of their ability, sound.

Risk

- Updates and innovations within hydropower production are driven by policy changes.

Impact

- Updates required to existing HPP resulting in financial implications and potential loss in energy capacity during updating and implementing innovations.

Context

10.6.26. Hydropower is well established as an energy source, though there are a number of innovation trends focused on increasing the resilience and capacity of hydropower plants. The six main themes when understanding the development of hydropower are:

i. Hydropower flexibility,

ii. Hydropower digitalisation,

iii. Energy storage and variable speed turbines,

iv. Generators with current-controlled rotors.

v. Novel small-scale hydropower technologies and

vi. Fish-friendly hydropower technologies.

10.6.27. Under a low emissions scenario, it is likely the policy transition will be more stringent thereby putting pressure on technological developments to achieve a lower carbon scenario. As such, under a low emission scenario the risk would be Medium.

10.6.28. Under a high emissions scenario, it is likely the Project's ability to be self-sufficient will be enough to abide with current and projected policies and targets, given the current political landscape in Tajikistan.

Current Scenario

2023		
Current Scenario		
Likelihood	**Impact**	**Risk**
Low	Low	**Low**

Future Scenario

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	**Impact**	**Risk**	**Likelihood**	**Impact**	**Risk**
Medium	Medium	**Medium**	Medium	Low	**Low**

Summary

10.6.29. The assessment of updates and innovations within hydropower production are driven by policy changes has revealed medium risk in the low emission scenario and low risk in the high emission scenario. Rogun JSC as operators of Rogun HPP will need to ensure that upgrades and innovation are suitably planned to minimise the financial and loss in energy production impacts.

Market Changes

Risk

- Uncertainty in market signals.

Impact

- Variances in supply and demand for hydropower (in both a national and international context).

Context

10.6.30. Tajikistan is highly dependent on hydropower, making it prone to exposure to water stress and therefore leave consumers exposed to seasonal water shortages. A market for energy services does not currently exist in Tajikistan, as there is a need to develop a more comprehensive framework. The uncertainties created by the lack of framework for Tajikistan may leave the HPP exposed to abrupt and unexpected shifts in energy demand and consumer markets.

10.6.31. The Tajikistan Governments are exploring frameworks in dealing with energy efficiency and renewable energy market developments; however, these have previously been unsuccessful due to the scarcity of public financing available for creating a dedicated fund to move these sectors forward and attract foreign markets.

10.6.32. Given the lack of a political energy framework and fundings for renewable energy within the region, the direction of Tajikistan's transition journey in renewable energy generation and consumption is currently unknown. Therefore, the uncertainty in market risks would be high under a low emission scenario. The risk under a high emission scenario is 'medium' due to the scenario analysis that there will be a more relaxed transition to a lower carbon economy under a high emission scenario.

Current Scenario

2023		
Current Scenario		
Likelihood	Impact	Risk
Medium	Low	**Low**

Future Scenarios

2030s					
Low Emissions Scenario			High Emissions Scenario		
Likelihood	Impact	Risk	Likelihood	Impact	Risk
High	High	**High**	Medium	Medium	**Medium**

Summary

10.6.33. The assessment of uncertainty in market signals has revealed high risk in the low emission scenario and medium risk in the high emission scenario. Rogun JSC as operators of Rogun HPP will need to monitor the market status to ensure any potential risks are identify early and measures can be implemented in a timely manner.

Limitations

10.6.34. The developments within the climate / carbon market are highly uncertain for Tajikistan and therefore the risks identified have the potential to differ in severity, compared to despite what is reported on here.

10.6.35. Over time the Project should investigate these risks further and identify measures to decrease the impacts of the risks on the operation of the Project over its lifetime.

10.7 Greenhouse Gases

Introduction

10.7.1. A Carbon Footprint Assessment is to be undertaken as part of the Environmental and Social Impact Assessment (ESIA) report of the Project. Not all investment projects for the EIB require a carbon footprint assessment to be undertaken, investment projects with significant emissions must be assessed according to the EIB methodologies, and the thresholds are:

- Absolute emissions or carbon sequestration exceeding 20,000 tonnes CO2e/year;
- Relative emissions (relative to baseline) exceeding 20,000 tonnes CO2e/year (positive or negative).

10.7.2. EIB conducted research that indicates the project types that will or will not require a GHG assessment. Hydropower Dams, such as Rogun, falls under the category 'Renewable Sources of Energy' for which, a GHG assessment is required.

10.7.3. The overarching methodology to be used for calculating the carbon footprint must be consistent with the European Investment Bank (EIB)'s Project Carbon Footprint Methodologies **(Ref: 1.1)** guidance (in line with EIB Environmental and Social Standards 5 **(Ref: 1.2)** and the requirements of other lenders.

10.7.4. The EIB Board commitment in 2019 to: "*align all its financing activities with the principles and goals of the Paris Agreement by the end of 2020*". The commitment is to cover all its financing activities and the notion of alignment is to "*make finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development*" and that "*assets created today are consistent with a pathway to a climate-neutral economy, and that new investment should not undermine efforts to achieve the 1.5°C goal*". **(Ref: 1.3).**

10.7.5. The GHG Impact Assessment aims to support the meeting of these requirements by:

- Quantifying GHG emissions from the Proposed Scheme;
- Providing relevant information for the assessment in-line with EIB and other requirements; and
- Considering alternative measures to minimise project related GHG emissions.

10.7.6. This chapter includes a discussion on the direct effects and the indirect effects arising from the Project, and reports on the whole project impact assessment.

Standards and guidelines

Legislation

- **Nationally Determined Contributions (NDC) of The Republic of Tajikistan (Ref: 2.1)**:

  Tajikistan submitted its revised NDC in October 2021. Tajikistan's revised NDC commits to a 40-50% reduction in emissions by 2030 compared to 1990 levels, conditional on international support. The country also set an unconditional emissions reduction target of 30-40% by 2030 compared to 1990 levels.

- **National Action Plan (NAP) of the Republic of Tajikistan for Climate Change Mitigation** (**Ref: 2.2**): The NAP 2003 is a national-wide policy aiming at implementing the commitments of the Republic of Tajikistan concerning the UN Framework Convention on Climate Change (UNFCCC).Tajikistan's NAP includes the following measures on reduction of GHG emissions and enhancing of natural sinks of carbon:
  - Enhancement of energy efficiency in relevant sectors of the national economy;
  - Application of effective technologies and use of energy sources that promotes high rates of economic growth and reduce or limit GHG emissions;
  - Protection and enhancement of natural sinks and reservoirs of GHG emissions;
  - Promotion of sustainable forest management practices, afforestation and reforestation;
  - Promotion of sustainable forms of agriculture;
  - Research on promotion, development and use of new and renewable energies together with advanced and environmentally sound technologies;
  - Encouragement of appropriate reforms in relevant sectors to promote measures to limit or reduce GHG emissions.

Standards

- **EIB Environmental and Social Standards (Ref: 1.2)**: This Standard promotes the alignment of projects supported by the EIB with the goals and principles of the Paris Agreement and the Sustainable Finance Action Plan. It states that all projects located outside Europe shall comply with the applicable national legislation and this standard, which reflects the core principles and essential procedural elements laid down by EU legislation that the EIB considers relevant to climate mitigation. A requirement for compliance with EIB's alignment framework, as set out in the EIB Group Climate Bank Roadmap (CBR) is to ensure consistency with the "Do No Significant Harm" principle to climate change mitigation, as defined by the EU Taxonomy Regulation.

Guidance documents

- **Environmental, Climate and Social Guidelines on Hydropower Development**[17]: The document mandates a carbon footprint assessment for all hydropower project with the exception where the emissions fall below the threshold levels. The methodology for calculating the hydropower carbon footprint must be consistent with the EIB's Methodologies for the Assessment of Project GHG Emissions and Emission Variations.
- **EIB Project Carbon Footprint Methodologies**[18]: This document contains the EIB's carbon footprinting methodology. It provides guidance on how to calculate the carbon footprint of EIB-financed investment projects.

[17] EIB. (2019). Environmental, Climate and Social Guidelines on Hydropower Development. [Accessed: 14/07/2023]

[18] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

- **IEMA Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance[19]:** This guidance was published to assist practitioners in delivering robust, appropriate, and consistent assessments. Section 5 sets out the steps a GHG emissions assessment should take, including detailed guidance to support each of these steps:

  1. Define goal and scope of GHG emissions assessment;
  2. Set study boundaries;
  3. Decide upon assessment methodology;
  4. Collect the necessary calculation data; and
  5. Calculate/determine the GHG emission inventory.

OTHER LENDER STANDARDS CONSIDERED

- **Greenhouse Gases from Reservoirs Caused by Biogeochemical Processes[20]**: This document by the World Bank acts as a technical note to provide guidance on how to assess GHG emissions from reservoirs at an early stage of the preparation process. It recommends the use of GHG Reservoir tool (G Res tool) which has been developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Hydropower Association (IHA).
- **Guidelines for Estimating Greenhouse Gas Emissions of Asian Development Bank Projects[21]**: The ADB guidance document puts forth general methodologies to estimate GHG emissions during project appraisal/development stage. The methodologies included are consistent with the approaches used by International Finance Institutions (IFI) and are based on the Clean Development Mechanism (CDM) methodologies and Japan Bank for International Cooperation's Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions (Japan Bank for International Cooperation's J-MRV)[22].

EXISTING ASSESSMENT

ESIA From 2014

10.7.7. The Environmental and Social Impact Assessment (ESIA) Report 2014[23] for the project touches upon the assessment of GHG emissions stating:

'Under certain conditions (large amounts of biomass submerged, eutrophication of the reservoir with high productivity or organic material) there is a risk that due to high oxygen consumption for the breakdown of this biomass, the water gets anoxic in deeper layers of the reservoir, which in turn can lead to an emission of methane from the reservoir, a very potent greenhouse gas. This is the case mainly in large reservoirs in moist tropical areas. On the other hand, hydropower can reduce

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[19] IEMA. (2022). Assessing-greenhouse-gas-emissions-and-evaluating-their-significance (iema.net). [Accessed: 11/07/2023]

[20] World Bank. (2017). Greenhouse Gases from Reservoirs Caused by Biogeochemical Processes. [Accessed: 11/07/2023]

[21] ADB. (2017). Guidelines for Estimating Greenhouse Gas Emissions of Asian Development Bank Projects. [Accessed: 08/08/2023]

[22] Japan Bank for International Cooperation. (2021). Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions in JBIC GREEN Operation (J-MRV Guidelines). [Accessed: 08/08/2023]

[23] Pöyry: Engineering Balanced Sustainability. (2014). ESIA Report (Draft) Volume I [offline] [Accessed: 07/08/2023]

greenhouse gas emissions by reducing the amount of fossil fuels (coal, oil and gas) burned for producing electricity in thermal power plants, and thus the emission of CO_2.'

10.7.8. However, calculation of emissions from the project was not undertaken as part of the 2014 ESIA report. The methane emissions produced by the reservoir have not been calculated to date and any potential carbon savings from replacing fossil fuels with hydropower was not calculated either.

10.8 Baseline – Current Conditions

10.8.1. The current and future baseline conditions shall be explored under two scenarios:

'Do nothing' scenario

10.8.2. The 'Do Nothing' scenario comprises of "without project" baseline emissions associated with the current operations of 2x400MW units generating power. One typical year of operational emissions are to be calculated following the EIB methodology[24].

'Do something' scenario

10.8.3. The 'Do something' scenario assesses the emissions from the whole project. One typical year of the whole project's operations emissions is to be calculated following the EIB methodology.

10.8.4. As part of Phase 2, the 2x400MW ("without project") will be upgraded to 2x600MW along with the additional 4x600MW units. Hence, the total power generated in the "with project" would be 3,600MW (6x600MW).

Scoping

Area of Influence

10.8.5. The 2014 ESIA report stated that the study area for the project has been defined to be inclusive of:

- Construction site including dam and powerhouse site, appurtenant structures and immediate surroundings;
- Future reservoir, that is, the area that will be covered by water;
- Immediate reservoir catchment, implying the area directly surrounding the reservoir which is likely to be influenced due to change in groundwater regime; and
- Downstream area at the risk of water pollution and its potential impacts from the Project.

10.8.6. GHG assessment is not restricted by geographical area but instead includes any increase or decrease in emissions as a result of the Project, wherever that may be.

Scope of the GHG Assessment

10.8.7. The scope of the carbon footprint assessment has therefore been updated and reviewed as per the EIB Project Carbon Footprint Methodology[25] wherein the 'project boundary' defines what is to be included in the calculation of total and relative emissions of a typical year of operations. The EIB methodologies use the concept of 'scope' (as defined in the section *Assessment Methodology*)

[24] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

[25] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

based on definitions from the WRI/WBCSD GHG Protocol Corporate Accounting and Reporting Standard[26] when defining the project boundaries.

10.8.8. As per the EIB methodology (and broader GHG accounting best practice) emissions are classified as follows:

- Scope 1 emissions: These include direct GHG emissions that are physically emitted from sources operated by a particular project. For example, emissions produced by the combustion of fossil fuels, by industrial processes and by fugitive emissions, such as SF6 leakage or in the case of a reservoir, the breakdown of organic matter and the release of methane.
- Scope 2 emissions: These account for indirect GHG emissions associated with energy consumed but not produced by the project i.e. electricity. These are included because the project has direct control over energy consumption, for example, by improving it through energy-efficiency measures or by switching to consuming electricity from renewable sources.
- Scope 3 emissions: As per the EIB methodology, Scope 3 emissions are to be excluded, unless they are from 100% dedicated sources that without the project, would not exist. It was advised that the concrete plants will not operate during a typical year of operations of the baseline or the future baseline. All scope 3 emissions were excluded from this Carbon Footprint Assessment.

10.8.9. Scope 3 emissions represents all indirect emissions and relate to all other GHG emissions associated with the supply chain, this includes any carbon emissions arising during the manufacturing of building materials, the transportation of these materials to the job site and the construction practices used. The combination of these represents the typical definition of 'construction' emissions, which is therefore outside the scope of assessment.

10.8.10. Potential sources of emissions for each scope are set out as per **Table 10-16**, including justification of each being scoped in or out of the assessment.

Table 10-16 – Scope of the GHG Assessment

Scope	Potential Sources of Emissions	Scope In or Out for Assessment	Justification
Scope 1	SF6 gas leaks from Switch gear Any fuel powered machinery in operation of the dam	In	These sources of emissions are included within the EIB methodology and have the potential to generate emissions considered to be material to the assessment.
Scope 1	Combustion of fuel by site vehicles	In	These sources of emissions are included within the EIB methodology and have the potential to generate

26 World Business Council for Sustainable Development / World Resources Institute. (2015). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. [Accessed: 08/08/2023]

Scope	Potential Sources of Emissions	Scope In or Out for Assessment	Justification
			emissions considered to be material to the assessment.
Scope 1	Biogenic emissions from the reservoir	In	These sources of emissions are included within the EIB methodology and have the potential to generate emissions considered to be material to the assessment.
Scope 2	Electricity, heating, cooling and/or steam is procured from off site for operations	In	These sources of emissions are included within the EIB methodology and have the potential to generate emissions considered to be material to the assessment.
Scope 3	Embodied Carbon of Materials Construction Processes	Out	This is out of scope as defined in the EIB Methodology.

Assessment Methodology

Introduction

10.8.11. The overarching methodology to be used for calculating the carbon footprint of the Project is consistent with that set out in detail in the EIB Project Carbon Footprint Methodology[27]. The EIB methodology is based upon the internationally recognised Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories[28], the World Resource Institute (WRI) and World Business Council for Sustainable Development (WBCSD) GHG Protocol Corporate Accounting and Reporting Standard[29] and the International Financial Institutions (IFI) Framework for a Harmonised Approach to Greenhouse Gas Accounting[30]. The development of the methodology has also been informed by ISO 14064 Parts 1[31] and 2[32] and the Verified Carbon Standard[33] which provide guidelines for the development of GHG inventories at the corporate and project levels.

[27] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

[28] IPCC. (2019). IPCC Guidelines for National Greenhouse Gas Inventories. Available at: [Accessed: 08/08/2023]

[29] World Business Council for Sustainable Development / World Resources Institute. (2015). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. [Accessed: 08/08/2023]

[30] International Financial Institutions. (2015). International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting. [Accessed: 08/08/2023]

[31] International Organization for Standardization. (2018). ISO 14064-1:2018 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals. [Accessed:08/08/2023]

[32] International Organization for Standardization. (2019). ISO 14064-2:2019 Greenhouse gases - Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements. [Accessed: 08/08/2023]

[33] Verra. (2019). Verified Carbon Standard. [Accessed:08/08/2023]

10.8.12. The responsibilities regarding project specific GHG emissions assessment, management and monitoring have been outlined in EIB Standard 5[34] as follows:

- Projects are required to assess GHG emissions and their alignment with pathways to limit global warming to 1.5oC above pre-industrial levels and options to reduce transition risks; and
- Projects will provide the EIB with all relevant information on the nature and magnitude of its GHG emissions and/or sequestration.

10.8.13. The aim is to determine alignment with the EIB Group Climate Bank Roadmap (CBR)[35], its consistency with the "Do No Significant Harm" principle to climate change mitigation objectives, as set out in the EU Taxonomy Regulation[36].

VALUED COMPONENTS

VC2-1

10.8.14. Valued Components (VC) are the receptors of the receiving environment that is impacted, for example this could either be a component of the physical, ecological or atmospheric environment. In terms of this carbon footprint assessment, the value component is the atmosphere. The impacts of GHG emissions, in terms of their contribution to climate change, are global in nature, every tonne contributes to impacts on natural and human systems. The VC2-1 is therefore the Global Atmosphere.

METHODOLOGY

10.8.15. The main steps involved in the carbon footprint assessment of the Project are as follows:

- **Step 1: To define the 'project boundaries' for the Project.**
  - Based on the limits of project boundaries, emission sources are scoped in for the calculation of total/absolute and relative emissions. The EIB methodologies use the concept of 'scope' based on definitions from the WRI/WBCSD GHG Protocol Corporate Accounting and Reporting Standard[37] when defining the project boundaries.

10.8.16. The EIB methodology advocates the approach for assessment of GHG emissions depending on the type and scale of a project. In table 3 from the EIB methodology below, the Rogun Hydropower project is considered to fall under All Project, when it comes to project type. Therefore, this carbon footprint assessment follows the Footprint Boundary Clarification outlined in Table 3 below.

[34] EIB. (2022). Environmental and Social Standards. Available at: [Accessed: 11/07/2023]

[35] EIB. (2020). Climate Bank Roadmap. [Accessed: 08/08/2023]

[36] European Union. (2021). EU Taxonomy Regulation. [Accessed: 08/08/2023]

[37] World Business Council for Sustainable Development / World Resources Institute. (2015). The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. [Accessed: 08/08/2023]

Table 3: Carbon footprinting of projects: boundary clarifications

PROJECT TYPE	FOOTPRINT BOUNDARY CLARIFICATION
ALL PROJECTS (OTHER THAN THOSE EXCEPTIONS SPECIFIED BELOW)	INCLUSION: Scope 1 and 2 emissions for a typical year of operation. EXCLUSION: Scope 1 and 2 emissions associated with the commissioning, construction and decommissioning of the project. EXCLUSION: Scope 3 emissions. INCLUSION: Scope 3 emissions from 100% dedicated sources upstream or downstream that would not otherwise exist, and a number of specific cases below. An example of the first case would be a power plant that exists solely to supply the project (upstream) or a waste disposal site for the exclusive use of the project (downstream) that would not have otherwise existed.

- **Step 2: To quantify a typical year of operational GHG emissions from the Project.**

The GHG emissions are calculated with respect to the project boundaries defined in Step 1.

- **Step 3: To identify and quantify "without project" baseline emissions.**

Evaluation of the "without project" baseline emissions of the project provides a credible alternative do nothing' scenario, against which the "with project" do something' scenario can be compared. Emissions for the current baseline scenario (or 'do nothing' scheme scenario) shall also be calculated using equations from 'Step 2', as per the EIB Methodology[38]. However, in this case, the flooded total surface area would correspond to that of the existing "without project" scheme (2x400MW).

- **Step 4: To calculate relative emissions.**

  The potential impact of the project in terms of carbon footprint has been calculated by the following equation:

  Relative Emissions = "With / Do something" Project Emissions (W_p) - "Without / Do nothing" Project Emissions, or Baseline Emissions (B_e).

  Relative emissions (R_e) concern a project's emissions from a typical year of operation (that is, not including its commissioning or unplanned shutdowns). The "with / do something" project emissions must have the same boundary as the "without / do nothing" project emissions in terms of scope[39].

  Relative emissions may be positive or negative; where negative, the project is expected to result in savings in GHG emissions relative to the baseline and vice versa (subject to the general caveats surrounding the carbon footprint methodologies).

  Expressing relative carbon footprint is one way of evaluating the impact in emissions' terms since it provides a context to the emissions of the Project (whether it reduces or increases GHG emissions overall).

- **Step 5: To report potential impacts**.

[38] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

[39] EIB. (2023). EIB Project Carbon Footprint Methodologies. Available at: [Accessed: 14/07/2023]

Relative carbon emissions (potential impacts) of the Project are used as an indicator of its environmental performance and are compared to the relevant national and local carbon budgets and reduction targets and other relevant guidance. This is reported in the Carbon Footprint Assessment. The construction emissions, though not included explicitly as part of the EIB Methodology, were considered in the development of mitigation measures for the Project.

Calculation methods

10.8.17. Of the four scoped in emissions sources, data was only available for Biogenic emissions from the reservoir. This is expected to be the largest source of emissions scoped in. Emissions related to project owned vehicles, SF6 leakage and purchased electricity are not expected to be large and their quantification and management is covered in the Construction Environmental Management Plan (CEMP).

10.8.18. For biogenic emissions from the reservoir, these were quantified using the EIB methodology outlined in the box below.

Figure 10-4 - EIB GHG Assessment Equations

The EIB Methodology (**Ref: 1.1**) gives the following formula for the calculation of GHG emissions for a reservoir:

$CO_2 = 365 * ii * i$ ...1

$CH_4 = (365 * iii * i) + (365 * iv * i)$ ...2

wherein,

'i' is the flooded total surface area,

'ii' is CO_2 diffusive emission factor,

'iii' is CH_4 diffusive emission factor and

'iv' is CH_4 bubbles emission factor.

10.8.19. The climate data for the Region of Republican Subordination has been taken from the 'Techno-Economic Assessment Study for Rogun Hydroelectric Construction Project'. This data with the IPCC classification scheme for default climate regions, found the Project within a 'Cold temperate' climate zone.

10.8.20. The EIB methodology provides emission factors only for 'Cold Temperate, wet' climate zone, however it should be noted that the region is more aligned with a 'Cold Temperate, dry' climate zone for which an emissions factor is not available. Therefore, it is likely that the emissions factors are an over estimation. The GHG emission factors for the Project are provided in **Table 10-17**.

Table 10-17 – Reservoir GHG Emission Factors

Emission factor	Value	Unit
CO2 diffusive emission factor	0.2	$kgCO_2$/ha/d
CH4 diffusive emission factor	9.3	$kgCH_4$/ha/d
CH_4 bubbles emission factor	0.14	$kgCH_4$/ha/d

10.8.21. The flooded total surface area for the project use for the calculation was 17,000 hectares, in line with the 2014 ESIA. Using the equations as set out in the methodology, the baseline CO_2 and CH_4 emissions for the 6 x 600 MW units are 1.24 kt and 58.57 kt respectively. With 27 as the GWP conversion factor for CH_4, the total project emissions are 1,582 $ktCO_2e$ for a typical year[40].

10.8.22. The latest 100-year time horizon GWP for methane (non-fossil) is 27, relative to CO_2 as per IPCC's Sixth Assessment Report (AR6).[41]

10.8.23. For the existing units, that is, 2 x 400 MW unit, flooded total surface area is 2,402 hectares. The emission factors from Table 10-18, the absolute CO_2 and CH_4 emissions for the baseline (2 x 400 MW) are 0.17 kt and 8.28 kt respectively. With 27 as the GWP conversion factor, the total baseline emissions are 223 $ktCO_2e$.

Table 10-18 – Reservoir GHG Emission Factors

Scenario	Project capacity	Flooded total surface area (ha)	Methane emissions ($ktCO_2e$ per year)
Stage 1 Dam "Without Project" Baseline	800 MW (2 X 400 MW)	2,402	223
Stage 2 Dam "With Project" Emissions	3,600 MW (6 X 600 MW)	17,000	1,582
Stage 2 Dam "With Project" Emissions	3,600 MW (6 X 600 MW)	17,000	1,582

10.8.24. The electricity generation to calculate the emission intensity was calculated by subtracting the assumed Stage 1 Dam "without project" baseline electricity generation from the estimated Stage 2 Dam "with project" generation from the project.

10.8.25. The estimated electricity generation from the Project is assumed at 17 billion kWh.

10.8.26. The electricity generated from the baseline (2 x 400 MW) was apportioned from the total project (i.e., 17 billion kWh X (2 x 400 MW) / (6 x 600 MW)) and estimated as 3.67 billion kWh.

10.8.27. The emission intensity was estimated by dividing the relative emissions with the electricity generation.

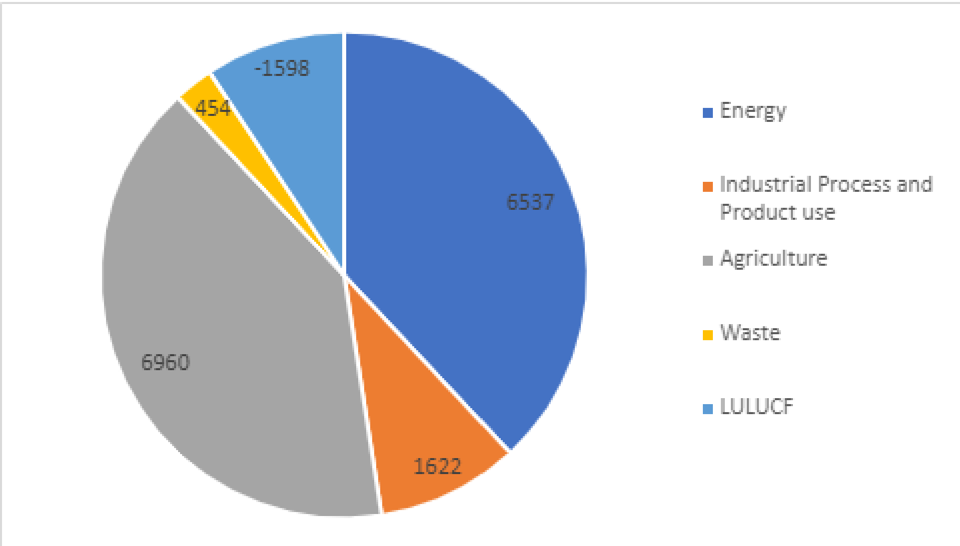
40 EPA. (2023). Understanding Global Warming Potentials | US EPA. [Accessed: 18/09/2023]

41 IPCC. (2023). Sixth Assessment Report — IPCC. [Accessed: 18/09/2023]

10.8.28. In order to provide context to the GHG emissions, the estimated GHG emissions arising from the Project will be compared with the Tajikistan's National emissions and the grid average.

10.8.29. According to fourth National Communications submitted to UNFCCC, most of Tajikistan's 13.9 Gg of GHG emission (including LULUCF) in 2016 was from agriculture (45%), followed by emissions from energy (42%), industrial process and product use (10%) and waste (3%)[42].

Figure 10-5 - Sector wise GHG emissions (Gg CO_2e) in Tajikistan for 2016



10.8.30. The Tajikistan electricity emission factors was provided in Table A1.3 (Country-specific electricity emission factors) of the EIB methodology, which is 106 gCO_2/kWh.

10.8.31. The fossil fuel alternatives for Tajikistan would likely be coal or natural gas, which would have a higher carbon intensity than the grid average. Based on available data from the IFC[43], the typical CO_2 emissions performance of new thermal power plants for coal (using the lowest carbon option of integrated gasification combined cycle (IGCC) technology) would be in excess of 700 gCO_2/kWh, similarly for gas (using the lowest carbon option of combined-cycle gas turbine (CCGT)) would be over 300 gCO_2/kWh.

10.9 Impact Assessment

Assessment of Impacts

10.9.1. The magnitude of GHG emissions from the Project has been calculated and contextualised with the various other power generating sources.

10.9.2. GHG emissions is defined as the tonnes of carbon dioxide equivalent (tCO_2e), emitted. The quantity of these gases emitted must be multiplied by the correct global warming potential (GWP) to convert this into tonnes CO_2e. GWP has extensively been employed in climate policy to report emissions of different GHGs on the same scale.

[42] UNFCC. (2022). Fourth National Communication of The Republic of Tajikistan under The United Nations Framework Convention on Climate Change. Available at: Tajikistan. National Communication (NC). NC 4. | UNFCCC [Accessed: 21/08/2023]

[43] IFC. (2008). Guide for Preparation of Draft Industry Sector EHS Guidelines (ifc.org). [Accessed: 15/09/2023]

10.9.3. The assessment, results presented in **Table 10-19**, finds that the GHG emissions from the Project (With Project Emissions) are expected to be 1,582 tCO_2e/year, with a GHG emission intensity of 102 gCO_2/kWh.

Table 10-19 – Estimated Emission Intensity

	Value	Unit
Relative Emissions	1,359	$ktCO_2e$/annum
Electricity generation (4 X 600 MW) and 2 X 200 MW)	13.22	Billion kWh
Emission intensity	102	gCO_2e/kWh

Emissions context

10.9.4. In the context of total annual emissions available (2016) for Tajikistan, the Project represent an annual emission of 9.73%.

10.9.5. Additionally, the Project emission intensity is much lower when compared to the Tajikistan Grid Mix, Coal (IGCC) and Gas (CCGT), as detailed in **Table 10-20**. This present a reduction of 4%, 87% and 71% respectively.

Table 10-20 – Emissions Context

	Emissions Intensity (gCO2/kWh)	% Reduction this Project Represents
This Project	102	
Tajikistan Grid Mix	106	4%
Coal (IGCC)	760	87%
Gas (CCGT)	348	71%

10.9.6. The emission intensity presented in this GHG assessment likely represents an over estimation of potential emission (a worst-case scenario), as vegetation will be removed prior to construction (as committed in the watershed management plan and using representative emissions for “Cold Temperate, Wet” as there was emission factor available for “Cold Temperate, Dry” which would be lower.

Direct Effects

10.9.7. The direct effect of GHGs released from the project into the atmosphere is that it contributes to the greenhouse effect, amplifying climate change. The greenhouse effect keeps the Earth’s climate liveable, but human activities have increased the amounts of carbon dioxide and other GHGs like methane in the atmosphere which is warming the globe and changing the climate. A changing climate results in more flooding, droughts, fires, and sea level rise.

Indirect Effects

10.9.8. The indirect effects of climate change include impacts on health from air pollution, disease, extreme weather events, forced displacement, food insecurity due to increased extreme weather events.

Whole Project Impact Assessment

10.9.9. The GHG emissions have been calculated for this project align to the EIB methodology as per detailed in the section "Assessment Methodology". This methodology requires a "without project" and "with project" conditions from a typical year of the project operations.

TRANSBOUNDARY EFFECTS

10.9.10. The impacts of GHG emissions, in terms of their contribution to climate change, are global in nature, and therefore have a transboundary effect that occurs in the global atmosphere. As a result, it is difficult to specifically name the effects and so a transboundary screening has not been completed.

Summary of impacts

10.9.11. The assessment of Impacts is presented in **Table 10-21**.

Table 10-21 – Greenhouse Gases Impact Assessment Summary

Impact Factor	Impact Factor 1 - What is the Impact of Reservoir Emissions on Climate Change?
Valued Component	**VC2-1 - Impact of GHGs on Climate Change**
Sensitivity	**High**
	Any increase in GHG emissions from human activity is said to impact Climate Change, and therefore the sensitivity is high.
Type	**Negative**
	The proposed project will lead to an increase in GHG emissions from the baseline existing project. This will have a negative effect on climate change, but it will have less of a negative effect if the proposed project output of electricity was met with coal or gas power stations instead.
Extent	**Global**
	Increasing GHG emissions into the atmosphere has a global impact, as it affects the global climate.
Duration	**Long-term**
	Releasing GHG emissions into the atmosphere has a long-term impact on the climate. Each GHG has a different average lifetime in the atmosphere i.e. CO_2 = 100's to 1000's of years, CH_4 = about a decade, SF6 = 3200 years.
Frequency	**Constant**
	The GHG emissions presented in this Carbon footprint represent 1 typical year of the reservoir's operations. These GHG emissions will be calculated annually, the amount of reservoir emissions will depend on the flooded area covered by the reservoir.
Likelihood	**Likely**

Impact Factor	Impact Factor 1 - What is the Impact of Reservoir Emissions on Climate Change?
	It is likely that the reservoir will emit GHG emissions into the atmosphere. It is also likely that there will be other emissions from the Projects Scope 1 & 2 emissions emitted, although compared to the reservoir emissions the remaining emissions are of lesser significance.
Reversibility	**Irreversible**
	Many of the impacts of climate change are now irreversible according to the UN's latest IPCC assessment.
Magnitude	**Medium**
	The reservoir will emit GHG emissions into the atmosphere but compared to the number of emissions released from an alternative coal of gas fired power station the impacts will be a lot less.
Significance	**Medium**
	Compared to the of various Power Generation types, Hydropower comes in at medium significance, Coal and Gas are Major significance, with Wind On-shore and Nuclear are minor significance, based on median lifecycle carbon emissions (gCO_2/kWh).
Additional Mitigation?	**Yes**
	Included as AM2-1 & AM2-2 Section 8 – Management and Mitigation
Residual Significance	**Minor**

MANAGEMENT AND MITIGATION

10.9.12. GHG mitigation for a project like Rogun requires planning, design optimisation, efficient construction methods and sustainable operational practices. PAS 2080 is a global framework developed by the Infrastructure Carbon Review (ICR) which outlines a systemic approach to managing and mitigating carbon emissions in infrastructure projects and operations.

10.9.13. To manage and mitigate carbon emissions effectivity it requires a process such as PAS 2080:

- Assessment and Baseline: quantify whole life carbon;
- Strategy and Target Setting: develop strategy to reduce emissions;
- Implementation and Innovation: put strategy into action, include innovative technologies to reduce emissions during construction and operation; and
- Monitor and Continuous Improvement: Monitor emissions and track against targets and seek improvements.

10.9.14. A carbon management process can really help to focus in on emissions and ensure that the mitigation measure being taken are having the desired outcome of carbon reduction. Outlined below are some construction phase mitigation measures that have been taken to date and then some mitigation measures for during operations are presented.

Construction Phase

10.9.15. To reduce the carbon footprint of the Project and ensure energy efficiency, mitigation measures have been incorporated in its construction phase, examples of which are listed below from 8.1.1 to 8.1.7. These measures stated below form part of the Energy Saving Initiatives for the Project and help to reduce GHG emissions in the construction phase.

10.9.16. Green air ventilation system is an automated ventilation system capable of optimizing jet fan speed based on real-time pollutants measurements. The main benefits if the system include:

- Better healthy conditions in tunnels through continuous monitoring of pollutants (CO_2, NO_2) and ventilation speed adaptation.
- Greater energy efficiency leading to reduced consumption and GHG emissions.
- The system ensures energy efficiency of 96.78% on average, which implies reduction in:
  - Energy consumption by 6023 kWh/day;
  - Emissions by 337.28 kg CO2/day;
  - Running costs by 216.82 €/day.

10.9.17. This is a 10.8km electrically controlled belt conveyance system proposed to transfer crushed materials from crusher plants to silos near the dam area. The main benefits from the system include:

- Capable of handling wide range of bulk materials;

- Reduced risk of accidents;
- Configured to change elevation;
- Reduced manpower;
- Energy savings.

10.9.18. Approximately 4.8km of the conveyance system was installed under Phase 1 and the remaining 6.02km is to be installed under Phase 2. The system is expected to result in annual energy savings of 9 million kWh and annual CO_2 savings of 13.7 kilo tonnes[44].

10.9.19. As part of the continuous effort to minimise the use of diesel-powered generator sets as a source of electricity power for site works of the Project, a direct power source was solicited from the Nurek Power Station. The external power feeds into a 16,000kVA transformer substation which subsequently phases down the infeed power into usable electricity power source. In this way, the direct power feed effectively replaces the use of 12 generator sets of 1200kVA. This is expected to result in 101 million kWh energy savings, 2.3 million € cost savings and 73.08 kilo tonnes CO_2 savings annually.

10.9.20. LED lights have been introduced to replace the more conventional fluorescent lighting. Energy efficient lighting has been installed at various locations of the site. LED lighting is expected to result in annual energy savings of 239,919 kWh for the main offices and camp area and 460,776 kWh for the workshop area.

10.9.21. This involves the use of on-site water resources for dust suppression. The use of energy efficient water hoses, energy and water efficient water guns significantly reduces water consumption. Energy savings also result from reduced water truck mileage. These measures are expected to lead to annual energy savings of 76,000 kWh, annual cost savings of 4,000 € and annual CO_2 savings of 69.02 tonnes.

10.9.22. In September 2021, a refurbishment of the diesel-powered engines by replacing them with electrically driven engines was proposed. The engine transformation project commenced in the 4th quarter of 2021 for a duration of 2 months. Testing and commissioning of the new engines for a total 5 drilling & grouting machines was completed in October 2021. This shift to electric engines is likely to result in energy savings of 1.3 million kWh, cost savings of 110,700 € and CO_2 savings of 345.1 tonnes on an annual basis.

10.9.23. To reduce these emissions further, it is recommended that all engines are turned off when not in use to be implemented through the CEMP.

10.9.24. Savings in fuel consumption can reduce GHG emissions to a great extent. Transportation emissions during the construction phase of the Project have been optimised by:

- Deploying only vehicles that will get better fuel mileage;
- Ensuring regular and proper vehicles' technical inspection and maintenance;

[44] 1 Ton = 0.99 tonnes; values in tons have been converted to tonnes in order to maintain uniformity throughout the assessment.

- Re-siting expat camps next to Main Office to cut down travelling; and
- Using multiple-passenger vans or bus to transport staff.

10.9.25. This is expected to result in energy savings of 6 million kWh per year, cost savings of 342,500 € per year and CO_2 savings of 917.6 tonnes per year.

OPERATIONAL PHASE

10.9.26. The recommended good practice measures to reduce the generation and release of methane and other GHGs to the atmosphere include:

- Hydropower projects (e.g. those with emissions greater than 20 kt CO2e/year), like the Rogun Dam, must consider alternative project design configurations to minimise emissions wherever possible:
  - One means of achieving this might be the removal of vegetation from the reservoir footprint prior to inundation, which has already been proposed as part of the 2014 ESIA.
  - Other measures may include re-siting offtake structures to avoid drawing water from the anoxic bottom layer of a reservoir, or a reduction in surface area by lowering the operating level.
  - The current estimate of Rogun Dam is 102g of CO2e per kWh, this may be an overestimate of GHGs, as it is deemed that the catchment area is low on biomass compared to other Hydropower projects and it also plans to clear biomass and trees before impoundment.
  - EIB also requires that all hydropower projects considered large Hydropower projects, must undertake direct and continuous monitoring of CO2e emissions during operation. The assessment is based on available data, which is from Scope 1 and 2 operations. To manage these emissions, it is recommended that an ongoing monitoring and mitigation plan (GHG Reduction Plan) of operational GHG sources is put in place. This will need to include the sources of emissions described in Table 10-22.

Table 10-22 – Mitigation measures for identified Scope 1 and Scope 2 Emissions.

Monitor	Manage and Mitigate
Scope 1 Emissions:	
What amount of SF6 gas leaks from Switch gear per annum?	Measure, monitor and reduce leakage to as great and extend as possible.
Are there any processes that release emissions during operations? For example: Are any fuel powered machinery used to remove plant matter from the dam?	Measure, monitor and switch to low carbon or no carbon plant machinery instead.
What fuel is combusted on site, per annum for the Project operations? For example: How much diesel, petrol, gas is used in operations per annum?	Measure, monitor and switch to low carbon or no carbon vehicles or generators, where possible.
Reservoir Emissions – where appropriate	Rogun, is likely to have a relatively small amount of biomass to be submerged. A thorough pre-impoundment reservoir clearing, should decrease the amount of methane released during the reservoir operations. Rogun reservoir will be filled in stages. The pre-impoundment clearing will have to be in coordination with this staged filling, with the aim of clearing areas as shortly before impoundment as possible, in order to prevent regrowth. In the last stage, care will have to be taken not to cut any trees, and not to burn any vegetation above this level. Watershed management (will be required as part of the Watershed Management Plan) will help reduce the contribution of organic matter from the catchment area to the reservoir and the removal of decomposable vegetative matter from the inundation area before flooding. Thermocline: a temperature gradient in a reservoir, can trap methane by limiting vertical water mixing. Methane, produced in deeper, cooler layers, stays dissolved due to this barrier. Less soluble in warm water, trapped methane is less likely to reach the surface and escape into the atmosphere, reducing emissions. However, effectiveness depends on factors like thermocline strength and reservoir dynamics.
Scope 2 Emissions:	

Is there any electricity, heating, cooling and/or steam is procured from off site for operations per annum?	Energy efficiency measures and switching to renewable electricity will reduce Scope 2 emissions.

Residual Effects

10.9.27. The GHG indicates that this Project is expected to have an Emission intensity of 102 gCO2e/kWh.

10.9.28. The emission intensity presented in this GHG assessment likely represents an over estimation of potential emission (a worst-case scenario), vegetation will be removed prior to construction (as committed in the watershed management plan and using representative emissions for "Cold Temperate, Wet" as there was emission factor available for "Cold Temperate, Dry" which would be lower.

10.9.29. An alternative to SF6 for switch gear may not yet be available. Research into options to replace this with a low carbon alternative is recommended to deal with any residual emissions.

10.9.30. As with most hydropower dams, the project is anticipated to contain biomass which will be submerged. The project will work to reduce any residual emissions. Where practicable monitoring of methane emissions can be undertaken to understand the long-term effects on carbon and carbon equivalent emissions.

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