TÜRKİYE PETROLLERİ ANONİM ORTAKLIĞI

OTC OFFSHORE TECHNOLOGY CENTER

SAKARYA GAS FIELD DEVELOPMENT PROJECT

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Chapter 9 Climate Change Risk Assessment

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WSP GOLDER

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Information Classification

Code	Description of Information Classification
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9.0 CLIMATE CHANGE RISK ASSESSMENT

As a part of this ESIA, a Climate Impact Assessment and Climate Vulnerability Assessment has been prepared in line with the Equator Principles 4 (EP4). The Climate Impact Assessment and Climate Vulnerability Assessment approach is designed to be consistent with the approach of the Taskforce for Climate-related Financial Disclosure (TCFD) and considers physical climate change risks to the Project.

9.1 PHYSICAL CLIMATE CHANGE RISK ASSESSMENT

This chapter is intended to provide a qualitative Physical Climate Change Risk Assessment for the Project. The assessment of physical climate risks employs a risk management screening approach based on available Project design to anticipate future climate conditions for the Project region, and how climate change related disruptions or impacts may affect the Project. A qualitative screening level risk assessment approach has been conducted based on the available Project design information. The following approach was used to conduct the physical climate change risk assessment:

1) Identifying qualitative regional climate projections for the short-term (2050s) and long-term (2080s), based on the Project lifespan. Climate projections were identified for different scenarios (e.g., RCP 4.5 and RCP 8.5), to help capture the uncertainty in future projections. These climate change projections are summarized in Chapter 9.1.3.2.

2) Identifying Project infrastructure that will potentially interact with climate variables. The Project components includes infrastructure from all facilities (Sakarya Gas Field- Block C 26, Subsea Production System (SPS), SURF, ONSHORE, Coastal Logistic Centre, and Industrial Waste Treatment Facility). The climate-infrastructure interactions are summarized in Chapter 9.1.4.

3) Assigning a qualitative risk rating based on the Project's existing risk ranking system (unacceptable, severe, medium, acceptable, negligible). The risk ranking identifies plans, policies, procedures that currently exist, and could be used to manage physical climate risks of high priority. The risk ranking for Project infrastructure is summarized in Chapter 9.1.5.

The approach used for physical climate change risk assessment is qualitative in nature to identify key risk areas for further quantitative study under recommendations section.

9.1.1 Project Background for Climate Change Risk Assessment

The Project consists of three main units: Subsea Production System (SPS) in Sakarya Gas Field in the exclusive economic zone of Turkey, land section including Onshore Processing Facility (OPF) and Transformer Station and Energy Transmission Line (ETL) in Çaycuma District of Zonguldak Province and marine and shore crossing subsea umbilical and pipelines unit (SURF) connecting these two units. They key Project timeframes involved are summarized in Chapter 9.1.1.2.

9.1.1.1 Construction Phase

Given that construction phase is till 2023, it is expected that the climatic conditions during construction will be very similar to the baseline climatic conditions presented in Chapter 9.1.3.2. The potential impacts of climate change on the construction phase of the Project have therefore not been considered in this assessment as these changes are not likely be discernible from the anticipated variations in weather on a day to day or seasonal basis. The projected changes in climate are likely to manifest in the medium and long term.

9.1.1.2 Operations Phase

The Project will begin operations in 2023, with an expected to remain in operation for 25-40 years. Onshore Processing Facility including all its facilities, equipment and buildings shall have a design life of 25 years. As these facilities have a longer time frame that could be impacted by changed in long term climate the operational phase of the Project has been considered for climate change risk assessment, The Project infrastructure that has been considered for the climate change risk assessment has been summarized in Table 9-1. The current climatic conditions and climate projections for 2050s summarized in Chapter 9.1.3.2 are mostly applicable to the operations phase of the Project.

Table 9-1: Project Infrastructure

Infrastructure	Description
Subsea Production System (SPS)	
Well Head Valves (Xmas Trees)	Horizontal wellhead valves would be placed at the head of the wells where production control and measurement connections for each well are made.
Distribution Chambers	To control the production of wells and collect the produced gas and transfer it to gas pipelines.
Flexible Pipelines	Wellhead valves will be connected to the production distribution chamber with flexible pipes. The flexible pipes will deliver both the gas and the MEG.
Steel Pipelines	Steel pipe joints are the assemblies that allow the flow of gas and MEG between the main head of the distribution chamber and the pipeline termination unit.
Marine and Shore Crossing Subsea Umbilical and Pipelines Unit (SURF)	
Seabed Umbilical	Approximately 6 inches (15.24 cm) in diameter that bundles together small pipes containing fluids, chemicals, and electrical and fibre optic lines. The seabed umbilical will be coming from offshore to onshore.
Gas pipeline	The gas pipeline would be 16 inches (40.64 cm). The gas pipeline will be coming from offshore to onshore.
MEG line	The MEG line approximately 10 inches (25.4 cm) in diameter. The MEG line is located away from the sea.
Onshore Processing Facility (OPF)	
Indirect Fired Heaters (Water Bath)	Water bath type with fuel gas fired burners will be provided in the gas stream to raise the fluid temperature when arrival temperatures are very low.
MEG Pre-Treatment & MEG Regeneration and Reclamation Unit	The MEG system will be a full stream reclamation process removing monovalent and divalent salts to low acceptable levels. The MEG-enriched combination will be sent to the MEG regeneration and reclamation unit. The vaporized MEG combination will be completely decomposed into wastewater and MEG by being distilled in an air-cooled distillation tower.

Infrastructure	Description
Fuel Gas Systems and Gas Engines	The fuel gas system will supply fuel gas to units that will use natural gas as a source of energy on-site. Gas engines will burn natural gas to generate electricity required for the facility
Flares	There will be high pressure and low-pressure flare systems in the OPF. This is also known as the cold flare ground system. The flare systems will provide a safe and reliable means of collection and disposal of any hydrocarbon released during upset or emergency conditions, operational venting as well as depressurization and venting of a system during maintenance operations.
Natural Gas Steam Boiler (LP Steam and Heating Medium System)	Fuel gas fired steam boilers will generate dry saturated steam to use as heating medium for the process systems.
Drainage Systems	The drainage systems at the facility include closed and open drains including rainwater collection lines.
Demineralized and Potable Water Generation Package - Sedimentation Package	Fresh water will be supplied through an underground water well and will be treated by reverse osmosis according to specification required for Boiler Feedwater and for the Potable System. Sedimentation package will treat backwash wastewater generated by the Demineralized and Potable Water Generation Package.
Air Cooling System	All devices and equipment that will be located in the gas production system will be cooled by air. This system will be linked to every unit that requires cooling.
Effluent Treatment Package (ETP-A)	ETP-A will be installed to treat the potentially contaminated water coming from open drains to river discharge specifications.
Sanitary Sewage Treatment System (ETP-B)	A sanitary sewage treatment system will be provided to treat the sanitary water collected in the facility.
Temporary Waste Storage Area	Temporary waste storage area will be established to temporary storage of wastes until disposal.
Produced Water Treatment Package	Effluent Wastewater including minimal quantities of organics e.g., lube oil, diesel, heat transfer oil, MEG, TEG, corrosion inhibitor and solids from MEG Reclamation Unit will be treated according to Project Standards before discharge to the Filyos River.
Transformer Station and Energy Transmission Line	
Transformer Station and Energy Transmission Line	The Project will be connected to the national electrical grid through a substation and an energy transmission line The national electrical grid will be utilized as a backup power supply when the gas engines are not in use during maintenance or repair.

Infrastructure	Description
BOTAS Fiscal Metering Station and Pipeline	
FMS[(a)]	Once measured in the FMS, the natural gas flows through the Pipeline Inspection Gauge (PIG) station and from there to the pipeline.
BOTAS Pipeline[(a)]	Pipeline (~36 km) would be used to connect the FMS to the national grid.

Note: (a) = The BOTAS pipeline and the FMS could be subject to natural hazards such as earthquakes and landslides, that could be impacted by climate change. However, the BOTAS pipeline would be a part of the national pipeline network and the impacts to this pipeline would be assessed and monitored as a part of this network. Hence, the BOTAS pipeline is excluded from this assessment.

9.1.1.3 Decommissioning Phase

After 25 years, the operational life of the OPF can be extended with the maintenance, repair and revision works. However, for the closure phase, currently there are two alternatives considered. Post-operation alternatives are removal of the facility components and restoration of the area or leaving the components as they are in the offshore section. Pipelines left in place will be disconnected and isolated from all potential sources of hydrocarbons; cleaned and purged of hydrocarbons; and sealed at its ends to mitigate any risks associated with decommissioning. After decommissioning, many site operations and infrastructure will be discontinued and hence this phase has been excluded from the risk assessment.

9.1.2 Approach and Methodology

First, a review of the current and future projected changes in climate is completed to identify potential climate hazards relevant to Project region (Chapter 9.1.3.2). Based on the site infrastructure (Chapter 9.1.1.2) and identified hazards (Chapter 9.1.3.2), a list of climate-infrastructure interactions is developed for further consideration, and summarized in Chapter 9.1.4.

Likelihood and consequence rankings of climate-infrastructure interactions are then estimated to identify climate risks under current climate conditions and near-future conditions (Chapter 9.1.5). Likelihood rankings are estimated under two future periods for the Project infrastructure to indicate how future climate risk may change for each in the future. The likelihood for which the interaction may occur, and the consequence associated with this interaction are assigned qualitatively using a ranking scale. The likelihood ranking scales has been summarized in Table 9-2, while the consequence ranking scales are summarized in Table 9-3 . For likelihood, the scale with categories ranges from improbable/rare (1) to almost certain/ highly probable (5), and insignificant (1) to catastrophic (5) for consequence. The consequence scales provide an indication of how risks are perceived by TPOC; therefore, they will be incorporated into this assessment to facilitate the communication of likelihood and consequence under current and future climate conditions. The site has a range of adaptation measures considered in the Project design which are considered in the likelihood and consequence rankings.

Table 9-2: Likelihood Ranking Scales

Qualitative Descriptor	Description
Improbable/ Rare	Not likely to occur during the entire Project's operational life. Not likely to increase in intensity or duration during the Project life.

Qualitative Descriptor	Description
Could Happen/ Unlikely	Likely to occur once during the entire Project's operational life. Likely to increase in intensity or duration in 30-40 years of the Project life.
As Likely As Not/ Possible	Likely to occur more than once during the Project's operational life. Likely to increase in intensity or duration in the coming 20 to 30 years of the Project life
Probable/ Likely	Likely to occur at least once every decade throughout Project's operational life. Likely to increase in intensity or duration in the next 10 to 20 years of the Project life.
Almost Certain/ Highly Probable	Likely to occur at least once or even more in every year of Project's operation life. Will increase in intensity and duration annually since the start of the Project.

Table 9-3: Consequence Ranking Scales

Qualitative Descriptor	Description
Insignificant	Minor loss/ damage to infrastructure. Plant/ equipment – no impact on availability.
Minor	Moderate loss / damage to infrastructure. Plant / equipment offline for less than 1 month.
Moderate	Significant loss / damage / reportable event within local legislation. Plant /equipment offline for 1-3 months.
Major	Severe loss / damage / business impact. Plant / equipment offline for 3-6 months.
Catastrophic	Major loss / damage /reportable event within local legislation. Plant /equipment offline for >6 months.

The consequence and likelihood of climate interactions can be used to identify key climate risks. If an interaction has a major consequence, but rare occurrence, the overall risk would be perceived as being medium risk. Evaluating both consequence and likelihood together allows for climate risks to be categorized (Figure 9-1). These risks are further defined in Table 9-4.

Consequence	Catastrophic	Medium Risk	Severe Risk	Severe Risk	Unacceptable Risk	Unacceptable Risk
	Major	Acceptable Risk	Medium Risk	Severe Risk	Severe Risk	Unacceptable Risk
	Moderate	Acceptable Risk	Acceptable Risk	Medium Risk	Severe Risk	Severe Risk
	Minor	Negligible Risk	Acceptable Risk	Acceptable Risk	Medium Risk	Medium Risk
	Insignificant	Negligible Risk	Negligible Risk	Acceptable Risk	Acceptable Risk	Acceptable Risk
		Improbable/ Rare	Could Happen/ Unlikely	As Likely As Not/ Possible	Probable/ Likely	Almost Certain/ Highly Probable
	Likelihood					

Figure 9-1: Risk Heat Map

Table 9-4: Risk Rating Definition

Risk Rating	Example
Negligible Risk	An identified interaction between the climate hazard and Project component has a negligible risk if the hazard has: ▪ An improbable/rare or could happen/unlikely likelihood of occurrence and an insignificant consequence; or ▪ An improbable/rare likelihood of occurrence and a minor consequence. No permanent damage. Risks do not require further consideration.
Acceptable Risk	An identified interaction between the climate hazard and Project component has an acceptable risk if the hazard has: ▪ An improbable/rare likelihood of occurrence and a moderate or major consequence ▪ A could happen/unlikely likelihood of occurrence and a minor or moderate consequence ▪ An As Likely As Not/ Possible likelihood of occurrence and an insignificant or minor consequence ▪ A Probable/ Likely or Almost Certain/ Highly Probable likelihood of occurrence and an insignificant consequence Minor damage. Actions might not be required.
Medium Risk	An identified interaction between the climate hazard and Project component has a medium risk if the hazard has: ▪ An improbable/rare likelihood of occurrence and a catastrophic consequence ▪ A could happen/unlikely likelihood of occurrence and a major consequence ▪ An As Likely As Not/ Possible likelihood of occurrence and a medium consequence ▪ A Probable/ Likely or Almost Certain/ Highly Probable likelihood of occurrence and a minor consequence Expected limited damage to infrastructure/operations. Some adaptation actions might be required.
Severe Risk	An identified interaction between the climate hazard and Project component has a high risk if the hazard has: ▪ A could happen/unlikely likelihood of occurrence and a catastrophic consequence ▪ An As Likely As Not/ Possible likelihood of occurrence and a major or catastrophic consequence

Risk Rating	Example
	▪ A Probable/ Likely of occurrence and a moderate or major consequence ▪ An Almost Certain/ Highly Probable likelihood of occurrence and a moderate consequence May result in permanent damage to infrastructure, assets, operations. High priority adaptation actions need to be implemented.
Unacceptable Risk	An identified interaction between the climate hazard and Project component has an extreme risk if the hazard has: ▪ A probable/likely likelihood of occurrence and a catastrophic consequence ▪ An Almost Certain/ Highly Probable likelihood of occurrence and a major or catastrophic consequence May result in permanent damage or loss of asset and operations. Immediate adaptation actions need to be implemented or risks need to be monitored as part of continual improvement.

9.1.3 Climate Change Projections

Qualitative regional climate change projections were identified for the Project region for the short-term (2050s) and long-term (2080s). A range of climate variables have been considered including temperature, rainfall, humidity, wind, and storm events. Climate projections have been identified for different scenarios (e.g., RCP 4.5 and RCP 8.5), to help capture the uncertainty in future projections.

9.1.3.1 Introduction to Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is generally considered to be the definitive source of information related to past and future climate change as well as climate science. The IPCC is a United Nations body dedicated to providing an objective, scientific assessment of climate change information, and the potential natural, political, economic, and human impacts of climate change. The IPCC periodically releases Assessment Reports, each of which provides the current state of climate change science, where there is agreement within the scientific community. The Fourth Assessment Report (AR4) was released in 2007, the Fifth Assessment Report (AR5) was released in 2013 and the Sixth Assessment Report (AR6) was released in 2021. The AR6 is the most current complete synthesis of information regarding climate change that include general global and regional trends.

When projecting future climate conditions, there needs to be a consideration of future climate scenarios which is based on assumptions about future GHG emissions and atmospheric concentrations. These future climate scenarios are termed as Representative Concentration Pathways (RCPs). They are described for changing climatic conditions till 2100. In AR5, IPCC (2013) has defined four scenarios, RCP 2.6 (low emissions), RCP 4.5, RCP 6.0, and RCP 8.5 (high emissions). These four RCPs have been described more fully by van Vuuren et al. (2011) in their paper *The Representative Concentration Pathways: An Overview* and are summarized in Table 9-5.

Table 9-5: Characterization of Representative Concentration Pathways

Name	Radiative Forcing in 2100	Characterization
RCP 8.5 (high emissions scenario)	8.5 W/m²	Increasing greenhouse gas emissions over time, with no stabilization, representative of scenarios leading to high greenhouse gas concentration levels.
RCP 6.0	6.0 W/m²	Without additional efforts to constraint emissions (baseline scenarios).
RCP 4.5	4.5 W/m²	Total radiative forcing is stabilized shortly after 2100, without overshoot. This is achieved through a reduction in greenhouse gases over time through climate policy.
RCP 2.6 (low emissions scenario)	2.6 W/m²	"Peak and decline" scenario where the radiative forcing first reaches 3.1 W/m² by mid-century and returns to 2.6 W/m² by 2100. This is achieved through a substantial reduction in greenhouse gases over time through stringent climate policy.

Source: Summarized from Van Vuuren et al. 2011.

RCP = representative concentration pathway; W/m² = Watts per square metre.

Compared to IPCC Fifth Assessment Report (AR5), a wider range of scenarios are provided in AR6, covering an updated set of pathways for future climate to unfold which are summarized in Table 9-6. Where possible, the analogous pathway of the Special Report on Emissions Scenarios (SRES) from the IPCC Fourth Assessment Report (AR4) and the Representative Concentration Pathways (RCP) from the IPCC Fifth Assessment Report (AR5) are noted for each SSP from O'Neil et al. (2014).

Table 9-6: Characterization of Shared Socioeconomic Pathways (SSPs) in IPCC Sixth Assessment Report

SSP	Radiative Forcing in 2100	Challenges	Global Temperature Change	Characterization
SSP1	1.9 W/m² 2.6 W/m²	Sustainability – Low for mitigation and adaptation	1.0°C – 2.4°C	Sustainable development proceeds at a reasonably high pace. Analogous to SRES B1 and A1T scenarios.
SSP2	4.5 W/m²	Middle of the Road – Medium for mitigation and adaptation	2.1°C – 3.5°C	An intermediate case between SSP1 and SSP3. Analogous to RCP 4.5 scenario.
SSP3	7.0 W/m²	Regional Rivalry – High for mitigation and adaptation	2.8°C – 4.6°C	Unmitigated emissions are high due to moderate economic growth. Analogous to SRES A2 scenario.
SSP4	3.4 W/m² 6.0 W/m²	Inequality – High for adaptation, low for mitigation	—	A mixed world, with relatively rapid technological development in low carbon energy sources in key emitting regions, leading to relatively large

SSP	Radiative Forcing in 2100	Challenges	Global Temperature Change	Characterization
				mitigative capacity in places where it mattered most to global emissions.
SSP5	8.5 W/m^2	Fossil-fuelled Development – Low for mitigation, high for adaptation	3.3 – 5.7°C	In the absence of climate policies, energy demand is high and most of this demand is met with carbon-based fuels. Analogous to SRES A1F1 scenario. Analogous to RCP 8.5 scenario.

Source: O'Neil et al. 2014.

9.1.3.2 Climate Change Projections

Future climate change projections from peer-reviewed publicly available research for regional, national, and provincial levels were used to describe changing climate trends. Specifically:

- Regional qualitative data based on down-scaled, regional level climate change projections from the IPCC AR6-WGI Atlas was taken for the Mediterranean region (where the Project is located) to identify medium-term (2041-2060) and long-term (2081-2100) projections for various climate variables (IPCC 2022). The information that contributes to this climate portal is based on IPCC'S AR6 data.
- National and provincial qualitative data based on down-scaled, regional level climate change projections data from the World Bank Group Climate Change Knowledge Portal was used to identify national and provincial level projections for various climate variables (World Bank Group 2021). Further, qualitative information regarding climate projections was also gathered from the IPCC's Working Group I, on the physical science of climate change, from both AR5 and AR6 reports.

The climate change projections for the Project region are summarized in Table 9-7.

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Table 9-7: Climate Change Projections for the Project Region

Climate Hazard Description		Trend	Description of Current Climate	Comments on Future Trends
TEMPERATURE				
Temperature	Mean Annual Temperature	Increasing	▪ As identified in Chapter 6.2.1.1, the average temperature recorded at Zonguldak meteorological station varies between 6.2 °C (January) and 22.0 °C (August) and the annual average temperature is 13.7 °C. ▪ For the Zonguldak province of Turkey, it has been observed that mean annual temperature has increased by approximately 1.1°C from 1995-2014 (World Bank Group 2021).	▪ Climate change projections for the Mediterranean region indicate that between 2041-2060, the annual mean temperature will increase by 1.5°C under SSP2-4.5 and by 2.0°C under SSP5-8.5, compared to the 1995-2014 baseline (IPCC 2022). For 2080-2100, climate projections indicate that the annual mean temperature will increase by 2.4°C under SSP2-4.5 and by 4.6°C under SSP5-8.5, compared to the 1995-2014 baseline (IPCC 2022). ▪ Climate projections for Turkey indicate that by the 2050s the annual mean temperature will increase by 1.89°C under SSP2-4.5 and by 2.36°C under SSP5-8.5, compared to the 1995-2014 baseline (World Bank Group 2021). By the 2080s the annual mean temperature will increase by 2.62°C under SSP2-4.5 and by 4.75°C under SSP5-8.5, compared to the 1995-2014 baseline (World Bank Group 2021). ▪ Climate projections for Zonguldak province indicate that by the 2050s the annual mean temperature will increase by 1.67°C under SSP2-4.5 and by 2.36°C under SSP5-8.5, compared to the 1995-2014 baseline (World Bank Group 2021). By the 2080s the annual mean temperature will increase by 2.34°C under SSP2-4.5 and by 4.28°C under SSP5-8.5, compared to the 1995-2014 baseline (World Bank Group 2021).
	Extreme Heat (Number of days above 35C)	Increasing	▪ In Turkey in 1995, there were 12.14 days where maximum temperature was greater than 35 degrees C (World Bank Group 2021). The number of days where maximum temperature exceeded 35 degrees C increased to 19.29 days in Turkey in 2014 (World Bank Group 2021). ▪ In Zonguldak, there were no days with maximum temperatures greater than 35 degrees C in 1995 (World Bank Group 2021) In 2014, in Zonguldak, there were 2.49 days where max temperature exceeded maximum temperature of 35 degrees C (World Bank Group 2021).	▪ For the Mediterranean region, medium-term projections (2041-2060) indicate that extreme heat days (days above 35°C) will increase by 11.0 days under SSP2-4.5, and by 15.3 days under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022). Long-term projections (2081-2100) in the same area indicate that there will be a 17.7 day increase in extreme heat days under SSP2-4.5, and a 37.9 day increase under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022). This means that by 2041-2060, there will be 44.0 days above 35°C under SSP2-4.5 and 63.6 days above 35°C under SSP5-8.5 (IPCC 2022). By 2081-2100 there will be 37.3 days above 35°C under SSP2-4.5 and 41.1 days above 35°C under SSP5-8.5 (IPCC 2022).
	Projected Max Temperature (mean)	Increasing	▪ The projected mean maximum temperature for Turkey was 17°C in 1995, and 18.1°C in 2014, which shows a 1.1°C increase. ▪ The projected mean maximum temperature for Zonguldak was 17.05°C in 1995, and 18.07°C in 2014, which shows a 1.02°C increase.	▪ The projected mean maximum temperature for the Mediterranean region, between 2041-2060 is 22.1°C under SSP2-4.5 and 22.6°C under SSP5-8.5 (IPCC 2022). In the same region, the projected mean maximum temperature between 2081-2100 is 23.1°C under SSP2-4.5 and 25.3°C under SSP5-8.5 (IPCC 2022). ▪ National level projections for all of Turkey indicate that in 2050 there will be a projected mean maximum temperature of 19.61°C under SSP2-4.5 and 20.04°C under SSP5-8.5 (World Bank Group 2021). In 2080, there is a national projected mean maximum temperature of 20.33°C under SSP2-4.5 and 22.39°C under SSP5-8.5 (World Bank Group 2021). ▪ Projections specific to the province of Zonguldak indicate that in 2050 there will be a projected mean maximum temperature of 19.51°C under SSP2-4.5 and 19.9°C under SSP5-8.5 (World Bank Group 2021). In Zonguldak in2080, there is a projected mean maximum temperature of 20.1°C under SSP2-4.5 and 21.96°C under SSP5-8.5 (World Bank Group 2021).
	Frost Days	Decreasing	▪ In Turkey, in 1995 there were 95.74 frost days (<0 degrees C), which decreased to 84.18 frost days in 2014 (World Bank Group 2021). ▪ In Zonguldak specifically, in 1995, there were 65.28 frost days, which decreased to 53.95 frost days in 2014 (World Bank Group 2021).	▪ In Turkey, in 2050, there is expected to be 71.91 frost days under SSP2-4.5 and 66.52 days under SSP5-8.5 (World Bank Group 2021). In Turkey, in 2080, there is expected to be 65.89 frost days under SSP2-4.5 and 49.72 frost days under SSP5-8.5 (World Bank Group 2021). ▪ In Zonguldak specifically, in 2050, there is expected to be 37.78 frost days under SSP2-4.5 and 33.88 days under SSP5-8.5 (World Bank Group 2021). In Zonguldak, in 2080, there is expected to be 32.64 frost days under SSP2-4.5 and 18.73 frost days under SSP5-8.5 (World Bank Group 2021).
PRECIPITATION				
Precipitation	Total Annual Precipitation	SSP2-4.5 decrease from base and	▪ The projected total annual precipitation for Turkey was 634.8 mm in 1995, and 610 mm in 2014, which shows a 24.8 mm decrease.	▪ At the national level in Turkey, projections indicate that in 2050, there will be a total annual precipitation of 596.44mm under SSP2-4.5 and a total annual precipitation of 595.31mm under SSP5-8.5 (World Bank Group 2021). Projections indicate that in

Climate Hazard Description		Trend	Description of Current Climate	Comments on Future Trends
		increase from 2050-2080 SSP5-8.5 Decreasing	■ The projected total annual precipitation for Zonguldak was 768 mm in 1995, and 736 mm in 2014, which shows a 32 mm decrease. ■ As identified in Chapter 6.2.1.1, the average annual precipitation recorded at Zonguldak meteorological station was 1222.7 mm.	Turkey, in 2080, there will be a total annual precipitation of 602.15mm under SSP2-4.5 and a total annual precipitation of 552.57mm under SSP5-8.5 (World Bank Group 2021). ■ Projections specific to Zonguldak indicate that in 2050, there will be a total annual precipitation of 734.53mm under SSP2-4.5 and a total annual precipitation of 724.32mm under SSP5-8.5 (World Bank Group 2021). Projections indicate that in Zonguldak in 2080, there will be a total annual precipitation of 735.07mm under SSP2-4.5 and a total annual precipitation of 673.67mm under SSP5-8.5 (World Bank Group 2021). ■ For the Mediterranean region, medium-term projections (2041-2060) indicate that there will be a 5.5% decline in the mean annual total precipitation daily under SSP2-4.5, and an 8.5% decrease under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022). Long-term projections (2081-2100) in the same area indicate that there will be an 8.3% decrease in mean annual total precipitation daily under SSP2-4.5, and a 19.2% decrease under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022).
	Maximum 1-day Precipitation	Increasing	■ The observed maximum 1-day precipitation value in Zonguldak in 1995 was 27.03mm and increased to 29.99mm in 2014 (World Bank Group 2021).	■ At the national level in Turkey, projections indicate that in 2050, the average largest 1-day precipitation will be 28.53mm under SSP2-4.5 and 28.83mm under SSP5-8.5 (World Bank Group 2021). Projections indicate that in Turkey, in 2080, average largest 1-day precipitation will be 29.47mm under SSP2-4.5 and 30.17mm under SSP5-8.5 (World Bank Group 2021). ■ Projections specific to Zonguldak indicate that in 2050, the average largest 1-day precipitation will be 29.57mm under SSP2-4.5 and 29.77mm under SSP5-8.5 (World Bank Group 2021). Projections indicate that in 2080, average largest 1-day precipitation will be 29.47mm under SSP2-4.5 and 32.54mm under SSP5-8.5 (World Bank Group 2021). ■ Similarly, the IPCC projections for the Mediterranean region show a maximum 1-day precipitation between 2041-2060 to be 26.3mm under SSP2-4.5 and 26.8mm under SSP5-8.5 (IPCC 2022). In the same region by 2081-2100, maximum 1-day precipitation is expected to be 26.7mm under SSP2-4.5 and 27.4mm under SSP5-8.5 (IPCC 2022).
	Consecutive dry days (days with precipitation <1mm)	Increasing	■ The historical number of consecutive dry days in Turkey in 1995 was 44.68 days and increased to 49.7 days in 2014 (World Bank Group 2021). Specifically in Zonguldak, the number of consecutive dry days in 1995 was 36.56 days and increased to 37.31 days in 2014.	■ In the Mediterranean, in which Zonguldak is located, between 2041-2060, projections indicate that there will be an increase in consecutive dry days by 6.5 days under SSP2-4.5 and 9.4 days under SSP5-8.5, from the 1995-2014 baseline (IPCC 2022). Projections indicate that in the Mediterranean, between 2081-2100 there will be an increase in consecutive dry days of 10.1 days under SSP2-4.5 and 20.4 days under SSP5-8.5 from the 1995-2014 baseline (IPPC 2022). ■ At the national level in Turkey, projections indicate that in 2050, the number of consecutive dry days will be 57.12 days under SSP2-4.5 and 58.84 days under SSP5-8.5 (World Bank Group 2021). Projections indicate that in Turkey, in 2080, average number of consecutive dry days will be 60.72 days under SSP2-4.5 and 68.3 days under SSP5-8.5 (World Bank Group 2021). ■ Projections specific to Zonguldak indicate that in 2050, the number of consecutive dry days will be 44.23 days under SSP2-4.5 and 50.97 days under SSP5-8.5 (World Bank Group 2021). Projections indicate that in 2080, average number of consecutive dry days will be 53.34 days under SSP2-4.5 and 64.34 days under SSP5-8.5 (World Bank Group 2021).
	Number of Snowfall Days	Decreasing	■ There is very high confidence that snow cover has declined since 1950 in the Northern Hemisphere, which Turkey is located in (Arias et al. 2021).	■ In the Mediterranean, medium-term projections (2041-2060) indicate 1.1 mm/day of snowfall under SSP2-4.5, and 0.9 mm/day under SSP5-8.5, which is a decline of 0.5 mm/day and 0.6 mm/day from 1995-2014 baseline respectively) (IPCC 2022). , long-term projections (2081-2100) indicate 0.8 mm/day of snowfall under SSP2-4.5, and 0.4 mm/day under SSP5-8.5, which is a decline of 0.8 mm/day and 1.2 mm/day from 1995-2914 baseline respectively) (IPCC 2022).
	Number of Hail and Frost Days	Decreasing	■ In Turkey, in 1995 there were 95.74 frost days (<0 degrees C), which decreased to 84.18 frost days in 2014 (World Bank Group 2021). ■ In Zonguldak specifically, in 1995, there were 65.28 frost days, which decreased to 53.95 frost days in 2-14 (World Bank Group 2021).	■ In Turkey, in 2050, there is expected to be 71.91 frost days under SSP2-4.5 and 66.52 days under SSP5-8.5 (World Bank Group 2021). In Turkey, in 2080, there is expected to be 65.89 frost days under SSP2-4.5 and 49.72 frost days under SSP5-8.5 (World Bank Group 2021). ■ In Zonguldak specifically, in 2050, there is expected to be 37.78 frost days under SSP2-4.5 and 33.88 days under SSP5-8.5 (World Bank Group 2021). In Zonguldak, in 2080, there is expected to be 32.64 frost days under SSP2-4.5 and 18.73 frost days under SSP5-8.5 (World Bank Group 2021).
OTHER WEATHER EVENTS				
Drought	Annual Drought Index	Increasing	■ Turkey's National Communication on Climate Change prepared in 2007 cites increased frequency of drought as a local impact of climate change (Turkey Republic Ministry of Environment and Urbanization 2012). In Turkey, the historical Annual SPEI Drought	■ At the national level in Turkey, projections indicate that in 2050, the Annual SPEI Drought Index will be -0.37 a under SSP2-4.5 and -0.73 under SSP5-8.5 (World Bank Group 2021). Projections indicate that in Turkey, in 2080, the Annual SPEI Drought Index will be -0.65 under SSP2-4.5 and -1.57 under SSP5-8.5 (World Bank Group 2021).

Climate Hazard Description		Trend	Description of Current Climate	Comments on Future Trends
			Index was 0.04 in 1995 and 0 in 2014 (World Bank Group 2021). Specifically, in Zonguldak, the historical Annual SPEI Drought Index was 0.04 in 1995 and decreased to 0.03 in 2014.	▪ Projections specific to Zonguldak indicate that in 2050, the Annual SPEI Drought Index will be -0.25 days a under SSP2-4.5 and -0.46 under SSP5-8.5 (World Bank Group 2021). Projections indicate that in Turkey, in 2080, the Annual SPEI Drought Index will be -0.24 under SSP2-4.5 and -1.32 under SSP5-8.5 (World Bank Group 2021).
Wind and Storm events	Frequency and Intensity of Storm Events and Surface Wind Speed	Decrease in Frequency and Increase in Intensity	▪ Globally, and increase in peak wind speeds has been observed. However, there are lot of uncertainties associated with wind data.	▪ In the Mediterranean region, from the baseline of 1995-2014, by 2041-2060, there is expected to be a decrease in average surface wind speed by 1.4% under SSP2-4.5 and 1.9% under SSP5-8.5. Projections indicate that by 2081-2100 there will be a decrease in average surface wind speed by 2.0% under SSP2-4.5 and 3.9% under SSP5-8.5. There is expected to be an increase in extreme storm related precipitation, but a decrease in frequency of storm related precipitation in the Mediterranean (IPCC 2013). ▪ There is medium confidence that severe windstorms will increase in the Mediterranean (Arias et al. 2021).
Changing Water Levels	Changing water levels	Increasing	▪ In the Black Sea, there has been an observed average rate of increase in water level rise of 2.5mm/year between 1993-2017 (**Avsar & Kutoglu 2018**).	▪ Projections of sea level rise in Turkey indicate that in 2050, there will be a sea level rise of 0.24m under SSP2-4.5 and 0.25m under SSP5-8.5 (World Bank Group 2021).
Humidity	Near Surface Relative Humidity	Decreasing	▪ Over global land area, relative humidity has decreased in recent years (Arias et al. 2021; IPCC 2013).	▪ Increased warming over ocean and land, which is projected to occur in this region of Turkey, causes a decrease in continental near-surface relative humidity (Arias et al. 2021).
Wildfires	Fire Conditions	Increasing	▪ Turkey's National Adaptation strategy states that increased forest fires is one of the evident climate change impacts in the country (Turkey Republic Ministry of Environment and Urbanization 2012).	▪ The IPCC states with high confidence that aridity, droughts and fire weather conditions will increase in the Mediterranean region with climate change (IPCC 2022). There is high confidence of an increase in fire weather in the Mediterranean, in which Zonguldak is located. (Arias et al. 2021).

9.1.4 Climate-Infrastructure Interactions

Identifying potential interactions between site infrastructure and climate is an important step in assessing climate risk. The presence of a climate interaction for a given infrastructure category is denoted by a checkmark. This process helps demonstrate each infrastructure category that could be affected by various climate related events. The construction phase of the Project was not considered due to the short time frame, which has a smaller potential for meaningful interactions with the climate outside of the normal seasonal variation experienced in the region. There is a larger potential for changes in both the climate mean and extreme weather events during the operations phase. Lastly, after closure, many site operations and infrastructure will be discontinued and has been excluded from the risk assessment.

The BOTAS pipeline and the FMS could be subject to natural hazards such as earthquakes and landslides, that could be impacted by climate change. However, the BOTAS pipeline would be a part of the national pipeline network and the impacts to this pipeline would be assessed and monitored as a part of this network. For this reason, the BOTAS pipeline is excluded from this assessment.

Some of the high-level climate-infrastructure interactions are identified in Table 9-8. Only potential climate events that may interact with the infrastructure components are shown. The SPS and SURF have the potential to be impacted by coastal winds and storm events that could increase the wave action and cause damage to the installed infrastructure including the pipelines. The Onshore building facilities could be impacted by changing temperatures that could overwhelm the capacity of the HVAC systems and process units. The buildings could also be impacted by extreme precipitation and snowfall that could cause flooding and may result in structural damage of buildings.

The Onshore drainage systems could be impacted by extreme precipitation and changes in snowfalls causing overflow of ditches, leading to flooding. On-site water availability could be impacted by extreme heat and drought-like conditions that could impact the site level operations. Wastewater treatment and sewage treatment plants could be impacted by increased temperatures and drought-like conditions that could lead to reduced water availability and water quality causing odour and health and safety issues. Treatment facilities could also be impacted by extreme precipitation, snowfall, and storm events causing overflowing of ditches and other facilities. Electricity generation facilities could be impacted by extreme heat and cold that may increase the demand of the energy system overwhelming the capacity of the power plant.

Table 9-8: Climate-Infrastructure Interactions Matrix

Infrastructure Components	Potential Hazards and Change Factors								
	Temperature		Precipitation		Extreme Events				
	Extreme Heat	Extended Cold Spell	Frequency / Amount of Heavy Rainfall Events	Increased Snowfall	Droughts	Wind and Storm Events	Changing Water Levels	Humidity	Wildfires
Subsea Production System (SPS)									
Well Head Valves						✓			
Distribution Chambers						✓			
Flexible Pipelines						✓			
Steel Pipelines						✓			
Marine and shore crossing subsea umbilical and pipelines Unit (SURF)[1]									
A Seabed Umbilical						✓			
Gas Pipeline						✓			
Onshore Processing Facility (OPF)									
Indirect Fired Heaters (Water Bath)		✓	✓	✓		✓	✓		✓
Natural Gas Steam Boiler (LP Steam and Heating Medium System)	✓							✓	
MEG Regeneration and Reclamation Unit		✓	✓	✓		✓	✓	✓	✓
Fuel Gas Systems and Gas Engines	✓	✓	✓	✓		✓	✓		✓
Flares		✓	✓	✓		✓	✓		✓
Drainage Systems			✓	✓		✓	✓		✓
Demineralized and Potable Water Generation Package	✓				✓				

Infrastructure Components	Potential Hazards and Change Factors								
	Temperature		Precipitation		Extreme Events				
	Extreme Heat	Extended Cold Spell	Frequency / Amount of Heavy Rainfall Events	Increased Snowfall	Droughts	Wind and Storm Events	Changing Water Levels	Humidity	Wildfires
Air Cooling System	✓	✓							
Effluent Treatment Package (ETP-A)	✓		✓	✓	✓	✓			
Sanitary Sewage Treatment System (ETP-B)	✓		✓	✓	✓	✓			
Temporary Waste Storage Area			✓	✓					
Produced Water Treatment Package			✓	✓					
Transformer Station and Energy Transmission Line									
Transformer Station and Energy Transmission Line	✓	✓							✓

Note: (1) No climate-infrastructure interactions were identified for the MEG line as it is away from the sea and not vulnerable to the other potential hazards and change factors.

9.1.5 Qualitative Risk Assessment

The likelihood of climate-infrastructure interactions occurring has been evaluated qualitatively using the likelihood scales. The resulting likelihood rankings are provided for current climate and near future (2050s). The consequence rankings represent the severity of impacts if an interaction were to occur and is based on the defined consequence scale. Combining the rankings for both likelihood and consequence allows for risk rankings for each climate-interaction across infrastructure. These rankings consider the adaptation measures that would be in place to reduce the climate related risk and may lead to lower risk rankings. This section provides an overview of the risk rankings, which are summarized in Table 9-9.

9.1.5.1 Subsea Production System (SPS) and Marine and Shore Crossing Subsea Umbilical and Pipelines Unit (SURF)

All SPS infrastructure could be impacted by extreme weather such as storm/wave conditions that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging. Most of the SPS infrastructure will be under 2.2 km subsea level on the seabed, which will reduce the impact of wave action. For all of the SPS infrastructure, the likelihood of interactions for current and future climate is ranked to Improbable/Rare as infrastructure is below the impact of wave action.. The consequence of this could be major as it could cause severe loss / damage / business impact. The risk is projected to remain Acceptable under current and future climate.

For the SURF infrastructure, particularly the umbilical and gas pipeline could be impacted by extreme weather such as storm/wave conditions that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging. The parts of the pipeline coming from offshore to onshore could be more susceptible to the impacts of wave action. For the umbilical and gas pipeline the likelihood for current climate is ranked as Could Happen/Unlikely and estimated to increase to As Likely As Not/Probable as extreme weather events are projected to increase by 2050s. The consequence of this could be major as it could cause severe loss / damage / business impact. The risk is projected to increase from medium under current climate to severe risk under future climate.

9.1.5.2 Land Section (Onshore Processing Facility)

The land section consists of various infrastructure such as buildings in utility units and Block 1, drainage systems, water treatment facilities, and air coolers.

Indirect Fired Heaters (Water Bath)

The Indirect Fired Heaters could be impacted by extreme precipitation and extreme snowfall that may result in structural damage because of corrosion. Increased precipitation may cause flooding in the Indirect Fired Heaters location. The site has mitigation measures in place as all electrical equipment will be located under shelters/sheds and designed and selected to endure long term heavy precipitation including water jets from any direction. Electrical equipment would be raised to reduce impact of flooding. There is an Improbable/Rare likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase considerably and considering the in-design mitigation measures. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The overall risk is projected to remain Negligible for current and future climate.

The Indirect Fired Heaters could also be impacted by extreme weather events. Increase in humidity could lead to corrosion and reduction in facility performance of Onshore facilities. High coastal water levels, high winds, and wildfires over onshore area could impact facility units and buildings causing physical damage. However, the project design has considered all potential extreme weather conditions in development of structural design basis. All Plants and Non-Plant structures and equipment shall be designed for wind loads based on Basic wind velocity (Vb). Wind loads on open frame structures, Enclosed Structures / Buildings and pipe racks shall be computed and applied on the structures. Wind pressure loads produced are applied in 4 directions (+X, +Z) under basic load cases. The site will have adequate firefighting services to reduce impact of wildfires. The likelihood for current climate is ranked as Could Happen/ Unlikely and estimated to increase to Probable/Likely as extreme events are projected to increase by 2050s. The consequence for this interaction is ranked as minor as the equipment could be offline for no more than 1 month. The risk is projected to remain Acceptable for current and future climate.

MEG Pre-Treatment & MEG Regeneration and Reclamation Unit

The MEG Pre-Treatment and MEG Regeneration and Reclamation Unit could be impacted by extreme temperature changes, including extreme heat, and extended cold spells, which may overwhelm the capacity of the HVAC systems and could cause degradation of buildings and insulation, which would reduce the life expectancy of the buildings. As part of in-design mitigation measures, all sub-station buildings have HVAC systems in place. Sub-station buildings are designed to withstand temperatures of 50°C and are designed with additional safety standards. The Project has considered maximum temperature case applicable, with safe design margin and fouling is considered for coolers providing extra margin. Design atmospheric temperature ranges from a minimum of 3.6°C to a maximum of 35°C. Maximum daily variation in temperature of ± 21°C shall be considered for the design. All mechanical equipment will be designed to 70°C. Considering the in-design mitigation measures, the likelihood for current and future climate is ranked to Improbable/ Rare. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. Considering the increase in likelihood for future, the risk is projected to remain Negligible for current and future climate.

MEG Pre-Treatment and MEG Regeneration and Reclamation Unit could also be impacted by extreme precipitation and extreme snowfall that may result in structural damage of buildings because of corrosion. Increased precipitation may cause flooding in the building areas. Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety. Snow loads for buildings shall be 0.75 kN/m^2 for snow fall (50cm). There is improbable/rare likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase considerably and considering the in-design mitigation measures. The consequence for this interaction is ranked to moderate as there could be significant loss / damage to the facility. The risk is projected to remain as Acceptable for current and future climate.

MEG Pre-Treatment and MEG Regeneration and Reclamation Unit could also be impacted by extreme weather events. Increase in humidity could lead to corrosion and reduction in facility performance of Onshore facilities. High coastal water levels, high winds, and wildfires over onshore area could impact facility units and buildings causing physical damage. However, the project design has considered all potential extreme weather conditions in development of structural design basis. All Plants and Non-Plant structures and equipment shall be designed for wind loads based on Basic wind velocity (Vb). Wind loads on open frame structures, Enclosed Structures / Buildings and pipe racks shall be computed and applied on the structures. Wind pressure loads produced are applied in 4 directions (+X, +Z) under basic load cases. The site will have adequate firefighting services to reduce impact of wildfires. The likelihood for current climate is ranked to Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme events are projected to increase by 2050s. The consequence for this interaction is ranked to moderate as there could be significant loss / damage to the facility. Considering the increase in likelihood for future, the risk is projected to increase from Acceptable for current climate to Medium for future climate.

Natural Gas Steam Boiler (LP Steam and Heating System)

Extreme weather events such as increased humidity could decrease the efficiency of natural gas boiler by affecting the cooling system. The likelihood for the current climate is ranked Improbable/ Rare and is estimated to increase to Could Happen/ Unlikely as temperatures and associated humidity are projected to increase in the 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. Considering the increasing likelihood in the future climate, the risk is expected to increase from negligible under current climate to acceptable under future climate.

Fuel Gas Systems and Gas Engines

Extreme heat and cold may increase the demand of the energy system overwhelming the capacity of the power plant. Extreme cold may cause physical damage to the power plant causing loss of on-site heat and electricity. The site would be connected to the national electrical grid through a substation and would have emergency generators on site. All sub-station buildings would have HVAC systems in place. Sub-station buildings will be designed to withstand temperatures of 50°C and are designed with additional safety standards. The likelihood for current climate is ranked to Improbable/Rare and estimated to increase to Could Happen/ Unlikely as extreme temperatures are projected to increase by 2050s. As the site has multiple back up power sources, the consequence has been ranked as insignificant and the risk has been ranked as negligible under current and future climate.

Electrical and mechanical equipment could be susceptible to extreme precipitation causing physical damage. All electrical equipment will be located under shelters/sheds. Equipment without covers will be designed and selected to endure long term heavy precipitation including water jets from any direction. Electrical equipment will be raised to reduce impact of flooding. There is an Improbable/Rare likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase significantly. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The risk is projected to remain as Acceptable for current and future climate.

Electrical and mechanical equipment could be susceptible to extreme weather events causing physical damage. The likelihood for current climate is ranked as Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme weather events are projected to increase by 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month and the risk is projected to remain Acceptable under current and future climate.

Flares

The high pressure and low-pressure flare systems in the OPF could be impacted extreme cold. Extreme cold may cause physical damage to the flares and associated systems. The likelihood for current and future climate is ranked to Improbable/Rare as extreme cold temperatures are projected to decrease by 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The risk is projected to remain as Acceptable for current and future climate.

Flares could be susceptible to extreme precipitation causing physical damage or preventing equipment use. The likelihood for current and future climate is ranked as Could Happen/ Unlikely. The consequence for this interaction is ranked as moderate as the equipment is a critical safety feature. The risk is projected to remain Acceptable for current and future climate.

Flares could be susceptible to extreme precipitation and extreme weather events causing physical damage or preventing equipment use. The likelihood for current climate is ranked as Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme weather events are projected to increase by 2050s. The consequence for this interaction is ranked as moderate as the equipment is a critical safety feature. Considering the increase in likelihood for future, the risk is projected to increase from Acceptable for current climate to Medium for future climate.

Drainage Systems

Heavy precipitation and snowfall events may affect ditches and swales causing overflow and structural damage. All drainage systems are designed for rain (last 5 years worst case weather data), storm water draining system is provided. Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. Filyos River flooding risk assessment had been performed as per 10 000 year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety.

There is Could Happen/ Unlikely likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase significantly. The consequence for this interaction is ranked to moderate as there could be significant loss and damage. The risk is projected to remain as Acceptable for current and future climate.

Extreme weather events such as wildfires could cause physical damage to the drainage systems or cause accumulation of debris. The site will have adequate firefighting services to reduce impact of wildfires. The likelihood for current climate is ranked to Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme events are projected to increase by 2050s. The consequence for this is ranked as insignificant as it would cause minor loss/ damage to infrastructure. The risk is projected to remain as Acceptable for current and future climate.

Demineralized and Portable Water Generation Package – Sedimentation Package

Extreme heat and an increase in drought like conditions could reduce on-site water availability that will be required for operation of natural gas steam boiler and the facility buildings. However, the likelihood of occurrence is Improbable/Rare under current and future climate as portable water and water for operations will be retrieved from wells, which is less vulnerable to impacts of changing temperature compared to surface water. The risk is projected to remain as Negligible for current and future climate.

Air Cooling System

Extreme temperature changes, including extreme heat could reduce the cooling capacity of the systems. The Project design has considered maximum temperature case applicable, with safe design margin and fouling is considered for coolers providing extra margin. The likelihood for current climate is ranked to Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as mean annual temperatures and extreme heat are projected to increase by 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. Considering the increase in likelihood for future, the risk is projected to remain Acceptable for current and future climate.

Effluent Treatment Package (ETP-A) and Sanitary Sewage Treatment System (ETP-B)

Increased temperatures could lead to reduced water availability and water quality required for effluent treatment causing odour issues. The likelihood for current climate is ranked to Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme temperatures are projected to increase by 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. Considering the increase in likelihood for future, the risk is projected to remain Acceptable for current and future climate.

Increase in extreme precipitation and snowfall events could lead to flooding and increased debris flow impacting the water quality available for treatment. There is Improbable/Rare likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase significantly. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The risk is projected to remain as Negligible for current and future climate.

Increased drought-like conditions could lead to reduced water availability and water quality required for effluent treatment. The likelihood for current climate is ranked to Could Happen/ Unlikely and estimated to increase to As Likely As Not/ Possible as extreme weather events are projected to increase by 2050s. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The risk is projected to remain Acceptable for current and future climate.

Temporary Waste Storage Area

Increase in extreme precipitation and snowfall events could cause flooding of the temporary waste storage areas with the potential of spills. There is Could Happen/ Unlikely likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase significantly. The consequence for this interaction is ranked to moderate as any spills and associated damage could be reportable within local legislation. The risk is projected to remain as Acceptable for current and future climate.

Increase in extreme weather events such as wind and storm events could cause increased debris or potential of spills. There is Could Happen/ Unlikely likelihood of occurrence under current climate, which is projected to increase to As Likely As Not/ Possible under future climate as extreme weather events are projected to increase. The consequence for this interaction is ranked to moderate as any spills and associated damage could be reportable within local legislation. The risk is projected to increase from Acceptable under current climate to Medium under future climate.

Produced Water Treatment Package

Increase in extreme precipitation and snowfall events could cause flooding of infrastructure, increased inflow, increased probability of flooding, overflow, and spills. All systems are closed systems, designed for rain (last 5 years worst case weather data), storm water draining system is provided. There is Could Happen/ Unlikely likelihood of occurrence under current and future climate as the mean annual precipitation and high rainfall days are not projected to increase significantly. The consequence for this interaction is ranked to minor as the equipment could be offline for no more than 1 month. The risk is projected to remain as Acceptable for current and future climate.

9.1.5.3 Transformer Stations and Energy Transmission Lines

Extreme heat and cold may increase the demand of the energy system overwhelming the capacity of the national grid including performance of general electrical equipment including switch gear and substations. Extreme cold may cause physical damage to the electrical equipment, causing loss of electricity. However, grid power will only be used as a backup and the site would have an on-site power plant and backup generators. The likelihood for current climate is ranked to Improbable/Rare and estimated to increase to Could Happen/ Unlikely as extreme temperatures are projected to increase by 2050s. As the site has multiple back up power sources, the consequence has been ranked as insignificant and the risk has been ranked as negligible under current and future climate.

Extreme weather events such as winds, storms and wildfires could cause physical damage to the transmission lines, impacting supply of electricity to the site. The site will have adequate firefighting services to reduce impact of wildfires. There is Could Happen/ Unlikely likelihood of occurrence under current and As Likely as Not/ Possible likelihood of the event occurring under future climate, as extreme weather events are projected to increase under future climate. However, connection to the grid electricity would be used as a backup for electricity supply. Additionally, the site would have backup generators on-site. Hence, the impact of loss of grid electricity is considered negligible. Hence, the risk is projected to increase from negligible under current climate to Acceptable under future climate.

Table 9-9: Risk Ranking for Current and Future (2050s) Climate

Infrastructure Component	Potential Interaction	Potential Interaction	Relevant Adaptation Measures	Current Climate			Future Climate (2050s)		
				Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
Subsea Production System (SPS)									
Well Head Valves	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ Most of the infrastructure will be under 2.2 km subsea level on the seabed, which will reduce the impact of wave action.	Improbable/ Rare	Major	Acceptable	Improbable/ Rare	Major	Acceptable
Distribution Chambers	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ Most of the infrastructure will be under 2.2 km subsea level on the seabed, which will reduce the impact of wave action.	Improbable/ Rare	Major	Acceptable	Improbable/ Rare	Major	Acceptable
Flexible Pipelines	Extreme Events	Extreme weather such as wind/storm events may increase wave action that could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ Most of the infrastructure will be under 2.2 km subsea level on the seabed, which will reduce the impact of wave action.	Improbable/ Rare	Major	Acceptable	Improbable/ Rare	Major	Acceptable
Steel Pipelines	Extreme Events	Extreme weather such as wind/storm events may increase wave action could damage the installation of riser pipelines and christmas tree (XT) especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ Most of the infrastructure will be under 2.2 km subsea level on the seabed, which will reduce the impact of wave action.	Improbable/ Rare	Major	Acceptable	Improbable/ Rare	Major	Acceptable
Marine and Shore Crossing Subsea Umbilical and Pipelines Unit (SURF)									
A Seabed Umbilical	Extreme Events	Extreme weather such as wind/storm events may increase wave action could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ No mitigation measures identified.	Could Happen/ Unlikely	Major	Medium	As Likely As Not/ Possible	Major	Severe
Gas Pipeline	Extreme Events	Extreme weather such as wind/storm events may increase wave action could damage the installation especially when this occurs in conjunction with any existing design defects, corrosion, or damage due to aging.	▪ No mitigation measures identified.	Could Happen/ Unlikely	Major	Medium	As Likely As Not/ Possible	Major	Severe
Land Section (Onshore Processing Facility)									
Indirect Fired Heaters (Water Bath)	Precipitation	Electrical and mechanical equipment could be susceptible to water damage due to increased precipitation and flooding events.	▪ All electrical equipment will be located under shelters/sheds. ▪ Equipment without covers will be designed and selected to endure long term heavy precipitation including water jets from any direction. ▪ Electrical equipment would be raised to reduce impact of flooding. ▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year	Improbable/ Rare	Minor	Negligible	Improbable/ Rare	Minor	Negligible

Infrastructure Component	Potential Interaction	Potential Interaction	Relevant Adaptation Measures	Current Climate			Future Climate (2050s)		
				Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
			return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety.						
	Extreme Events	may be vulnerable to extreme weather events including high winds, tornadoes, and wildfires that may cause structural damage to the systems.	▪ All potential extreme weather conditions are considered in development of structural design basis. ▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy "Suspension of work during extreme weather condition". ▪ All Plants and Non-Plant structures and equipment shall be designed for wind loads based on Basic wind velocity (Vb) ▪ Wind loads on open frame structures, Enclosed Structures / Buildings and pipe racks shall be computed and applied on the structures. ▪ Wind pressure loads produced are applied in 4 directions (+X, +Z) under basic load cases. ▪ The site will have adequate firefighting services to reduce impact of wildfires.	Could Happen/ Unlikely	Minor	Acceptable	As Likely As Not/ Possible	Minor	Acceptable
MEG Pre-Treatment and Reclamation Unit	Temperature	Extreme heat and extended cold spells, may overwhelm the capacity of the HVAC systems of the buildings needed to support the facility demands, causing thermal discomfort and unsuitable working conditions. Increased temperatures and extreme heat could cause degradation of buildings and insulation, which would reduce the life expectancy of the buildings. Increased temperatures could cause operational in-efficiencies.	▪ All sub-station buildings will have HVAC systems in place. ▪ Sub-station buildings will be designed to withstand temperatures of 50°C and will be designed with additional safety standards. ▪ All mechanical equipment will be designed to 70°C. ▪ Project design has considered maximum temperature case applicable, with safe design margin and fouling is considered for coolers providing extra margin. ▪ BPCS (basic process control system), condition monitoring system and ESD (emergency shutdown) system would be established to reduce temperature impacts. ▪ Design atmospheric temperature ranges from a minimum of 3.6°C to a maximum of 35°C. Maximum daily	Improbable/ Rare	Minor	Negligible	Improbable/ Rare	Minor	Negligible

Infrastructure Component	Potential Interaction	Potential Interaction	Relevant Adaptation Measures	Current Climate			Future Climate (2050s)		
				Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
			variation in temperature of ± 21°C shall be considered for the design.						
	Precipitation	Increasing extreme precipitation may result in structural damage of buildings because of corrosion. Increased precipitation may cause flooding in the building areas.	▪ All systems will be designed for rain (last 5 years worst case weather data), storm water draining system is provided. ▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety. Snow loads for buildings shall be 0.75 kN/m^2 for snow fall (50cm). ▪ MEG treatment is considerably far from the sea and river, at 7.5 m elevation.	Improbable/ Rare	Moderate	Acceptable	Improbable/ Rare	Moderate	Acceptable
	Extreme Events	Increase in humidity could lead to corrosion and reduction in facility performance of Onshore facilities. High coastal water levels over onshore area could impact facility units and buildings causing physical damage. Tidal flows and currents could impact the onshore facilities. Buildings may be vulnerable to extreme weather events, including high winds and tornadoes, that may cause structural damage to the roofs. Buildings might be vulnerable to the effects impact of wildfires. Wildfires could cause temporary suspension of activities because of danger to worker safety, discomfort, and unhealthy working conditions due to smoke inhalation.	▪ All potential extreme weather conditions are considered in development of structural design basis. ▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy. "Suspension of work during extreme weather condition". ▪ All Plants and Non-Plant structures and equipment shall be designed for wind loads based on Basic wind velocity (Vb) ▪ Wind loads on open frame structures, Enclosed Structures / Buildings and pipe racks shall be computed and applied on the structures. Wind pressure loads produced are applied in 4 directions (+X, +Z) under basic load cases. ▪ The site will have adequate firefighting services to reduce impact of wildfires. ▪ MEG treatment is considerably far from the sea and river, at 7.5 m elevation.	Could Happen/ Unlikely	Moderate	Acceptable	As Likely As Not/ Possible	Moderate	Medium
Natural Gas Steam Boilers	Extreme Events	Extreme weather events such as increased humidity could decrease the efficiency of natural gas boiler by affecting the cooling system..	▪ No mitigation measures identified	Improbable/ Rare	Minor	Negligible	Could Happen/ Unlikely	Minor	Acceptable
Fuel Gas Systems and Gas Systems	Temperature	Extreme heat and cold may increase the demand of the energy system overwhelming	▪ All sub-station buildings will have HVAC systems in place.	Improbable/Rare	Insignificant	Negligible	Could Happen/Unlikely	Insignificant	Negligible

Infrastructure Component	Potential Interaction	Potential Interaction	Relevant Adaptation Measures	Current Climate			Future Climate (2050s)		
				Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
		the capacity of the power plant. Extreme cold may cause physical damage to the power plant causing loss of on-site heat and electricity.	▪ Sub-station buildings will be designed to withstand temperatures of 50°C and are designed with additional safety standards. ▪ The project will be connected to the national electrical grid through a substation (380 kV, with a maximum of 1.3 km connecting lines) on the land side. The national electrical grid will be utilized as a backup power supply when the gas engines are not in use during a maintenance repair. Also, the emergency generators powered by diesel fuel will be available inside the facility.						
	Precipitation	Electrical and mechanical equipment could be susceptible to water damage due to increased precipitation and flooding events.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety. ▪ All electrical equipment will be located under shelters/sheds. ▪ Equipment without covers will be designed and selected to endure long term heavy precipitation including water jets from any direction. ▪ Electrical equipment would be raised to reduce impact of flooding. ▪ As a back-up the site will be connected to the national grid and the site will have emergency generators.	Could Happen/ Unlikely	Moderate	Acceptable	Could Happen/ Unlikely	Moderate	Acceptable
	Extreme Events	The power plant and facilities may be vulnerable to extreme weather events including high winds, tornadoes, and wildfires that may cause structural damage to the systems.	▪ As a back-up the site will be connected to the national grid and the site will have emergency generators. ▪ All potential extreme weather conditions are considered in development of structural design basis. ▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy "Suspension of work during extreme weather condition".	Could Happen/ Unlikely	Minor	Acceptable	As Likely As Not/ Possible	Minor	Acceptable

Infrastructure Component	Potential Interaction	Potential Interaction	Relevant Adaptation Measures	Current Climate			Future Climate (2050s)		
				Likelihood	Consequence	Risk	Likelihood	Consequence	Risk
			▪ The site will have adequate firefighting services to reduce impact of wildfires.						

Flares	Temperature	Extreme cold may cause physical damage to the flares, resulting in unscheduled shutdowns.	▪ Flare systems will be designed to withstand temperatures of -29°C. ▪ All sub-station buildings will have HVAC systems in place. ▪ Sub-station buildings will be designed to withstand temperatures of 50°C and are designed with additional safety standards. ▪ Project design has considered maximum temperature case applicable, with safe design margin.	Improbable/ Rare	Minor	Negligible	Improbable/ Rare	Minor	Negligible
	Precipitation	Increasing extreme precipitation may result in structural damage of buildings because of corrosion. Increased precipitation may cause flooding in the building areas.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety.	Could Happen/ Unlikely	Moderate	Acceptable	Could Happen/ Unlikely	Moderate	Acceptable
	Extreme Events	may be vulnerable to extreme weather events including high winds, tornadoes, and wildfires that may cause structural damage to the systems.	▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy "Suspension of work during extreme weather condition".	Could Happen/ Unlikely	Moderate	Acceptable	As Likely As Not/ Possible	Moderate	Medium
Drainage Systems	Precipitation	Heavy precipitation events may affect ditches and swales causing overflow and structural damage. Changes to the flow of water through the Project site as a result of changes in precipitation may damage water management infrastructure and containment structures.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety.	Could Happen/ Unlikely	Moderate	Acceptable	Could Happen/ Unlikely	Moderate	Acceptable

	Extreme Events	Drainage infrastructure may be vulnerable to the effects of wildfires.	▪ All potential extreme weather conditions are considered in development of structural design basis. ▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy "Suspension of work during extreme weather condition". ▪ The site will have adequate firefighting services to reduce impact of wildfires.	Could Happen/ Unlikely	Insignificant	Negligible	As Likely As Not/ Possible	Insignificant	Acceptable
Demineralized and Potable Water Generation Package – Sedimentation Package	Temperature	Extreme heat and an increase in drought like conditions could reduce on-site water availability that will be required for operation of natural gas steam boiler and the facility buildings.	▪ No mitigation measures identified.	Improbable/Rare	Minor	Negligible	Improbable/Rare	Minor	Negligible
Air Cooling System	Temperature	Extreme temperature changes, including extreme heat could reduce the cooling capacity of the systems.	▪ Project design has considered maximum temperature case applicable, with safe design margin and fouling is considered for coolers providing extra margin. ▪ BPCS (basic process control system), condition monitoring system and ESD (emergency shutdown) system would be established to reduce temperature impacts.	Could Happen/ Unlikely	Minor	Acceptable	As Likely As Not/ Possible	Minor	Acceptable
Effluent Treatment Package (ETP-A) and Sanitary Sewage Treatment System (ETP-B)	Temperature	Increased temperatures could lead to reduced water availability and water quality required for effluent treatment.	▪ No mitigation measures identified.	Could Happen/ Unlikely	Minor	Acceptable	As Likely As Not/ Possible	Minor	Acceptable
	Precipitation	Increase in extreme precipitation and snowfall events could lead to flooding and increased debris flow impacting the water quality available for treatment.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10 000 year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety. ▪ Stormwater systems will drain heavy rainfall and there will be no load on the sanitary sewage system. ▪ Sanitary sewage system would be a closed drain systems.	Improbable/ Rare	Minor	Negligible	**Improbable/ Rare**	Minor	Negligible
	Extreme Events	Increased drought-like conditions could lead to reduced water availability and water quality required for effluent treatment.	▪ No mitigation measures identified.	Could Happen/ Unlikely	Minor	Acceptable	As Likely As Not/ Possible	Minor	Acceptable

Temporary Waste Storage Area	Precipitation	Increase in extreme precipitation and snowfall events could cause flooding of the temporary waste storage areas with the potential of spills.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10.000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety. Hazardous and non-hazardous waste will be covered to protect from precipitation events and there will be closed channels and a pit against spills that may occur in the hazardous waste compartment.	Could Happen/ Unlikely	Moderate	Acceptable	Could Happen/ Unlikely	Moderate	Acceptable
	Extreme Events	Increase in wind and storm events could cause physical damage in the Temporary Waste Storage Area region, leading to increased debris and/or spills.	▪ All potential extreme weather conditions are considered in development of structural design basis. ▪ During extreme wind and storm events, the Project will follow Manual of Permitted Operation (MOPO) philosophy "Suspension of work during extreme weather condition".	Could Happen/ Unlikely	Moderate	Acceptable	As Likely As Not/ Possible	Moderate	Medium
Produced Water Treatment Package	Precipitation	Increase in extreme precipitation and snowfall events could cause flooding of infrastructure, increased inflow, increased probability of flooding, overflow, and spills.	▪ Drainage system within the facility will be designed for 15-minute duration considering maximum rainfall intensity of 70 mm per hour based on 5-year return period or maximum fire water demand whichever is higher. ▪ Filyos River flooding risk assessment had been performed as per 10,000-year return period flooding event for 7.00m height site elevation. Actual site elevation is +7.50m which is 50cm safer and also 80cm height Jersey barriers are being placed to provide extra safety.	Could Happen/ Unlikely	Minor	Acceptable	Could Happen/ Unlikely	Minor	Acceptable
Transformer Station and Energy Transmission Line									
Transformer Station and Energy Transmission Line	Temperature	Extreme heat and cold may increase the demand of the energy system overwhelming the capacity of the national grid including performance of general electrical equipment including switch gear and substations. Extreme cold may cause physical damage to the electrical equipment, causing loss of electricity.	▪ Grid power would only be used as a backup and the site would have an on-site power plant and backup generators.	Improbable/Rare	Insignificant	Negligible	Could Happen/ Unlikely	Insignificant	Negligible
	Extreme Events	Extreme weather events such as winds, storms and wildfires could cause physical	▪ Connection to the grid electricity would be used as a backup for electricity	Could Happen/ Unlikely	Insignificant	Negligible	As Likely As Not/ Possible	Insignificant	Negligible

		damage to the transmission lines, impacting supply of electricity to the site.	supply. Additionally, the site would have backup generators on-site. ▪ The site will have adequate firefighting services to reduce impact of wildfires.						

9.1.6 Summary and Recommendations

The Climate Change Risk Assessment considers infrastructure components for the operations phase of the Project. The attached climate risk assessment is a qualitative risk assessment, based on the physical climate change risk principles (Equator Principles 4). The site has in-design adaptation measures in places to reduce the impact of both current climate and projected changes to the future climate. Through the qualitative risk assessment, it is identified that the site is resilient as no unacceptable risks were identified. The majority of the identified risks to the for impacts of climate change on are medium or lower. However, two of the risks have been identified to have a 'severe' risk in the future due to climate change which are associated with impacts of extreme weather events, particularly increasing winds, storms, and associated wave action. To better understand these risks and to identify any required adaptation measures, the site could conduct a detailed, quantitative climate risk assessment in the future to further identify the impact of extreme weather events.

Although the mitigation measures have the potential to reduce climate risks, the measures need to be monitored for their performance through an ongoing monitoring and surveillance process. As a part of this, a continual improvement process could be developed to integrate climate change risks and opportunities in this process. This continual improvement process could be used to outline the decision-making process for when action needs to be taken to improve climate resilience. The continual improvement process could be updated through an ongoing process over the lifetime of the Project. The results from the monitoring programs would be integrated to test the effectiveness of resilience and mitigation actions and manage the unexpected outcomes.

9.2 Transitional Risk Assessment

This chapter presents an assessment of potential climate transition risks and opportunities to the Project. The assessment was conducted in line with the EP4 Principle 2: Environmental and Social Assessment requirements for conducting a climate change risk assessment relating to transition risks.

> *Climate Transition Risks* are risks which can arise from the process of adjusting to a lower carbon economy. These include: policy and legal risks, such as policy constraints on emissions, imposition of carbon tax and other applicable policies, water or land use restrictions or incentives; shifts in demand and supply due to technology and market changes; reputation risks reflecting changing customer or community perceptions of an organisation's impact on the transition to a low carbon and climate-resilient economy
>
> **Source:** Equator Principles 4 – *Exhibit I: Glossary of Terms*

Cautionary Statement[1], [2]

The analysis presented in this chapter is subjective, forward-looking and based on available information only. The analysis involves a variety of assumptions and uncertainties which may materially differ from actual Project results. Interdependencies and correlations between risk factors may also result in actual Project results to differ from chapter analysis and conclusions. The assessment is based on a Scenario Analysis that uses guidance from the Task Force on Climate-Related Financial Disclosures ("TCFD") as the framework. As stated by the TCFD "*Scenario analysis helps companies in making strategic and risk management decisions under complex and uncertain conditions such as climate change. It allows a company to understand the risks and uncertainties it may face under different hypothetical futures and how those conditions may affect its performance, thus contributing to the development of greater strategy resilience and flexibility.*"

As further discussed in this chapter, the scenarios are independent of Türkiye's national climate change commitments, as outlined in the Country's Intended Nationally Determined Contribution ("INDC") under the Paris Agreement. The 2°C or less scenario also aligns with the latest scientific research from the IPCC, the growing momentum of pledges to limit emissions to net-zero by 2050, and the spirit of the Paris Agreement. Use of the 3°C scenario should not be considered a recommendation regarding the GHG emissions from the Project, it is also noted that there are other higher emissions scenarios that were not used in this assessment. Achievement of any scenario will be based on global cooperation and will be influenced by regional policies and programs and national actions. It should be noted that independent assessment of Türkiye's INDC concludes that it is not sufficient to meet the Paris goals and increased actions may be required in the future.

WSP Golder provides no attestation or other form of assurance with respect to our work or the information upon which our work is based. WSP Golder did not audit or otherwise verify the information

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[1] https://assets.bbhub.io/company/sites/60/2020/09/2020-TCFD_Guidance-Scenario-Analysis-Guidance.pdf

[2] https://climateactiontracker.org/countries/Türkiye/

used in connection with this work, from whatever source. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this analysis.

Global Context

In the global drive towards achieving net-zero greenhouse gas (“GHG”) emissions, there is increasing international pressure on countries to take ambitious action on climate change. In 2015, the Paris Agreement on climate change was adopted by 196 countries, and ratified by Türkiye in 2021. The Paris Agreement is a binding agreement with a goal to limit global warming to well below 2°C (ideally well-below or 1.5°C) as compared to pre-industrial levels by achieving global climate neutrality by 2050 (or sooner).

Achieving climate neutrality over the next 30 years will require a clean energy transition characterized by unparalleled social and economic transformations in the way in which society produces and consumes energy[3]. As identified by the Intergovernmental Panel on Climate Change (“IPCC”), there is strong evidence to support the position that to avoid the worst impacts of climate change, the global economy requires rapid decarbonization and a massive shift from fossil fuel resources (e.g. coal, oil and gas) to low/zero carbon energy solutions. As the International Energy Agency’s (“IEA”) *Net Zero by 2050* (2021) report identifies, a global net zero by 2050 pathway excludes the development of new/ extension of existing coal, oil and gas assets[4]. Existing fossil fuel assets may also face the risk of becoming “stranded” – becoming devalued or considered as liabilities – prior to the end of their expected economic life as a result of climate-aligned policy, regulatory or market developments.

The required speed and scale of the clean energy transition in turn raises important considerations and complexities for countries regarding energy security and exposure to global and regional power markets – in particular ensuring that energy supplies are reliable, stable, and affordable. The IEA’s *Security of Clean Energy Transitions* (2021) report emphasizes the need to consider a decarbonization pathway that includes a portfolio of low-carbon generation sources to increase the diversity and resiliency of power supply and hedge against technology risks[5]. In this context, natural gas may be considered as a ‘transition’ fuel – or bridge to clean energy – that can offer ‘lower carbon’ dispatchable power generation (relative to coal) in combination with/as a complement to intermittent renewable energy sources. There are, however, competing views[6] that natural gas should not play a significant role in the clean energy transition, given the speed of global decarbonization that is needed to limit warming to 1.5°C/2.0°C, and the increasingly favourable economics of renewable/low-carbon technologies as compared to natural gas.

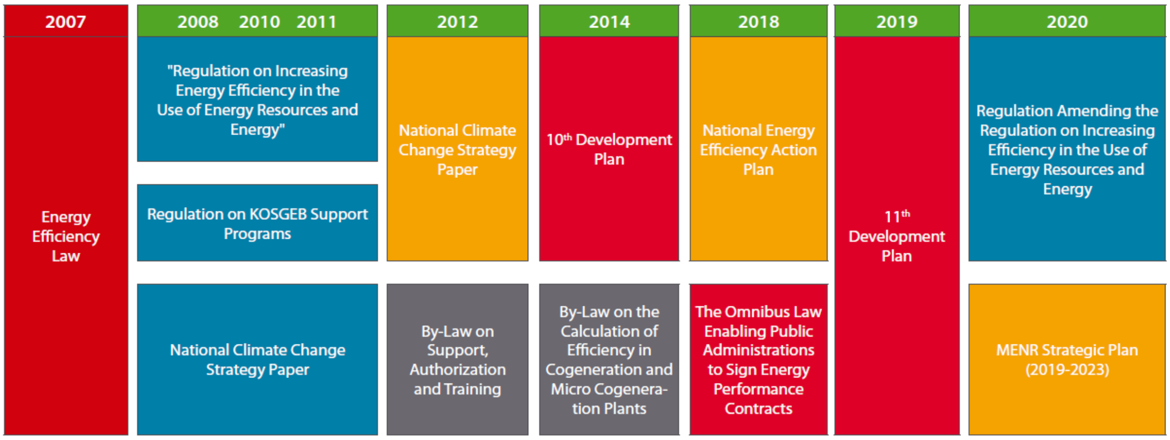
[3] According to the International Energy Agency, the energy sector is responsible for around three-quarters of all greenhouse gas emissions globally

[4] IEA. 2021. *Net Zero by 2050: A Roadmap for the Global Energy Sector*, p.11

[5] IEA. 2021b. *Security of Clean Energy Transitions*, p5

[6] TransitionZero. 2022. *Fuel Switching 2.0: Carbon Price Index for Coal-to-Clean Electricity*.

National Context



An understanding of the Türkiye's domestic energy market is a useful baseline for assessing future transition risks and opportunities relating to the Project's production and distribution of natural gas. At the country level, Türkiye has achieved a 230 percent increase in GDP between 1990 and 2012 and its population has increased more than 30 percent since 1990. Türkiye's energy demand increases by 6-7 percent every year [3]. The Country's rapid economic and population growth in the past two decades have not only strongly driven up energy demand, but also increased import dependency. Current energy imports account for approximately 74% of total domestic energy use, with approximately 99% of natural gas supply being imported from other countries (primarily Russia, Azerbaijan, Iran) and liquefied natural gas (LNG) from Qatar and the U.S.[7] Türkiye is second only to China in terms of the highest rate of growing demand for electricity and natural gas over the last twenty years[8].

Türkiye has limited resources to meet this demand domestically and the construction of new energy capacity is crucial to meet its growing energy demands as well as energy security objectives. Phase 1 of the Project is projected to deliver 10 million cubic meters of gas per day to the Turkish grid[9]. The Project natural gas offtake is expected to be fully allocated to meet domestic energy requirements, displacing 30% of current natural gas imports. Türkiye has prioritised the expansion of domestic exploration and production to help reduce its oil and gas import dependency for energy supply security and price stability objectives. A key target within Türkiye's strategic energy policy roadmap (2015-2019) is to increase natural gas storage in order to have a strong and reliable energy infrastructure[10].

Türkiye's current energy use, as demonstrated in Figure 1, is dominated by traditional fossil fuels. In 2020, fossil fuels accounted for approximately 85% of total energy supply. In recent years, Türkiye has seen considerable diversification in its energy mix. However, in 2020, renewable sources remain attributable to only 15% of the Country's total energy supply[11].

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[7] Republic of Türkiye. 2018. *Seventh National Communication and 3rd Biennial Report to the UNFCCC*

[8] Ibid. 2018., p.19

[9] Offshore Technology. 2021. h*ttps://www.offshore-technology.com/news/wood-contract-sakarya-field/*

[10] Ibid. 2018, p.47

[11] Republic of Türkiye. 2019. *Turkish Greenhouse Gas Inventory – 1990 – 2019*

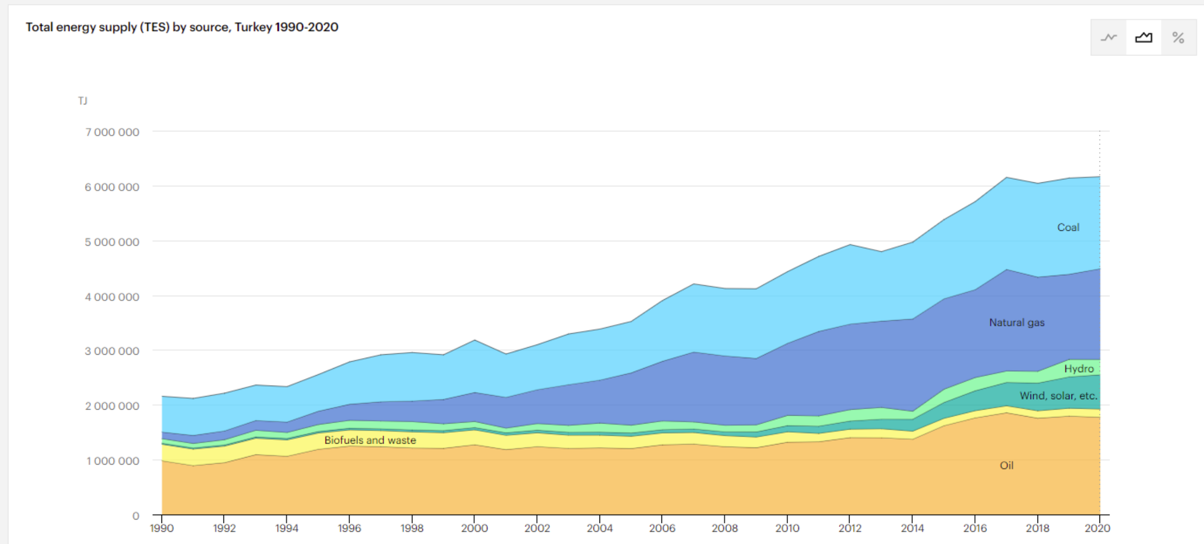

Figure 9-2: Total Energy Supply by Source [12]

As Figure 2[13] illustrates, in 2020, electricity production was dominated by hydropower (25.5%), natural gas (23.1%), bituminous coal (22.1%), Turkish lignite (12.4%), and other renewable and wastes (16.8%).

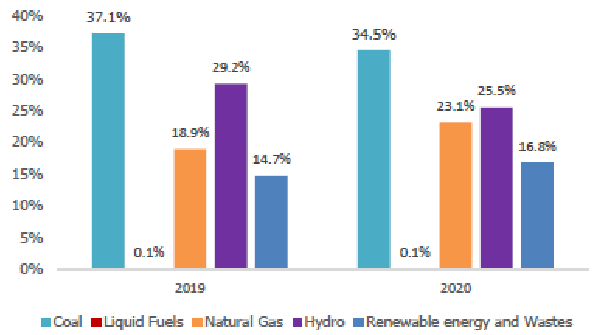

Figure 9-3: Total Electricity Production by Source[14]

Compared to other traditional fossil fuel sources, combustion of natural gas has a relatively lower $C0_2$ emissions intensity. Compared to coal, one of Türkiye's largest sources of energy, natural gas has a lower emissions profile by approximately 44%.

In addition to using natural gas for power generation, there is a range of small-to-large scale gas utilization options across sectors. Over the past 30 years, Türkiye has significantly increased the share of natural gas across these applications with declining shares of coal and liquid fuels (and with some increased penetration of renewables). During the processing of raw/ "wet" gas, natural gas liquids

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[12] International Energy Agency, *IEA Statistics – Türkiye*, https://www.iea.org/countries/turkiye

[13] Turkish Statistical Institute. 2022. *Turkish National Inventory Report 1990-2020*, p.71

[14] International Energy Agency, *IEA Statistics – Türkiye*, https://www.iea.org/countries/turkiye

(NGLs) including Liquefied Petroleum Gas (LPG) and Condensate are removed from the gas stream and marketed separately. Remaining lean/ "dry" gas is used as fuel for power generation, as well as an energy source for industrial heating or as a petrochemicals feedstock. Dry gas utilization options can be classified as follows:

- Power generation
- Cement production
- Industrial co-generation
- CNG vehicles
- Petrochemical synthesis
- Residential and commercial heating, cooking and water heating

In Türkiye's road transport sector, gasoline, diesel, LPG, natural gas and biodiesel are used as fuels. Biofuels and natural gas (combined) represent a small (1%) share of GHG emissions across all road transportation fuel types[15].

Industrial manufacturing and production (e.g. ammonia/fertilizer, steel, iron) within the country is reliant on natural gas, both as a combustion fuel and as a feedstock (non-energy use).

Fugitive emissions (CH4) from oil and natural gas systems have increased by 196% over the last 25 years, although total fugitive emissions represent a small share (1.67%) of total national GHG emissions[16].

Purpose of the Transition Risk Assessment

EP4 Principle 2 requires projects where combined Scope 1 and Scope 2 GHG emissions are expected to be >100,000 tonnes CO2e annually to conduct a climate change risk assessment (climate transition risks).

The Scope of a climate transition risk assessment is articulated in EP4, Annex A: Climate Change – Alternatives Analysis, Quantification and Reporting of Greenhouse Gas Emissions. Specifically, a transition risk assessment should address the following considerations:

- Current and anticipated climate transition risks of the Project's operations
- Existence of plans, processes, policies and systems to manage these risks
- Compatibility of the Project with the host country's national climate commitments

[15] Turkish Statistical Institute. 2022. *Turkish National Inventory Report 1990-2020*, p.129

[16] Republic of Türkiye. 2018. *Seventh National Communication and 3rd Biennial Report to the UNFCCC*, p.33

Structure

This chapter is organized as follows:

- Scope and Steps
- Risk Identification
- Risk Evaluation
- Conclusion

9.2.1 Scope of the Transition Risk Assessment

The EP4 refers to the recommendations of the Task Force on Climate-Related Financial Disclosures ("TCFD") as the framework to guide the conduct of a climate transition risk assessment.

TCFD has defined the following four (4) categories of transition risk and opportunities:

- **Policy and legal:** risks (opportunities) that arise from policy actions that attempt to constrain actions that contribute to the adverse effects of climate change or policy actions that seek to promote adaptation to climate change and legal or litigation risks as a result of the claims brought before the courts by property owners, municipalities, states, insurers, shareholders, and public interest organizations, including the failure of organizations to mitigate impacts of climate change, failure to adapt to climate change, and the insufficiency of disclosure around material financial risks. As the value of loss and damage arising from climate change grows, litigation risk is also likely to increase.
- **Technology:** risks (opportunities) that arise from technological improvements or innovations that support the transition to a lower-carbon, energy efficient economic system
- **Market**: risks (opportunities) from shifts in supply and demand for certain commodities, products and services as the global economy transitions towards lower carbon
- **Reputation:** risks (opportunities) of perceptions of a country's contribution to or detraction from the transition to a lower-carbon economy[17]

The assessment was conducted using these four transition risk categories.

9.2.2 Steps of the Transition Risk Assessment

The following steps were employed to conduct the transition risk assessment:

Step 1: Identify Potential Transition Risks and Opportunities

Step 1 comprised the identification of transition risk factors that could impact the Project. Risks (and opportunities) were identified according to the TCFD four categories of risk and reflect consideration of both current future trends and potential risk drivers. These factors included (with examples):

[17] Financial Stability Board, *Task Force in Climate-Related Financial Disclosures*, 2017

- **Policy & Legal factors** – regional or domestic legislations and policy commitments impacting the demand and economic viability of the natural gas project
- **Technology factors** – technology trends related to power generation, including advancements in technology of competing renewable energy sources and decarbonization opportunities relevant to the production of natural gas
- **Market & Economic factors** – economic conditions of the Project's targeted offtake markets including trends in oil and gas, commodity pricing and demand for gas
- **Reputational factors** – trends in domestic and international perceptions towards investment in the natural gas industry and the potential impacts on the Project[18]

Step 2: Assess Transition Risks and Opportunities

Risks identified in Step 1 were then qualitatively characterized in terms of the project's vulnerability to the risk factor(s), the likelihood of the risk occurring, and the magnitude of the potential impact to the project.

In alignment with TCFD recommendations (Strategy I), transition risks were qualitatively assessed. Two commonly referenced decarbonization scenarios were considered:

- 'Soft' transition representing an extension of current and planned policies and technological trends, and consistent with an implied global temperate rise of +3ºC (e.g., International Energy Agency – World Energy Model – New Policies scenario)

- 'Hard' transition representing an ambitious scenario consistent with limiting global temperature rise to 2ºC or less (e.g., International Energy Agency – World Energy Model – Net Zero Emissions by 2050 scenario)

As per the EP4 requirement to consider the project's compatibility with Türkiye's national climate change commitments, the assessment also includes a review of the country's Intended Nationally Determined Contribution ("INDC"). Specially, the assessment considers whether the domestic production of natural gas can help Türkiye to achieve its climate change targets via the displacement of higher-carbon fuels for domestic consumption.

[18] Ibid. 2017.

9.2.3 Risk Identification

The transition risk assessment considered risks and opportunities in relation to the TCFD risk categories. Potential risk drivers are described in relation to the Project, with identification of relevant risks and opportunities (as applicable).

Overall, four risks and opportunities were identified as summarized in Table 1. Detailed discussion of each risk category and identified risks/opportunities are provided in the subsequent sections.

Table 9-10: Project Climate Transition Risks and Opportunities

Category	Risk / Opportunity	Risk
Policy & Legal	Opportunity	Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal and fuel oil) to lower-carbon natural gas fuel
Policy & Legal	Risk	Future climate change legislation and policy may impose increasingly stringent restrictions on fossil fuels for power generation and other end-uses, thereby affecting the economic viability of the Project and creating a stranded asset
Policy & Legal	Risk	Domestic demand for the Project's natural gas offtake may be negatively impacted by EU border carbon adjustments applied to Turkish industrial export customers
Technology	Risk	Demand for Project natural gas offtake may be negatively impacted by increasingly cost competitive and accessible renewable/low carbon energy technologies
Technology	Opportunity	Non-power generation applications for natural gas end uses may generate additional offtake opportunities for the Project
Markets	Risk	Project economics may be negatively impacted by changes in natural gas prices due to shifting demand towards renewable/low carbon fuels
Reputation	Risk	Project economics may be negatively impacted by capital providers that assign a capital cost carbon premium
Reputation	Opportunity	Project economics may be positively impacted by capital providers that assign a capital cost carbon discount
Reputation	Risk	Project may be negatively impacted by climate change-related litigation

9.2.3.1 Policy and Legal

National Climate Change Strategies and Plans

Türkiye's approach to reducing GHG emissions is outlined in the following policy documents:

- National Climate Change Strategy (2010-2023)
- National Climate Change Action Plan (2011-2023)
- -11th National Development Plan (2019-2023)
- National Renewable Energy Action Plan (2023)
- Green Deal Action Plan in Türkiye (2021)
- Intended Nationally Determined Contribution (2019)

Türkiye's national climate change vision, as embodied within the National Climate Change Strategy is to "become a country fully integrating climate change policies with its development policies, disseminating energy efficiency, increasing the use of clean and renewable energy resources, actively participating in the efforts to tackle climate change within its special circumstances and providing its citizens with a high quality of life and welfare with low-carbon intensity."[19][20]

Countries across the globe adopted a historic international climate agreement at the U.N. Framework Convention on Climate Change ("UNFCCC") Conference of the Parties ("COP21") in Paris in December 2015. As a result of this agreement, signatory nations have publicly outlined what climate actions they intended to take under the new international agreement, known as their Intended Nationally Determined Contributions ("INDCs"). In October 2021, Türkiye ratified the Paris agreement and published its first INDC in parallel with its national climate change policy that includes development policies, plans and measures to implement the intended contribution.

Over the past 30 years, Türkiye's total GHG emissions (excluding LULUCF) have increased by 138.4%[21]. In 2020, the energy sector accounted for 70.2% of total emissions[22]. The INDC outlines a national target of a **reduction in GHG emissions of up to 21 percent reduction from the Business as Usual ("BAU") scenario level by 2030**[23]. The emission reductions projected to be achieved are presented in Figure 3 below.

[19] Republic of Türkiye. 2021. *11th Development Plan 2019 – 2023.*

[20] Republic of Türkiye. 2021. *Green Deal Action Plan of Turkey, 22 November 2021*

[21] Turkish Statistical Institute. 2022. *Turkish National Inventory Report 1990-2020*, p.ii

[22] Ibid. 2022., p.iii

[23] Republic of Türkiye. 2021. *Intended Nationally Determined Contribution*

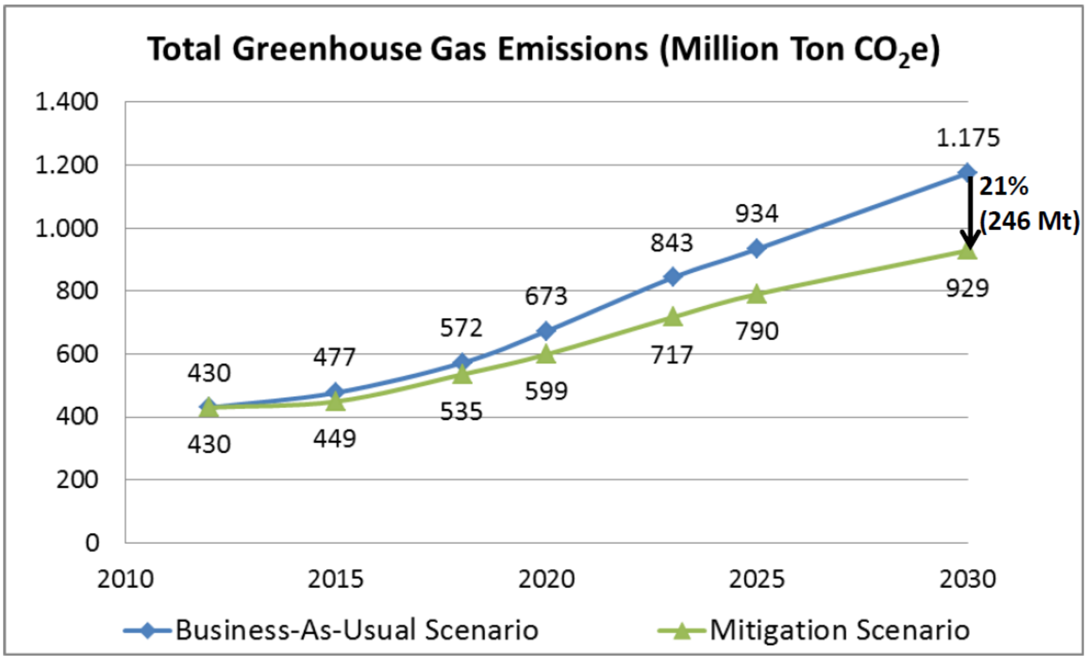

Figure 9-4: Total Predicted Greenhouse Gas Emissions

The Business-as-Usual scenario refers to Türkiye's projected total GHG emissions in the case of no national climate change strategy while the Mitigation scenario refers to the projected total GHG emissions assuming successful implementation of the INDC and policies.

The scope of the INDC is economy wide, including energy production. Relevant plans and policies pertaining to energy production include the following:

- Increasing capacity of production of electricity from solar power to 10 GW by 2030
- Increasing capacity of production of electricity from wind power to 16 GW by 2030
- Increasing capacity of hydroelectric electricity production (no specific target)
- Commissioning of a nuclear power plant by 2030

There are no specific plans and policies pertaining to addressing consumption of natural gas in the context of achieving GHG reduction targets. Türkiye continues to explore for and develop new fossil fuel projects (including this project) in order to meet domestic energy demands and to address concerns around energy security in relation to the historic high dependence on energy imports.

In addition to the INDC target, Türkiye announced in 2021 the adoption of a 2053 Net Zero target. Few details have been made publicly available about the country's intended pathway to Net Zero[24].

[24] Presidency of the Republic of Türkiye, 2021

Potential Transition Opportunity: Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal and fuel oil) to lower-carbon natural gas fuel.

Potential Transition Risk: Future climate change legislation and policy may impose increasingly stringent restrictions on fossil fuels for power generation and other end-uses, thereby affecting the economic viability of the Project and creating a stranded asset

Carbon Market and Carbon Pricing

An increasingly prevalent mechanism to fight climate change is the application of carbon pricing mechanisms. As of 2021, there are approximately 40 countries and more than 20 cities, states and provinces already use carbon pricing mechanisms, with more planning to implement them in the future. Together the carbon pricing schemes now in place cover about half their emissions, which translates to about 13 percent of annual global greenhouse gas emissions.[25]

Türkiye does not currently have a carbon tax or a carbon emissions trading system and does not currently have plans for carbon price reform[26]. It does levy fuel excise taxes, including[27]:

- Special Consumption Tax (SCT) – applies to solid, liquid and gaseous fuels
- Electricity Consumption Tax – applies to electricity consumption for industry, transport and other users

Within industry, fuel oil and diesel are taxed. Natural gas is taxed unless when used in autoproducer electricity plants. Other fossil fuels, renewables and other electricity and heat sources are not taxed.

European Union Carbon Border Adjustment Mechanism

In March 2022, the European Union ("EU") introduced the Carbon Border Adjustment Mechanism ("CBAM") regulation. The main objective of this environmental measure is to avoid carbon leakage and encourage partner countries to establish carbon pricing policies to fight climate change.

The CBAM targets imports of carbon-intensive products, in full compliance with international trade rules. The CBAM objective is to prevent offsetting the EU's GHG emission reduction efforts through imports of products manufactured in non-EU countries where comparable policies are less stringent or do not exist.

Products of the following sectors will be covered by the CBAM: cement, aluminium, fertilisers, electric energy production, iron and steel[28]. A transition phase between 2023 and end of 2025 will collect

[25] "What is Carbon Pricing", The World Bank, https://www.worldbank.org/en/programs/pricing-carbon

[26] OECD. 2018. *Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading.*

[27] OECD. 2019. *Taxing Energy Use for Sustainable Development: Country Note – Türkiye, p.1*

[28] "*Council agrees on the Carbon Border Adjustment Mechanism*", https://www.consilium.europa.eu/en/press/press-releases/2022/03/15/carbon-border-adjustment-mechanism-cbam-council-agrees-its-negotiating-mandate/#:~:text=The%20Commission%20presented%20its%20proposal,than%20those%20of%20the%20EU

emissions data on imports but will not apply tax. Imports will be taxed at a reduced rate from 2026 to 2035.

In the absence of an equivalent domestic carbon price framework, carbon-intensive aluminium exports from Türkiye to the EU may be exposed to the CBAM, subject to the gradual phase in period as described above[29]. As a non-EU country with a high percentage of energy-intensive exports to the European Union, this new mechanism is expected to lead to steep adjustment costs for Türkiye. An assessment by the European Bank for Reconstruction and Development found that CBAM payments can represent a significant share of current prices for some of Türkiye's largest export products. For instance, these payments may represent up to about 50 per cent for cement, 18 per cent for aluminium and 9 per cent for steel. In total, CBAM payments would represent 0.07 per cent of Türkiye's GDP forecast in 2023[30].

In the absence of an equivalent domestic carbon price framework, carbon-intensive exports from Türkiye to the EU may be exposed to the CBAM, subject to the gradual phase in period as described above.

Potential Transition Risk: Incoming carbon pricing mechanisms of partner nations may lead to increased tariffs for Türkiye's exports produced using fossil fuels such as natural gas

9.2.3.2 Technology Risks & Opportunities

Alternative Energy Technologies

Türkiye's INDC and accompanying National Climate Change Adaptation Strategy and Action Plan includes objectives for the installation of wind and solar in the coming years. A historical barrier for investment in renewable energy capacity is the high costs of renewable technology when compared to traditional fossil fuels. This has conferred natural gas an economic advantage over competing renewable sources.

In addition to challenges associated with renewable generation variability and dispatch, and need for investment in cost effective distribution infrastructure, a historical barrier for investment in renewable energy capacity in Türkiye (as elsewhere in the world) has been the relatively higher cost of renewable technology when compared to traditional fossil fuels. This has conferred natural gas an economic advantage over competing renewable sources.

Recent trends indicate a narrowing of the cost differential between natural gas and renewable/low carbon energies. A recent analysis of the levelized cost of energy shows that the cost of renewable energy has been declining year over year. Figure 4 presents Lazard's Levelized Cost Analysis showing the levelized cost of energy installation (assuming an unsubsidized basis) for 2021. Renewable energy technologies that may compete with natural gas as low/zero carbon technologies (e.g., solar, wind, biomass/waste-to-energy, hydro/wave power), have started to become more cost-competitive with

[29] ERCST. 2021. *Implication of EU Carbon Border Adjustment Mechanism for Türkiye*.

[30] European Bank for Reconstruction and Development. *Turkish exporters could face steep extra costs under new EU carbon rules, 2022*

fossil fuel sources for energy generation[31]. As these technologies mature and increase in scale of adoption, the cost competitiveness of renewable energy generation may be expected to decrease further.

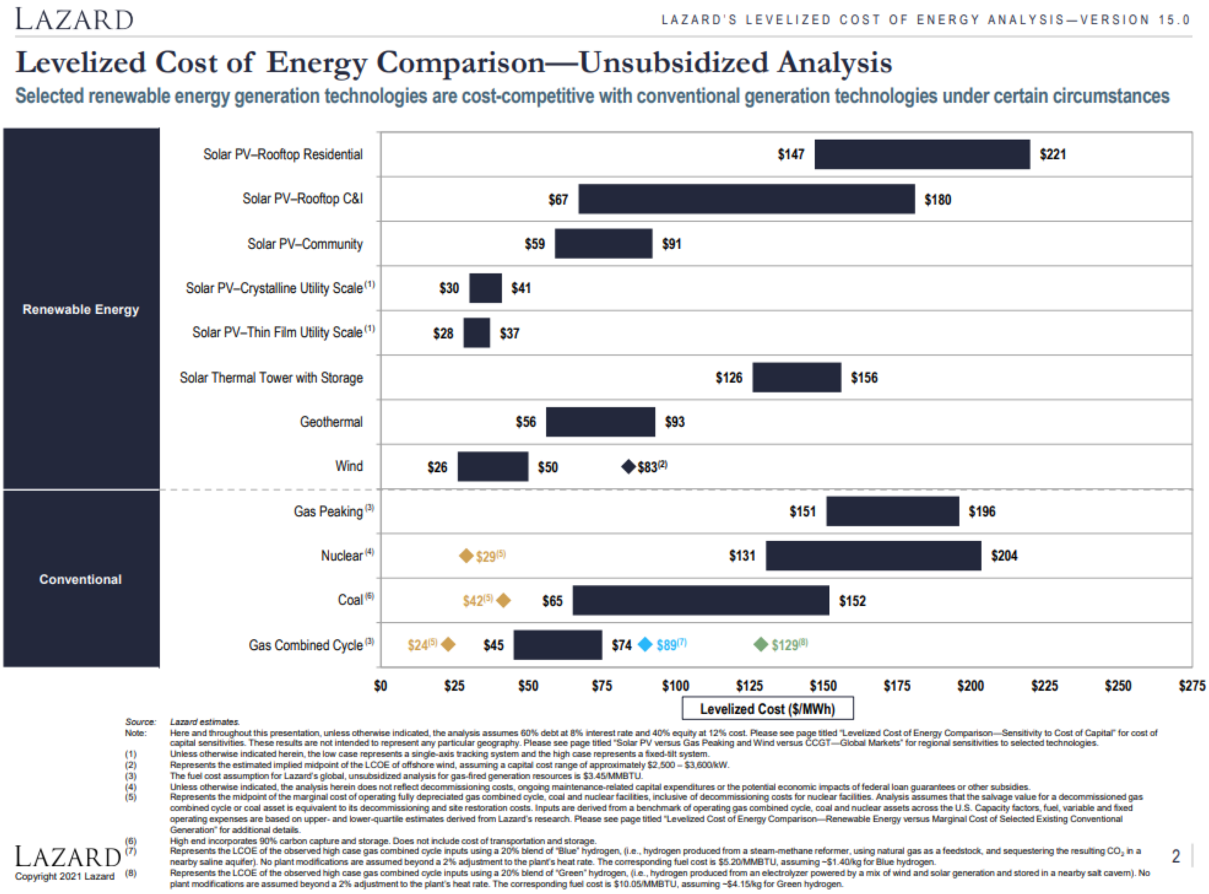

Figure 9-5: Unsubsidized Levelized Cost of Energy, 2021

Aside from increased renewable/low carbon technology cost competitiveness, key barriers for increased penetration and uptake of these technologies include: 1) attachment to conventional energy sources; 2) continued subsidization of conventional fossil energy; 3) insufficient experience in renewable energy development; 4) land availability and suitability; and 5) amount of investment required to upgrade / construct new electrical grid distribution infrastructure.

Potential Transition Risk: Demand for Project natural gas offtake may be negatively impacted by increasingly cost competitive and accessible renewable/low carbon energy technologies.

[31] "*Lazard's Levelized Cost of Energy Analysis*", https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen-2020/

Other Natural Gas End-Use Applications

As identified in the Context section of this report, in addition to power generation requirements, there are potential additional downstream end-use markets for the Project's natural gas output. Project documentation about anticipated end uses other than power generation was not available for review as input to this transition risk assessment.

Raw / "Wet" Natural Gas

Natural gas withdrawn from natural gas or crude oil wells is processed prior to transport via pipelines or truck distribution. Natural gas contains methane, natural gas liquids (ethane, propane, butane, pentane), water vapor, and non-hydrocarbons (sulphur, helium, nitrogen, hydrogen sulphide, carbon dioxide). During processing, water vapor and natural gas liquids are removed from the gas stream and may be sold/marketed separately.

Lean / "Dry" Natural Gas

The remaining gas is considered lean/ "dry" and then may be marketed for consumption as a fuel for power generation, as well as an energy source for industrial heating or as a petro-chemicals feedstock. Non-power generation dry gas utilization options can be classified as follows:

- Industrial co-generation/ heat
- Compressed Natural Gas ("CNG") vehicles
- Petrochemical synthesis
- Residential and commercial heating, cooking and water heating

Table 2 outlines the potential for natural gas application to industrial, transportation and commercial/household end-uses:

Table 9-11: Natural Gas End-Uses

End-Use	Considerations
Industrial co-generation / heat	Potential to supply natural gas to factories for heat in industrial processes. Natural gas would compete with other existing sources such as Coal, Fuel Oil and Liquefied Petroleum Gas. Cost differential would have to be sufficiently attractive to incentivize fuel switching. Investment in natural gas distribution networks would be needed.
CNG vehicles	CNG is a potential alternative to gasoline to diesel fuels within road transport vehicles. The price differential between gas and oil may make CNG a more attractive option, with associated environmental benefits. Barriers include high capital costs of vehicle conversion.
Petrochemicals and fertilizers	The demand for petrochemical products in Türkiye has been increasing rapidly, with domestic production capabilities able to meet approximately 30% of total domestic demand. As a key feedstock for petrochemicals manufacture, Project natural gas could experience increased demand.

Cooking & water heating	Natural gas would compete with traditional fuels (fuel oil, biomass) as well as more recent technologies such as LPG and solar water heating. Cost differential would have to be sufficiently attractive to incentivize fuel switching. Investment in natural gas distribution and storage networks would be needed with significant cost.

9.2.3.3 Markets & Economy Risks & Opportunities

Project Offtake Market

Currently, 100 percent of the Project's offtake is targeted for domestic use, aligning with Türkiye's energy policy of reducing reliance on foreign energy supply. The Project's offtake is intended to displace foreign natural gas imports and is not expected to generate a domestic surplus of energy. Under these circumstances, product demand is likely less sensitive to economic factors, as domestic energy demand greatly exceeds the capacity of the Project.

Natural gas is expected to play a significant role in meeting domestic energy demand. The national focus on energy efficiency and expansion of renewable/low carbon energies may have an effect on demand for Project output, although it is unclear how this may translate into impacts on Project economics as domestic energy demand greatly exceeds the capacity of the Project. Given the priority placed on natural gas in Türkiye's development strategy, the risk of stranded assets due to changing project economics might be considered low.

Potential Transition Risk: Project economics may be negatively impacted by changes in natural gas prices due to shifting demand towards renewable/low carbon fuels

9.2.3.4 Reputational Risks & Opportunities

Investor Demand for Environmental Disclosures

Financial investors (commercial and development banks, asset owners) and regulators are increasingly interested in understanding the operational GHG impact and financial risk profile of companies that they do business with. In addition to the TCFD (a voluntary disclosure framework), jurisdictions around the world (e.g. 1) U.S. Securities Exchange Commission – Proposed Rules on the Enhancement and Standardization of Climate-Related Disclosures for Investors; 2) International Financial Reporting Standards Foundation – Exposure Draft IFRS S2 Climate-Related Disclosures) are beginning to put forth proposed rules and regulations for disclosure of climate-related matters. These developments suggest an increasing interest in aligning capital flows and costs of capital with companies that can demonstrate that they have effective strategies to succeed in a carbon-constrained future. Companies that don't meet investor expectations regarding carbon performance and disclosure may experience increased costs of capital or inability to access capital. Conversely, companies that are able to meet investor expectations may benefit from decreased costs of capital or increased ability to access capital (e.g. Sustainability-linked Loans; Sustainability-adjusted.

Potential Transition Risk: Project economics may be negatively impacted by capital providers that assign a capital cost carbon premium **Potential Transition Opportunity:** Project economics may be positively impacted by capital providers that assign a capital cost carbon discount

Litigation

Litigation to hold companies to account for their actions to address and contributions to climate change is becoming increasingly common. Over the past 20 years, a total of 1,550 climate litigation cases have been filed around the world, with the nearly half of the cases occurring since 2017[32]. Cases can be grouped into the following 6 categories:

- Climate rights – fundamental and human rights to compel climate action
- Domestic enforcement (non-enforcement) – of climate related laws and policies
- Keeping fossil fuels in the ground
- Corporate liability and responsibility for climate harms
- Failure to adapt and the impacts of adaptation
- Greater climate disclosure and an end corporate to greenwashing on the subject of climate change and the energy transition

For the Project, the risk of direct legal action is uncertain. There is no evidence of climate-related lawsuits filed previously in Türkiye, and it is unclear if the domestic legal regime would be conducive to such action. The potential for indirect litigation risk via lawsuits applied to downstream customers is equally unclear.

Potential Transition Risk: Project may be negatively impacted by climate change-related litigation

[32] London School of Economics. 2021. *Global Trends in Climate Litigation*

9.2.4 Risk Evaluation

This section evaluates the nine (9) transition risks and opportunities to determine their level of significance to the Project.

Methodology

The risks and opportunities identified were qualitatively characterized in terms of the project's vulnerability to the risk factor(s), the likelihood of the risk occurring, and the magnitude of the potential impact to the project. The following sub-steps occurred:

- Screen risks and opportunities based on the extent to which they have the potential to interact with the Project. Based on the extent of interaction, assign a vulnerability rating to each risk and opportunity. Risks and opportunities that have a <u>significant potential to directly interact*</u> with the Project are rated as "YES", and those that do not are rated as "NO".
- For those risks and opportunities that do interact with the Project, conduct scenario analysis (see below description) to determine the likelihood and consequence of occurrence of each risk and opportunity under two decarbonization scenarios.
- Assign a qualitative risk rating based on the Project's existing ranking system (unacceptable, severe, medium, acceptable, negligible).

<u>Significant</u> potential to <u>directly</u> interact = there is a clear risk/opportunity driver that is relevant and applicable to the Project, and that could directly (versus indirectly) impact the Project

- Risks and opportunities were evaluated in relation to two (2) decarbonization pathway scenarios: **Scenario 1:** 'Soft' transition representing an extension of current and planned policies and technological trends, and consistent with an implied global temperate rise of +3^{o}C (as represented by International Energy Agency – World Energy Model – New Policies scenario)
- **Scenario 2:** 'Hard' transition representing an ambitious scenario consistent with limiting global temperature rise to 2^{o}C or less (as represented by the International Energy Agency – World Energy Model – Net Zero Emissions by 2050 scenario)

Following an assessment based on the above steps, a conclusion is presented about the Project's overall level of transition risk and opportunity.

As per the EP4 requirement to consider the project's compatibility with Türkiye's national climate change commitments, the assessment also includes a review of the country's Intended Nationally Determined Contribution ("INDC"). Specially, the assessment considers whether the Project's production of natural gas is in line with the INDC.

Risk Evaluation

Step 1: Screen for Project Interaction

Identified risks and opportunities have the potential to interact with the Project. An overall vulnerability rating of either "YES" or "NO" was assigned to each risk/opportunity on the basis of the Project: a) Exposure to the risk/opportunity (i.e. would the Project interact with the risk); and b) Sensitivity to the risk/opportunity (i.e. would the Project experience a positive or negative impact as a result of being exposed to the risk/opportunity). Vulnerability ratings are presented in Tables 3 and 4.

Table 9-12: Risk Vulnerability Ratings

Transition Category	#	Risk	Assessed Project Interaction	Vulnerability Rating
Policy & Legal	1	Future climate change legislation and policy may impose increasingly stringent restrictions on fossil fuels for power generation and other end-uses, thereby affecting the economic viability of the Project and creating a stranded asset	The Project is subject to current domestic climate change policy. There is the potential for future legislation and additional policy requirements	YES
	2	Domestic demand for the Project's natural gas offtake may be negatively impacted by EU border carbon adjustments applied to Turkish industrial export customers	Project downstream customers export to the EU with potential exposure to the CBAM. The upstream impact to natural gas is uncertain	YES
Technology	3	Demand for Project natural gas offtake may be negatively impacted by increasingly cost competitive and accessible renewable/low carbon energy technologies	Renewables are a key focus of the Türkiye national climate change plans, but uptake faces numerous barriers. Cost competitiveness of renewable/low carbon energies could affect natural gas demand	YES
Markets	4	Project economics may be negatively impacted by changes in natural gas prices due to shifting demand towards renewable/low carbon fuels	Uncertain how domestic energy markets will respond to decarbonization pressures.	NO
Reputation	5	Project economics may be negatively impacted by capital providers that assign a capital cost carbon premium	Project financing costs already reflect operational carbon profile. Uncertain about future financing requirements	NO
	6	Project may be negatively impacted by climate change-related litigation	No precedent for legal action on climate in Türkiye	NO

Table 9-13: Opportunity Vulnerability Ratings

Transition Category	#	Opportunity	Assessed Project Interaction	Vulnerability Rating
Policy & Legal	1	Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of	Natural gas is a primary focus of Türkiye's development and climate	YES

Transition Category	#	Opportunity	Assessed Project Interaction	Vulnerability Rating
		its power system by shifting from higher-carbon (e.g. coal and fuel oil) to lower-carbon natural gas fuel	change mitigation strategies	
Technology	2	Non-power generation applications for natural gas end uses may generate additional offtake opportunities for the Project	Project offtake may be fully allocated to meet industrial (mining) power generation requirements. Ancillary markets are a potential.	YES
Reputation	3	Project economics may be positively impacted by capital providers that assign a capital cost carbon discount	Project financing costs already reflect operational carbon profile. Uncertain about future financing requirements	NO

Based on the qualitative screening, three (3) Risks and two (2) Opportunities were carried forward for assessment.

Table 9-14: Risks and Opportunities Carried Forward for Assessment

Transition Category	Risk / Opportunity	Assessed Project Interaction	Vulnerability Rating
Policy & Legal	Opportunity #1: Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal) to lower-carbon fuels	100 percent of the Project's offtake is targeted for domestic consumption, and will replace approximately 30% of current natural gas foreign imports.	YES
Policy & Legal	Risk #1: Incoming carbon pricing mechanisms of partner nations may lead to increased tariffs for Türkiye's exports produced using fossil fuels such as natural gas	100 percent of the Project's offtake is targeted for domestic consumption. No exports of Project energy production are expected.	NO
Technology	Risk #2: The declining cost of renewable energy technologies may reduce future domestic demand for natural gas production	The projected increase in Türkiye's renewable energy capacity is not expected to meet or exceed demand for natural gas. Any increase in renewable energy capacity will offset other higher-intensity fuels (i.e., oil and coal).	NO
Technology	Opportunity #2: Emerging applications for natural gas end uses may generate additional	Projected domestic energy demands greatly exceed capacity of the Project. Offtake will not likely be	NO

Transition Category	Risk / Opportunity	Assessed Project Interaction	Vulnerability Rating
	offtake opportunities for domestically produced natural gas	available for alternative end uses.	

Step 2: Scenario Analysis

Following the determination of significant potential risks and opportunities that could directly interact with the Project, scenario analysis was conducted to assess the likelihood and consequence of occurrence of each risk and opportunity under the two (2) selected decarbonization scenarios.

Likelihood and consequence ratings were applied to each risk and opportunity independently according to the following 5-point scales:

Consequence

Table 9-15: 5 Point Consequence Scale

Value	Description
5	Very High
4	High
3	Moderate
2	Low
1	Minor

Likelihood

Table 9-16: 5 Point Likelihood Scale

Value	Description
5	Definite/Unknown
4	Highly Probable
3	Medium Probability
2	Low Probability
1	Unlikely
0	None

Results of the analysis are presented in following tables.

Table 9-17: Risk Likelihood & Consequence Assessment

#	Risk	Description		Likelihood		Consequence	
		+3ºC Scenario (Less Rapid, Less Stringent Decarbonization)	2ºC or less Scenario (More Rapid, More Stringent Decarbonization)	+3ºC Scenario	2ºC or less Scenario	+3ºC Scenario	2ºC or less Scenario
1	Future climate change legislation and policy may impose increasingly stringent restrictions on fossil fuels for power generation and other end-uses, thereby affecting the economic viability of the Project and creating a stranded asset	A less rapid and less stringent national decarbonization pathway is not likely to affect projected Project economics and offtake demand (as this pathway largely corresponds to existing national policies and plans)	A more rapid and more stringent national decarbonization pathway may affect the future economic viability of Project, depending on the country's approach to addressing natural gas within the total energy mix	**UNLIKELY (1)**	**LOW (2)**	**MINOR (1)**	**MODERATE (3)**
2	Domestic demand for the Project's natural gas offtake may be negatively impacted by EU border carbon adjustments applied to Turkish industrial export customers	The EU CBAM has been enacted into legislation and will affect Turkish industrial customers that export to the EU. Under a less rapid and less stringent decarbonization pathway, the likelihood of demand and prices for Project output being affected may be considered to be lower than	The EU CBAM has been enacted into legislation and will affect Turkish industrial customers that export to the EU. EU climate policy objectives are currently much more stringent than is the case in Türkiye, and can be anticipated to further tighten	**Low (2)**	**Medium (3)**	**LOW (2)**	**MODERATE (3)**

		under a more rapid and stringent pathway					
3	Demand for Project natural gas offtake may be negatively impacted by increasingly cost competitive and accessible renewable/low carbon energy technologies	A less rapid and less stringent national decarbonization pathway is not likely to change the anticipated future market dynamic between natural gas and renewables (as this pathway largely corresponds to existing national policies and plans). Projected Project economics and offtake demand are less likely to be affected	A more rapid and more stringent national decarbonization pathway may affect the future economic viability of Project, depending on the country's ambitions to scale up renewables penetration for intermittent and dispatchable power generation, and to make corresponding investments in distribution and storage infrastructure	**UNLIKELY** **(1)**	**LOW** **(2)**	**MINOR** **(1)**	**MODERATE** **(3)**

Table 9-18: Opportunity Likelihood & Consequence Assessment

#	Opportunity	Description		Likelihood		Consequence	
		+3°C Scenario (Less Rapid, Less Stringent Decarbonization)	2°C or less Scenario (More Rapid, More Stringent Decarbonization)	+3°C Scenario	2°C or less Scenario	+3°C Scenario	2°C or less Scenario
1	Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal and fuel oil) to lower-carbon natural gas fuel	A less rapid and less stringent national decarbonization pathway is not likely to positively affect projected Project economics and offtake demand (as this pathway largely corresponds to existing national policies and plans)	A more rapid and more stringent national decarbonization pathway could cause Türkiye to put increased emphasis on the shifting from higher carbon fuels to lower carbon natural gas	**UNLIKELY (1)**	**MEDIUM (3)**	**LOW (2)**	**MODERATE (3)**
2	Non-power generation applications for natural gas end uses may generate additional offtake opportunities for the Project	A less rapid and less stringent national decarbonization pathway is not likely to change project end-use demand for Project output (as this pathway largely corresponds to existing national policies and plans)	A more rapid and more stringent national decarbonization pathway could cause Türkiye to extend its current approach to reducing GHG emissions by further scaling up natural gas capacity and consumption and reducing reliance on higher-carbon coal, fuel oil and diesel	**UNLIKELY (1)**	**LOW (2)**	**LOW (2)**	**MODERATE (3)**

Table 9-19: Likelihood Assessment

Risk / Opportunity	Description		Likelihood	
	+3ºC Scenario	2ºC or less Scenario	+3ºC Scenario	2ºC or less Scenario
Opportunity #1: Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal) to lower-carbon fuels	Under a less rapid and less stringent decarbonization scenario, investment in renewable energy capacity is likely to be lower, increasing the likelihood that the Project's natural gas will play a role in supporting achievement of Türkiye's climate goals	Under a more rapid and more stringent decarbonization scenario, investment in renewable energy capacity, decreasing the likelihood that the Project's natural gas will continue to play as significant a role in supporting achievement of Türkiye's climate goals	**HIGH**	**MEDIUM**

Table 9-20: Consequence Assessment

Risk / Opportunity	Description		Consequence	
	+3ºC Scenario	2ºC or less Scenario	+3ºC Scenario	2ºC or less Scenario
Opportunity #1: Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal) to lower-carbon fuels	Under either Scenario, the use of Project natural gas to displace other higher-carbon fuels can be expected to continue. Forecast project returns are based on expected demand forecasts.		**HIGH**	**HIGH**

Step 3: Assignment of Risk/Opportunity Rating

Likelihood and consequence ratings were then combined to assign an overall risk or opportunity rating (Tables 13 and 14). A three (3)-level scale was used to characterize the significance of each risk and opportunity.

Table 9-21: Significance Rating

Score	Significance	Description
20 - 25	High Significance	May influence project design decisions regardless of any possible action. An impact which could influence the decision about whether/ how to proceed with the project
9 -16	Medium Significance	Would influence decisions on project design unless mitigated. An impact or benefit which is sufficiently important to require management consideration
1 - 8	Low Significance	Will not have any influence on the decision. Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative action

Table 9-22: Risk Significance Rating

#	Risk	Likelihood		Consequence		Risk Rating	
		+3ºC Scenario	2ºC or less Scenario	+3ºC Scenario	2ºC or less Scenario	+3ºC Scenario	2ºC or less Scenario
1	Future climate change legislation and policy may impose increasingly stringent restrictions on fossil fuels for power generation and other end-uses, thereby affecting the economic viability of the Project and creating a stranded asset Project and creating a stranded asset	**UNLIKELY (1)**	**LOW (2)**	**MINOR (1)**	**MODERATE (3)**	**LOW (1)**	**LOW (6)**
2	Domestic demand for the Project's natural gas offtake may be negatively impacted by EU border	**MEDIUM (2)**	**HIGH (3)**	**LOW (2)**	**MODERATE**	**LOW (4)**	**MEDIUM (9)**

	carbon adjustments applied to Turkish industrial export customers				**(3)**		
3	Demand for Project natural gas offtake may be negatively impacted by increasingly cost competitive and accessible renewable/low carbon energy technologies	**UNLIKELY (1)**	**LOW (2)**	**MINOR (1)**	**MODERATE (3)**	**LOW (1)**	**LOW (6)**

Table 9-23: Opportunity Significance Rating

#	Opportunity	Likelihood		Consequence		Risk Rating	
		+3°C Scenario	2°C or less Scenario	+3°C Scenario	2°C or less Scenario	+3°C Scenario	2°C or less Scenario
1	Domestic demand for natural gas produced by the Project may increase as Türkiye seeks to reduce the carbon intensity of its power system by shifting from higher-carbon (e.g. coal and fuel oil) to lower-carbon natural gas fuel	**UNLIKELY (1)**	**MEDIUM (3)**	**LOW (2)**	**MODERATE (3)**	**LOW (2)**	**MEDIUM (9)**
2	Non-power generation applications for natural gas end uses may generate additional offtake opportunities for the Project	**UNLIKELY (1)**	**LOW (2)**	**LOW (2)**	**MODERATE (3)**	**LOW (2)**	**LOW (6)**

9.2.5 Conclusion

Based on the above assessment, the Project is considered to have no high significant Transition Risks. The Project is considered to have one moderate significant Opportunity relating to the continued/increased domestic demand for natural gas as a lower-carbon fuel.

Compatibility with INDC

As per the EP4 requirement to consider the project's compatibility with Türkiye's national climate change commitments, the project was assessed against the Country's Intended Nationally Determined Contribution ("INDC"). Specific consideration was given to whether the domestic production of natural gas can help Türkiye to achieve its climate change targets via the displacement of higher-carbon fuels for domestic consumption.

As discussed in the Risk Identification section, Türkiye's INDC outlines a national target of a reduction in GHG emissions of up to 21 percent reduction from the Business as Usual ("BAU") scenario level by 2030. The Business-as-Usual scenario refers to the Country's projected total GHG emissions in the case of no national climate change strategy while the Mitigation scenario refers to the projected total GHG emissions assuming successful implementation of the INDC and accompanying policies.

It is important to note that the INDC does not specify absolute reductions of GHG emissions, rather a reduction in the growth of emissions by 2030. Under both scenarios, total GHG emissions are projected to grow between 2020 and 2030. For the BAU scenario, emissions are projected to increase by approximately 75 percent, and under the Mitigation scenario, emissions projected to grow by approximately 55 percent. The INDC does not contain an objective relating to the use of natural gas (e.g. switching from higher carbon fuel oil to lower carbon natural gas, such as replacing light crude oil and diesel with natural gas in thermal generation plants). Natural gas, however, presents an opportunity to achieve relative reductions in GHG emissions growth by displacing higher GHG intensity energy sources such as coal and oil.

While the IEA has identified in its 2050 Net Zero report that continued oil and gas extraction is not compatible with the Paris Agreement temperature limit, Türkiye's INDC is not considered to be Paris compatible. Therefore, while the Project's gas output may not be compatible with global GHG reduction needs, the Project is not inconsistent with the country's INDC.