SAKARYA GAS FIELD DEVELOPMENT PROJECT - ESIA

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Chapter 4 Alternatives Assessment

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Information Classification

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PUBLIC	Information and data that may be shared without restrictions because it is unlikely to result in any harm if disclosed to outside parties. Permission to actually release information to the public must be obtained separately through External Affairs
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4.0 ALTERNATIVE ANALYSIS

IFC PS1 requires full and detailed justification for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. In addition, in the Annex A of the Equator Principles (EP) IV, it is described that the alternatives analysis requires the evaluation of technically and financially feasible and cost-effective options available to reduce Project-related Greenhouse Gas (GHG) emissions during the design, construction and operation of the Project.

With reference to the emissions, the analysis will endeavour to ascertain the best practicable environmental option and will include consideration of alternative fuel or energy sources if applicable. Where an alternatives analysis is required by a regulatory permitting process, the approach has to follow the methodology and time frame required by the relevant process. For projects in high carbon intensity sectors, the alternatives analysis have to include comparisons to other viable technologies, used in the same industry and in the country or region, with the relative energy efficiency, GHG efficiency ratio, as appropriate, of the selected technology.

High carbon intensity sectors indicatively include but are not limited to the following: oil and gas, thermal power, cement and lime manufacturing, integrated steel mills, base metal smelting and refining, and foundries, pulp mills and potentially agriculture. Notably, EP4 describes the oil and gas sector, which the Project falls within, as a 'high carbon intensity' sector. In accordance with EP4s high carbon intensity sector Alternatives Analysis~~A~~ guidance, the Project is required to consider alternative fuel or energy sources and viable technology that is used in the same industry or region with energy efficiency and GHG efficiency of the various technologies.

Following completion of an alternatives analysis, the Project Proponent is expected to provide, through appropriate documentation, evidence of technically and financially feasible and cost-effective options and justification on why alternative technologies were not selected. This does not modify or reduce the requirements set out in the applicable standards (e.g., IFC PS 3).

The purpose of this section is to summarize how the Project siting and components represent an optimized design that is technically and financially viable while minimizing overall environmental and social impacts. Chapter 7 of this ESIA Report contains an assessment of the impacts that the Project will have together with the selection of suitable mitigation and monitoring measures.

4.1 Site Alternatives

4.1.1 Gas Field

Sakarya Gas Field is located within the Sakarya Gas Field Block C26 in the western Black Sea, approximately 155 km offshore Filyos, located in Zonguldak, Turkey. The Sakarya Gas Field is the first deepwater gas field discovery and the biggest natural gas reserve in the country. It is anticipated that 30% of the domestic natural gas demand will be met by the SGFD Project with the first production from the field planned in the first quarter of 2023.

Sakarya Gas Field discovery was initiated with the Tuna-1 deepwater exploration well, set at a depth of 2,115 m to reach a depth of 4,525 m, using its sixth generation deepwater drillship Fatih, in August 2020. The well intercepted more than 100 m of the natural gas-bearing reservoir in the Pliocene and Miocene sandstone formations. The initial natural gas reserve estimation was 320 billion cubic meters (bcm)/11 trillion cubic feet (tcf)) of lean gas, which is considered the largest gas reserve discovered both in the Turkish Exclusive Economic Zone and in the Black Sea.

4.1.2 Subsea Umbilical, Risers and Flow Lines (SURF)

The Project the SURF, connecting the wells to the coast, will include:

- A seabed umbilical, approximately 6 inches (15.24 cm) in diameter that bundles together small pipes containing fluids, chemicals, and electrical and fibre optic lines;
- Gas pipeline, 16 inches (40.64 cm);
- MEG pipeline approximately 10 inches (25.4 cm) in diameter.

Several options to the **landfall siting** in Filyos were taken into consideration. In particular, two areas were considered as appropriate to the landfall (Figure 4-1~~Figure 4-1~~).

Figure 4-1: The two possible landfall sites in Filyos area.

In these two areas, choosing the one that was previously designated as an industrial area and that was already subject to environmental impacts due to projects of other institutions prevented the introductions of pressures and impacts (e.g., dredging, cutting trees and deforestation) in an area almost pristine. For this reason, the **1st Area** was selected.

Within the selected area (1st Area) in the Filyos landfall location, the least environmental impacting (as far as technically feasible) **routing option** was selected. In particular, the direct impact (pipeline footprint) on a wetland (i.e., the pond in Figure 4-2) was avoided as much as possible. In fact, even if the technical study highlighted the green track shown in Figure 4-2 as the technically most feasible option, the red one plus the dotted line was chosen. This option was the furthest feasible site from the wetland where the first onshore pipeline curve could be placed. Any further option towards east results technically hardly achievable because the pipeline would require the creation of angles (curve) below the minimum technically possible value.

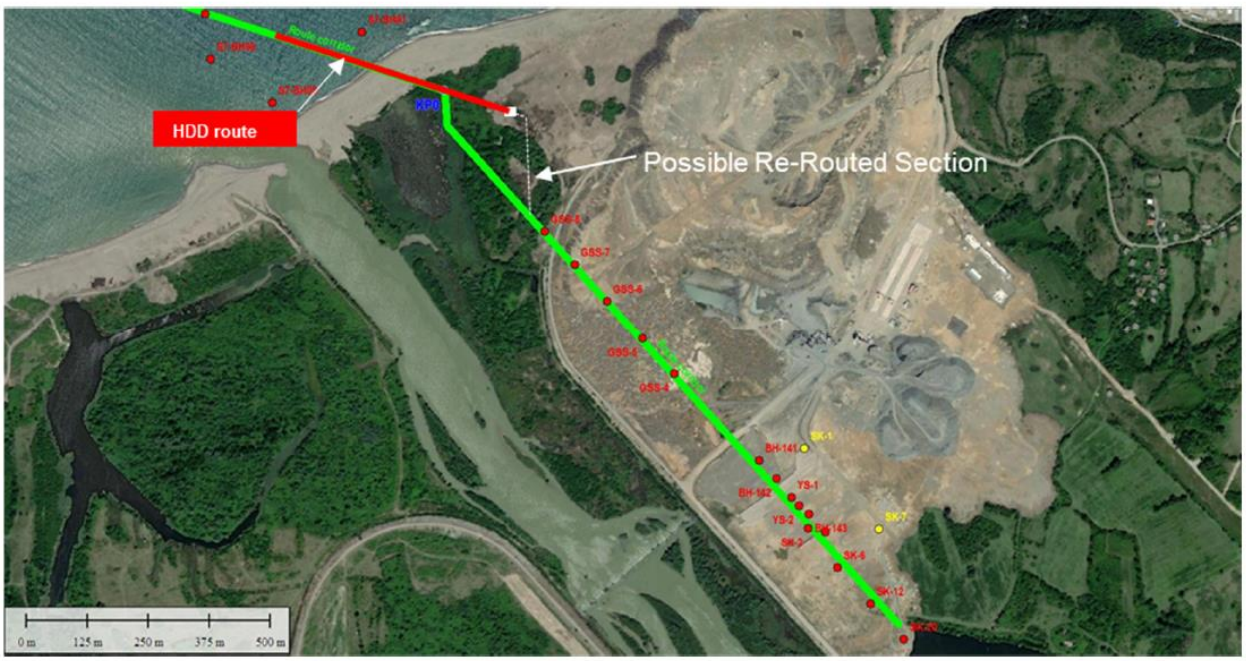

Figure 4-2: Possible routing options in the 1st Area of Filyos landfall location.

4.1.3 Onshore Facilities

While determining the site for onshore production facilities, several conditions have been considered. In order to assure the safety of the gas flow, the Project site has been selected to be the shortest distance from the Sakarya Gas Field. The shortest SURF is substantial for minimizing the pressure and conductivity loss inside the lines and therefore assuring the safety of flow and controls.

The project area is also significant in terms of its transportation and logistics facilities. In comparison to nearby ports, the Filyos Port, close to the project area, has a significantly wider area of use. TP-OTC, the affiliate of TPAO, also operates the Coastal Logistics Centre, which is located inside the boundaries of the Port of Filyos. The logistics centre will be temporarily utilised during the construction stage under the Project scope. As can be seen from the figure below, while the distance of Filyos Port to the Sakarya Gas Field Tuna-1 well location is 155 kilometers, the distance of the other land points hosting a port to the said location is at least 45 kilometers longer.

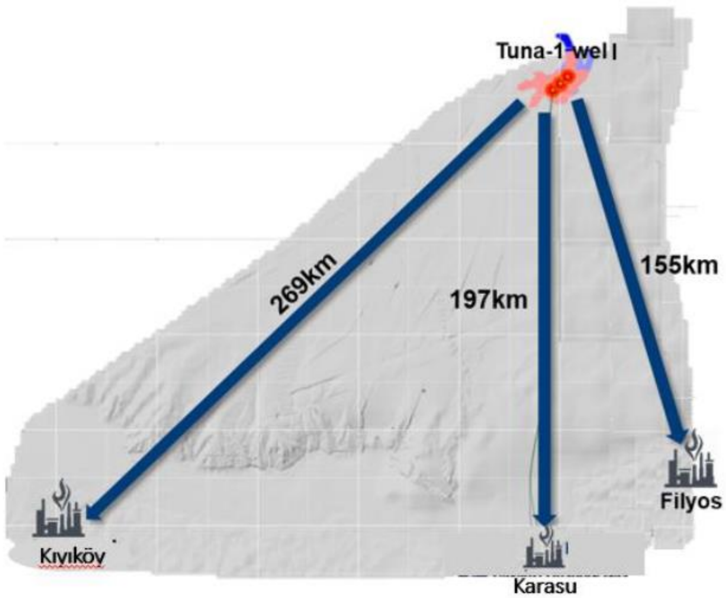

Figure 4-3: Port Alternatives

In the route of Karasu port, there is a difficulty in urban road transport in the process of transporting materials and equipment and Karasu Port area is very close to the city center and living areas and is among the holiday centers of the Black Sea coast region.

In the selected Project area, the transportation routes that will be available in the region are planned to be expanded through the highway and railway networks, which will incorporate the Filyos Industrial Zone in the future. No new temporary roads will be built to be utilised during the construction stage due to the existing highways in the region. Considering the distances between the alternatives and the nearest airports, the Filyos Industrial Zone comes out the closest, with an 18-kilometre distance to Çaycuma Airport.

The selected project area in Filyos has been designated as an industrial zone and is not surrounded (or limited surrounded) by any private land or forest land. Furthermore, since the selected Project area was organized as an Industrial Zone and used during the construction of the Filyos Port, a limited extension of vegetation clearing within the area will be necessary.

In case Filyos area is chosen for the establishment of the onshore production facilities, a shorter umbilical and MEG/Methanol (chemical liquids) pipeline will be required to be constructed due to the decrease in the distance between the Sakarya Gas Field and the facilities, this process will be shorter when the depressurization operation (pressure reduction) will be performed in the pipeline, less gas flares will occur, and the required equipment supply, delivery time and construction time will be shortened due to the decrease in construction items. For example, the construction of an extra 45 kilometres of pipeline imposes an extra 45 bar (650 psi) pressure load on the wells, given the overall pressure loss of 1 km/bar. A pressure load that will occur in this way will directly affect the production capacity of the wells and will cause a decrease in production. Also, as the reservoir is known to depressurize over the years, the need for seabed compressors will arise more severely, in greater numbers, and sooner in response to decreasing reservoir pressure.

In addition, the extension of the pipeline has an effect on hydrate and fluid management and flow safety. Flow problems in natural gas pipelines are mostly caused by solid sedimentation. The most common of these deposits are hydrate, asphaltene and paraffin/wax formations. They occur depending on many parameters, especially pressure, temperature and fluid composition. The pressure and temperature change that occurs during the transport of wet gas creates favourable conditions for the formation of hydrate in the pipeline. Although it is a substance formed by gas and water at certain pressure and temperature, it constitutes one of the most important problems in terms of flow safety. Failure to carry out the necessary work in case of its occurrence has the risk of causing blockages in the pipeline and stopping the operations. In this way, the construction of longer pipelines increases the mentioned risk and makes the management of this risk more complex and costly. Namely, the extra distance the gas has to be transported, the more the gas temperature will drop, the gas expansion will occur, and the greater the hydrate management difficulty. In addition, the length of the pipelines from land to sea for MEG to be piped to manage the hydrate will also increase to the same extent. In terms of the amount of water to accumulate in the pipeline, the amount of water produced from the well will increase with the increase in the distance. strategy will be required. In summary, the analyses show that if the Filyos area is selected for the production of natural gas discovered in the Sakarya Gas Field, there will be a significant reduction in flow safety risk and a reduction in associated costs.

For the production facilities to be built a total area of 1,150 decares is needed which is composed of area requirements presented in Figure 4-4~~Figure 4-4~~. Filyos Port and its surroundings meet the aforementioned need with a port area of 1,900 decares and a port expansion area of 650 decares; other alternatives on the Black Sea coast are far from meeting this need. It should also be noted that while the said expansion area is capable of providing a usable area for the other phases to be constructed following the first phase production facilities; other alternatives cannot offer such a usage area as seen in the figure below.

Units in decares

Land		Need	Filyos	Karasu
Port area use	Port area	250	✓ 1650	✓ 250
Port Expansion Area	Onshore Facility Usage	400	✓ 400	✗ -
	Subsea Contractor	200	✓ 200	✓ 200
	Onshore Facility Contractor	100	✓ 100	✓ 100
	Pipeline Contractor	100	✓ 100	✗ -
	Well Completion Contractor	100	✓ 100	✗ -
	Total Area	1150	✓ 2250	✗ 550

Figure 4-4: Port Surface Area Needed to Support the Project

In addition, due to the limited presence of privately owned land, there will be limited or no need for an expropriation process within the scope of the Project. In addition, the existing environmental plan and master development plan are also suitable for the planned facilities. These issues will also bring with them the minimization of cost and time loss that will arise with expropriation, environmental and zoning plan studies.

In summary, Project site selection was made according to following reasons:

- Closest tieback route to onshore.
- The subject of construction work will be less items.
- Relevant material procurement, their delivery time and construction time will be shortened.
- By reducing the pressure loss, flow safety will be maximized and thus a serious saving will be achieved in daily production.
- Hydrate management is provided in a more practical and less costly manner; the amount of liquid that will accumulate in the pipeline can be minimized and this will serve to establish the flow safety at the maximum level.
- Sufficiently large processing land area - already designated as an industrial zone prior to gas discovery – for maximum economic recovery of the reservoir in a phased manner.
- It will be in an advantageous position in terms of infrastructure and transportation networks.
- Minimum environmental and social impact due to isolated location and predeveloped nature of the industrial zone.
- Since there is limited privately owned land in the relevant areas and the existing environmental plan and master development plan are suitable for the planned facilities, the expropriation process will be limited or not required and there will be no significant cost in these matters.

Location of BOTAŞ FMS which was previously designed as to be inside the OPF boundaries was moved to a new location due to difficulties related with soil improvement and time constraint on the Project delivery. Therefore, BOTAŞ moved to the new location which does not require much soil improvement for the FMS construction.

Two routes have been considered for the connection of the transformer station to the existing energy transmission line, and the route has been chosen in a way that does not require new access roads and causes the least number of trees to be cut with minimum expropriation. During the route selection process, the route was finalized by taking the opinions of the relevant governmental authorities.

4.2 Design Alternatives

4.2.1 Technology Selection

This section discusses the various technologies that have been considered for use in the Project that may result in environmental and social impacts.

OPF – A concept selection workshop was carried out in December 2020 to identify the various known uncertainties due to the early stage of the reservoir evaluation and propose feasible concepts that provide a workaround for these uncertainties and would allow the progress of the design to meet the main project driver, the schedule, prior to complete well test results being available. In-house tools Facility Planner and Symmetry simulation software were used to develop the process building blocks for the required onshore facility. The software allows the evaluation of various scenarios where impact of inlet flow, temperature and composition can be evaluated in order to weigh the available technologies and guide in selecting a concept for detailed studies. The concept selection report considers environmental impacts (e.g., hydrocarbon recovery from the produced water, minimisation of effluents and by-products, electricity and fuel gas consumptions).

Flare – No continuous production flaring has been adopted as part of the development and flaring will be in place for emergency, safety and operational upsets only. The flare locations are upwind of process units and has been selected considering local meteorological conditions and thermal radiation footprints based on the release rates, composition, tip types, etc. This approach follows the industry good engineering practice for facility siting and layout and reduces the potential risks to As-Low-As-Reasonably-Practicable (ALARP) levels. The flaring system options analysis considered 1) demountable vertical flare, and 2) a multiport ground flare system. The multiport ground flare system with heat and radiation fencing was selected as it would not be feasible to construct a vertical flare due to the height required for the adopted design flow rate. The ground flare system also offers the following environmental advantages: reduced adverse visual and noise impact; makes monitoring of emissions easier; and multiple tips ensures smokeless burning under all flow conditions. The flare system selected will ensure efficient combustion of excess gases when flaring from emergency situations due to:

- Flare pilots are of a robust design that have been proven to remain lit in extreme wind and rain conditions.
- Backup supply of pilot fuel via propane bottles to supply up to 8 hours of uninterrupted pilot operation should the fuel gas supply fail.
- Redundant pilots on every stage of the flare.

- Redundant ignition system (high energy ignition/flame front generator) with automatic pilot relight capability.

Flare Gas Recovery (FGR) was not chosen due to the intermittent nature of the flare.

Noise and emission modelling studies have been carried out to ensure that selected types of flares do not exceed Project Standards.

Disposal of Produced Water – Treatment options assessed as part of the produced water treatment appraisal included: chemical oxidation (ozone and sodium hydroxide injection); electrochemical; biological; and filters (followed by dissolved air floatation unit). Treatment technologies were assessed in terms of safety, technology readiness level, operability, maintainability, supplier availability, delivery time, constructability, ease of pre-commissioning and commissioning, reliability, flexibility/expandability, track record and cost. The treatment technology selected was a biological treatment plant due to following reasons:

- Responding to spikes in methanol concentrations. It will generally be known when this will occur and produced water with methanol will be sent to the produced water tanks upstream of the treatment unit and will be diluted in line.
- Equalisation tanks are positioned and sized downstream of the treatment unit to deal with surges in flow as well as pollutant loadings.
- Re-routing flow back to the system if water samples do not comply with discharge limits.
- Mature technology with many successful industrial applications. Commonly used for industrial and municipal water COD removal.
- Produced water treatment plant operators or trained process plant operators can run this biological process which is conventional and commonly used. There is enough flexibility in the design to accommodate for peaks in methanol and keep meeting specs (media and carbon filters and holding tank to dosify peak contaminant load). In normal conditions filters are not receiving meaningful load.
- There are available qualified suppliers for all the components of this technology making continuity of operations over time independent of selected vendor.
- The required construction, pre-commissioning and commissioning techniques are conventional and similar to what is required for the rest of the facility. May require initial participation from technology provider to ensure proprietary equipment is properly brought into operation. The biological process requires an initial period of bacterial growth prior to receiving process feed.
- System can be expanded and interconnected with multiple similar units. Modular design has been already considered to reach final plant capacity.
- Ease of regular disposal of dried sludge and eventual disposal of spent filter media to outside location.
- Good industry experience for wide range of organic contaminants including glycol and methanol.
- Shorter delivery of components.

Discharge options were considered in the context of the water being treated, making discharge to either surface waters or land suitable, as opposed to injection into a dedicated disposal well. No well with suitable receiving subsurface geological formation is available for disposal of produced water and drilling of a dedicated disposal well was discounted because the additional environmental impacts and risks associated with drilling such a well (including atmospheric emissions etc.) outweigh the benefits of disposing produced water into a well. Since the facility is located in a rainy geography, reuse of treated water for landscape irrigation and dust control purposes is considered unfeasible. Discharge to deep-sea by mixing with the monovalent salts was considered in case disposal option of the monovalent salts through a waste disposal company was not available. From the feasible options considered, discharge to Filyos River was selected as the preferred option because of the high load and environmental and safety risks.

Disposal of Hydrotest Water – Pre-commissioning activities of offshore section of the SURF and SPS involves flooding, cleaning, gauging and hydrotesting activities with filtered seawater with the addition of corrosion inhibitors, oxygen scavengers, biocides, dyes and MEG to verify equipment and pipeline integrity. Chemical additives (RX 5255 MSDS; RX 5954 MSDS, RX 5955) were selected for their sustainability (no bioaccumulation, high level of dilution) and effectiveness (2-3 years long term preservation). Chemicals are ranked as gold (least hazardous) according to Cefas (The Centre for Environment, Fisheries and Aquaculture Science, UK) ranking based on the physical, chemical and ecotoxicological properties of products. Disposal to deepsea at WD 2,200 m was selected as injection into a disposal well option is not available due to the same reasons explained above. Pre-commissioning activities of onshore section of the SURF and OPF do not involve chemical additives. Therefore, it was decided on discharging resulting wastewater to Filyos river in case discharge standards are complied. If the discharge does not comply with the standards, the option of transporting it to licensed wastewater treatment plants with vacuum trucks is also being considered.

Power Generation – Power supplied to the facility will be by power generation on site (fuelled by natural gas) and a connection to the grid as stand-by. There will be four diesel generators, to be used only as back-up. The on-site power generation options analysis considered either 2 x gas turbine generators (GTG), or 3 x reciprocating gas engine generator (2 online and 1 on standby). Reciprocating engines were selected as power generation solution due to providing the advantages listed below.

- Higher fuel efficiencies: Typical GTG upper efficiencies is in region of 25-35% while the reciprocating engines have efficiency 35-48% (Lean burn). For same electrical loading, the GTGs would consume 88 mmBTU/h of fuel gas while the engines would consume only 63 mmBTU/h; with projected savings in the region of $39.3 million across Project's 25-year design life.
- The lower fuel consumption will result in lower overall emissions from power generation during operational phase.
- Shorter start-up times of the reciprocating engines (15 minutes vs hours for typical GTG) reducing vulnerability to deferred production in event of generator trips.

- A combustion control system called “Leanox” system will be used to guarantee fuel emissions of NOx is limited to 500 mg/Nm^3 (based on 5% vol O_2.). CO will be limited to 650 mg/Nm^3 using oxidation catalyst technology (based on 5 %vol O_2.
- Noise and emission modelling studies have been carried out to ensure that selected types of gas engine generators do not exceed Project Standards.

Solar power has been considered and ultimately decided unsuitable due to land availability and the region’s climatic parameters do not support use of solar power. Wind farms have also been considered however, the inherently low availability of power makes them impractical as sole replacement for onsite power generation.

Heating Medium –Steam has been selected as heating medium of preference based on economic evaluation and environmental and safety risks. Steam based heating has following advantages over use of thermal oils:

- Medium is readily available; with lower environmental and safety risk than thermal oil in event of accidental release.
- High heat release potential per unit of medium, hence reduced fuel gas consumption and emissions.

Some design additions were incorporated to increase the thermal efficiency. Significant CAPEX has been invested to purchase Air Preheater to further improve energy efficiency of steam system to ≥95%. Design has incorporated use of ball valves for condensate drains to reduce leaks and reduce heat losses. System has been appropriately insulated to ensure heat losses are minimised.

Noise and emission modelling studies have been carried out to ensure that selected types of steam boilers do not exceed Project Standards.

Cooling System – The units requiring cooling will be cooled down by their air cooled system, therefore; the plant will not require cooling water or discharge of cooling water into receiving bodies.

Technical options for the pipeline construction - The pipelines are designed to be initially routed through a concrete culvert from the tie-in valve at the onshore plant. The culvert extends beyond the plant boundary passing under the plant road and Turkish Petroleum Corporation (TPAO) road. The pipeline is then **trenched** until the public road and Filyos railway bridge crossing, which is routed through a conduit, the remaining onshore route is trenched and buried until the landfall tie-in point (KP0).

Besides the trenching options, which involves the dredging, the Horizontal Direction Drilling (HDD), a trenchless construction method, was considered.

Such technique is known to cause less disturbance to the local environment and therefore it would be preferable. However, the feasibility is heavily dependent on suitable soil conditions and pipe diameter.

However, based on the feasibility study carried out, the HDD construction will result in additional cost and time, and there are still expected environmental impacts, particularly in connection with the release of drill fluids into the environment and the setting up of the drill site on shore. Hence, the environmental benefits of the HDD method for this particular shore crossing appears to be very limited to negligible.

In such a case, the implementation of appropriate environmental restoration and offsetting measures for the impact caused on the dune area by the trench may be considered as more effective in comparison with the introduction of an HDD with the related cost, time impact and release of drill fluids.

4.2.2 GHG Emissions

This Alternatives Analysis~~A~~ follows the guidance of the Equator Principle 4 (EP4), which requires an account of the considerations the Project has taken to attain the best practicable environmental options to mitigate its contribution to climate change through reduction on GHG emissions. Notably, EP4 describes the oil and gas sector, which the Project falls within, as a 'high carbon intensity' sector. In accordance with EP4s high carbon intensity sector Alternatives Analysis~~A~~ guidance, the Project is required to consider alternative fuel or energy sources and viable technology that is used in the same industry or region with energy efficiency and GHG efficiency of the various technologies. The below sections outline the following information:

- main sources of GHG emissions of the Project;
- comparison of the Project GHG Emissions within the context of sector, national and global emissions;
- a summary of the best practicable environmental options for the natural gas processing; and
- alternative options that were considered and justification of the selected processes.

4.2.3 Summary of Project's GHG Emissions

EP4 requires projects to calculate Scope 1 and Scope 2 emissions. The scope 1 emissions at the Project site are from stationary combustion, fugitive, and on-site transportation. To be consistent with the air quality section, emissions from stationary combustion and fugitive emissions have been calculated. Project emissions from stationary combustion sources and fugitive emissions are summarized in **Table 4-1~~Table 4-1~~**.

Table 4-1: Project Emission Sources

GHG Emissions Type	Source of Emissions	Emissions (t CO_2e)	% of Project Total
Stationary Combustion	Upset and Maintenance Emissions	4132	2.8
	Power Generation	54727	37.7
	Process Emissions	86449	59.5
	Emergency Equipment	0.1	0.0
Fugitive Emissions	Connection Equipment Losses	707.17	0.5
Total		**146016**	100%

4.2.4 Alternative Considered and Best Practicable Options Selected

The information in this section is resultant of a meeting with the design team of TP-OTC and provided information request documents to understand the consideration taken in reducing GHG emissions. This alternatives analysis is discussed in terms of GHG reductions, other environmental benefits, and feasibility of each alternative option. Only alternatives in the highest emitting Project sources are discussed below.

Table 4-2: Alternatives Considered and Justification of Selected Processes.

Source of Emissions	Selected Processes	Alternatives Considered	Associated GHG Emissions for Selected Process	Other Environmental Considerations for Selected Process	Other Factors
Upset and Maintenance Emissions	Non- continuous flaring for upset situations only. HP Ground Flare and enclosed type LP/LLP flare installed at two separate locations.	Demountable vertical flare	Flaring is non-continuous and is only in place for operational upsets and emergency situations. The practice of non-continuous flaring causes less GHGs than continuous flaring practices, which contributes to lower overall emissions of the Project.	Other environmental advantages of ground flaring include reduced noise and visual impact, smokeless burning ensured under all conditions due to multiple burner tips. Also, personnel exposed to flare radiation would not exceed appropriate exposure levels with this option. Modelling shows that worst case emissions from HP Flare are below 50% of the emission limits set by Turkey Regulation on Industrial Air Pollution table 2.2. Modelling based on worst case scenario show that LP/LLP flare emissions fall within the limits set by Turkey Regulation on Industrial Air Pollution Table 2.2 Monitoring emission is also made easier with the ground flaring option, contributing to potential future emissions.	**Demountable Vertical Flare** This alternative is not appropriate for height required for design flow rate. Although these are most cost-effective flares and require less ground space, they are noisy, smoky, and liquid carry over leading to 'burning rain' is more likely with vertical stacks. **Flare Gas Recovery** This practice was not chosen because the flare is not continuous and is only in place for emergency situations. **Ground Flare** This method was chosen as it meets the height requirement for the design flow rate. Ground flares are suitable for high levels of gas. This system will also provide efficient combustion of excess gases in emergency situations. This system also has lower operation costs and better turndown.
Power Generation	Reciprocating gas engine generator (natural gas) with connection to the grid as standby	Gas turbine generators Solar power Wind	Reciprocating engine emissions were shown to be significantly below the Industrial Air Pollution Control Regulation limits (IAPCR). Reciprocating gas engines have an efficiency of 35-48% while gas turbine engines have an efficiency of 25-35%, which reduces emissions. Therefore, choosing reciprocating gas engine generator over gas turbine generators directly contributes to the reduction of GHG emissions. Connection to the Turkish electricity grid does not save GHG emissions due to the coal that powers the electricity grid. However, if a future scenario arises where the grid in Turkey is less carbon intensive, there is a stand-by connection to the grid. In this event where power is used from the grid, emissions from power generation would decline. A renewable energy source such as solar and wind would result in less GHG emissions, however these have been deemed unsuitable (see last column).	A combustion control system called "Leanox" will ensure that emissions of oxides of nitrogen will be limited to bellow the emissions limits. Further, the emissions from carbon monoxide, sulfur dioxide, and total particulate matter are well below the limits in place by IAPCR when using reciprocating gas engine generator. The insignificant levels of these emissions means that air quality is not a concern from reciprocating gas engines.	**Gas Turbine Generators** This alternative was not selected due to lower fuel efficiency, which causes higher emissions and costs more money. There are also longer start up times with these generators, which increases vulnerability in the case of a generator trip. **Solar Power** This alternative has been deemed unsuitable due to lack of land availability and the climactic parameters of the area that do not support solar power generation. **Wind Power** This alternative has been dismissed due to inherently low availability of power. This makes wind an unviable replacement for power generation on-site. **Reciprocating Gas Engine Generator** This method was chosen as it meets energy requirements while maintaining fuel efficiency. This is projected to save about $40 million over the lifetime of the project due to its fuel efficiency. The shorter start of time of 15 minutes (compared to hours for gas turbine generators), reduces vulnerability in the event of generator trips.

Source of Emissions	Selected Processes	Alternatives Considered	Associated GHG Emissions for Selected Process	Other Environmental Considerations for Selected Process	Other Factors
Process Emissions	Natural Gas fired steam boiler	N/A	Emissions for natural gas fire steam boiler were found to be below Industrial Air Pollution Control Regulation (Table 2.1, Annex-2) and the EHS General Guidelines. The potential to generate power from steam due to proximity of steam generation and power generation poses possibilities to reduce emissions from power generation in the future.	In the event of a leak, there are less environmental and safety risks.	Natural Gas Fired Steam Boiler has been chosen as a heating medium because both power and steam will be generated in the same plant and allows flexibility of being able to convert to power generation in the future. This medium is also readily available and there is high heat release potential per unit of medium.
Process Emissions	General considerations: valve and flange regulations to reduce potential leakage Fugitive testing on control valves under ISO 15848 Permissible leak limit placed Best Isolation practices selected Best practices applied for piping (i.e. protective coating on pipeline)	N/A	N/A	**N/A**	**N/A** Fugitive emissions were assessed and were estimated to be low compared to the stationary combustion emissions. Hence, a detailed alternatives assessment is not required for fugitive emissions.
Emergency Equipment	Emergency diesel generator (EDG) Test Runs Fire water Pumps Test Runs	Due to safety concerns, these processes are required to be in place at the facility.	Periodic testing of the emergency equipment is required.	N/A	Despite relatively high emissions from these emergency measures, there are no suitable alternatives to mitigate these emissions.

N/A = Alternatives not considered based on Design Considerations for Reduction of Fugitive Emissions_05Jult2022.pdf

4.2.5 Net Zero/GHG Abatement Plan

A net–zero plan/GHG abatement plan typically outlines how the facility (including proposed expansions where appropriate) is designed and operated in a way to reduce emissions, to provide support for emission reductions, and to manage emissions in accordance with corporate/regulatory GHG reduction targets. In Turkey, recent, unprecedented, climactic events such as the 2021 forest fire season, and Turkey's high climate vulnerability, make climate change mitigation and adaptation a national priority (World Bank 2022). Turkey has ambitiously committed to being net-zero by 2053, which was a decision that was resultant of Turkey ratifying the Paris agreement in October of 2021 (World Bank 2022). New institutional arrangements have been established in Turkey to assist in achieving the net-zero target including an updated National Climate Change Action Plan and the Ministry of Environment, Urbanization and Climate Change (MoEUCC) (World Bank 2022). Due to Turkey's national commitments of net-zero operations, the project will comply with these commitments as Turkey moves towards its net-zero goals though a net-zero/GHG abatement plan.

Turkey's national plan will require a shift in major sectors towards energy efficiency, electrification, and renewable energy as well as practices that maximize carbon sequestration from forest landscapes (World Bank 2022). Energy efficiency practices in the proposed project aligns with the national plan to achieve net zero by 2053, and as Turkey moves towards this goal, the project may adapt to create higher GHG emission reductions.

4.3 No Project Alternative

The 'No Project' alternative is the situation where the Project, does not proceed. Under this scenario, there would not be any impacts on the environment, the beneficial socio-economic outcomes of the Project would not happen.

However, the need for the Project is driven by Turkey's rapidly increasing natural gas demand and shortages due to political and technical reasons; further details are provided in Chapter 3.1.2. If the Project does not proceed, the goal of reducing dependency on imports of natural gas and meeting the increasing demand without any shortages accordingly would not be realized. Consequently, the economic benefit to local and national stakeholders, as well as the energy security it would bring, would not be realised. On this basis, the 'No Project' option was rejected.

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