# CLIMATE CHANGE RISK ASSESSMENT (CCRA)

Prepared for

**Pengerang Energy Complex Sdn Bhd (PEC)**

**10.05**
**2022**

ESC

# CLIMATE CHANGE RISK ASSESSMENT (CCRA)

**For Pengerang Energy Complex Sdn Bhd (PEC)**

For and on behalf of
EnviroSolutions & Consulting Sdn Bhd,

Approved by,

**Andrew Young**
Group Director
10th May 2022

Project Number: EPA20.7047-J01
Report Version: 02

| Rev. | Description | Prepared | Reviewed | Approved | Date |
|---|---|---|---|---|---|
| 00 | Draft | ZK/EA/RY/HZ/ST/TMM | TN | ZAR | 11/08/2020 |
| 01 | Draft | ZK/EA/RY/ST/TMM | SR | AY | 31/03/2022 |
| 02 | Draft FInal | TO/RY | AY/ CF | AY | 10/05/2022 |

**Distribution**
☐ Internal ☐Confidential ☒ Public

## CONTENTS

**LIST OF FIGURES**

## Executive Summary

This Climate Change Risk Assessment (CCRA) was developed for the proposed Pengerang Energy Complex (PEC), located in the Pengerang Industrial Park in the state of Johor as well as the associated facilities owned by 3rd parties (Dialog) which will import feedstock and export product via its jetties, offsite storage tanks and pipelines. The proposed Pengerang Energy Complex (PEC) is planned as a world-scale condensate splitter and aromatics complex, on a 250-acre site in the Pengerang Industrial Park (PIP), situated within the Pengerang Integrated Petroleum Complex (PIPC). The production capacity of the PEC will be about 5.844 million metric tonnes per annum (MMtpa), or 16.7 kilometric tonnes per day (kMtpd), of aromatic petrochemicals and oil products, which will be processed from 6.324 MMtpa of condensate feedstock.

The purpose of this Climate Change Risk Assessment (CCRA) is to assess the baseline climate conditions in the proposed project area, identify the natural hazards that may impact upon the PEC project and associated facilities and to assess the priority for developing adaptation strategies for these natural hazards, minimising the Physical and Transition risks likely to occur as a result of climate change, increasing climate-change preparedness.

The existing climate conditions of Pengerang are typical of tropical equatorial conditions with abundant rainfall, high and uniform temperatures, and high humidity all year round. The 2020 Status Report on Disaster Risk Reduction in Malaysia, published by the UN Office for Disaster Risk Reduction highlighted that Malaysia, despite being relatively sheltered from natural hazards originating from tectonic movements (such as volcanic eruptions and earthquakes), faces threats arising primarily from natural hazards such as cyclones, floods, landslides, droughts, epidemics, and environmental degradation due to natural and anthropogenic stressors. The report also highlighted that these natural hazards may increase in intensity under the effects of climate change.

Assessment of the baseline conditions of climate related hazards was conducted based on climate model projections extracted from the Climate Change Knowledge Portal (CCKP) by the World Bank (refer*Table Table 5.3*). The CCKP provides global data on country-specific climate modelling based on historical baselines, assessing future climates, vulnerabilities, and impacts.

Modelled projections from the CCKP are based on the Shared Socioeconomic Pathways (SSP) scenarios from the IPCC Sixth Assessment Report.

For this study, two GHG scenarios two (2) possible future scenarios were explored. The first scenario, SSP 2 – 4.5 represents a Business-as-Usual approach, in which GHG emissions continue around current levels until 2050, then falling but not reaching net zero by 2100, and a conservative Mitigation Scenario (SSP 1 – 2.6), whereby CO2 emissions cut to net zero around 2075. Summary on the timelines used for each scenario are as follows:

- Historical baseline, spanning years 1995 – 2014
- SSP 2 – 4.5, spanning years 2030, 3050 and 2080
- SSP 1 – 2.6, spanning years 2030, 2050, and 2080

Climate projection data from the CKMP is modelled from the global climate model compilations of the Coupled Model Inter-comparison Projects (CMIPs), overseen by the World Climate Research Program. The CMIPs form the data foundation of the IPCC Assessment Reports. CMIP6 supports the IPCC's Sixth Assessment Report. Projection data is presented at a 1.0º x 1.0º (100km x 100km) resolution.

Detailed graphs and modelling of this data is available in **Appendix A.**

Key findings of the Climate Model Projections for Malaysia are as follows:

A) Temperatures

- Under the Business-as-Usual Approach (SSP 2 – 4.5) the years 2030, 2050 and 2080 showed an increase in Annual Mean Temperatures by 0.51°C. Under the Mitigation Approach (SSP 1 – 2.6), the years 2030, 2050 and 2080 showed an increase in Annual Mean Temperatures by 0.21°C
- The average number of hot days (Tmax > 35°C) was projected to increase between the years 2030, 2050 and 2080 in both the Business-as-Usual Approach (SSP 2 – 4.5) scenario (and the Mitigation approach (SSP 1 – 2.6) scenario. The Business-as-Usual Approach (SSP 2 – 4.5) scenario was projected to have an average of 2.2 days increase in Tmax values, whilst the mitigation approach was projected to have an average of 0.5 days increase in Tmax values.

B) Precipitation (mm)

- There seems to be low variation in mean annual precipitation for the years 2030, 2050 and 2080 under both the Business-as-Usual Approach (SSP 2 – 4.5) scenario and the Mitigation approach (SSP 1 – 2.6) scenario.
- Climate model projections for the max number of consecutive dry days and the max number of consecutive wet days also showed little variation between the years 2030, 3050 and 2080.

**Physical Risks**

Based on the outcomes of this Climate Change Risk Assessment (CCRA), overall, the climate risks identified were found to be of moderate to low concern and can be mitigated with appropriate management strategies in place. The key natural hazard that should be prioritised for the development of adaptation and mitigation strategies is flooding. This is because there have been significant flooding events that have occurred in the past, within 5 km radius from the proposed project area, namely, in Kg Lepau, where flooding events occurred almost on an annual basis from the year 2014, with the most recent flooding event occurring in January 2022. As such, the likelihood and consequence ratings for flooding events is ranked higher than all other identified natural hazards.

Additionally, other hazards that need to be monitored, and which adaptation strategies may need to be developed in the near future include sea level rise, and increased temperatures. Lastly, hazards such as increased precipitation or rainfall does not seem to serve as a source of concern for the proposed PEC project. This is because based on the assessment of historical baseline data on annual precipitation level patterns, as well as projections under Business-as-Usual and Mitigation climate scenarios with data obtained from the World Bank, there seems to be little variation in precipitation levels projections for years 2030, 2050 through to the year 2080. As such, natural hazards resulting from an increase in precipitation levels is not of a concern. However, it is important to note that existing rainfall and precipitation patterns have already caused flooding events within vicinity of the project area and should be taken into consideration in mitigation efforts.

Additionally, climate hazards such as increased precipitation/rainfall, as well as sea-level rise were rated as hazards that need to be monitored, and adaptation strategies may need to be developed in the future. This is because although climate model projections of rainfall patterns show that variation in rainfall patterns is not likely to occur through to the year 2080, existing rainfall patterns have already resulted in severe flooding events and would likely cause detrimental impacts to the PEC project and its associated facilities, in the event that climate change increases rainfall intensity. Consequently, sea-level rise was also given a higher risk rating due to the high likelihood of occurrence. Thus, climate adaptation strategies for sea-level rise-induced risks may also need to be developed in the near future.

**Transition Risks**

Transition risk scenarios are particularly relevant for resource-intensive organizations with high GHG emissions within their value chains, where policy actions, technology, or market changes aimed at emissions reductions, energy efficiency, subsidies or taxes, or other constraints or incentives may have a particularly direct effect.

The main sources of carbon dioxide ($CO_2$) emission from PEC during the operational phase are from the hydrocarbon or fuel-burning equipment such as the boilers, reboilers, heaters, and flare stacks.

Based on the emission calculations done in Section 4.8.3, the proposed PEC project is estimated to produce 2,867,727.93 tonnes $CO_2e$ per year (based on conservative calculation measures). As such, the proposed project may be subjected to some level of transition risks associated with changes in policies and legal frameworks in this scenario, if emission reduction technologies are not adopted. Where possible, technologies and emission reduction strategies should be adopted to reduce GHG emissions from the PEC project, to align with Malaysia's climate change targets and policies moving forward, ensuring that emissions from the proposed project are kept at a minimum.

In line with this goal, The PEC project plans to adopt an Aromatics Complex design that is as close to steam neutral as practical. This design is the lowest in fuel consumption and would result in the least $CO_2$ emissions as practicable.

The emission reduction strategy to be used for the PEC project to reduce emissions and the associated transition risks are as follows:

| | ChemOne PEC Case High $H_2$ in FG Case | ChemOne PEC Case 2 Normal FG Case | Aromatic Complex Next Best Alternative (NBA) |
|---|---|---|---|
| Total $TCO_2e$/year | 749,186 | 1,032,171 | 1,193,426 |
| Total Aromatic products* T/year | 2,457,000 | 2,457,000 | 2,014,000 |
| Total $TCO_2e$/T Aromatic Products | 0.3049 | 0.4200 | 0.5926 |

These emission reduction technologies to be adopted by PEC would greatly reduce the project's GHG emissions. However, detailed assessments and calculations will need to be conducted upon confirmation on the emission reduction strategies to be used for the PEC project.

**Conclusion**

The outcomes of this CCRA shall be the guiding document for the priority in developing mitigation and adaptation strategies for climate related hazards, a detailed CCRA may be developed at a later date following acquisition of any updated data.

Summary of the CCRA Report Findings is shown in the tables below.

**Climate Change Risk Assessment (CCRA) Results (PEC Facilities)**

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | L | C | R | L | C | R |
| Temperature Rise | High temperatures for workforce | May slow down supply chain efficiency<br>May cause an increase in cooling loads, causing possible shutdowns in condensate splitter plant, and power outages<br>Reduced efficiency of electricity-producing turbines and compressors<br>Increased bacterial reactions activity of effluent treatment system | L3 | C2 | | L4 | C1 | |
| Increased precipitation/ rainfall | Flooding of project area/facilities, and or buildings | Flooding may cause unforeseen shutdowns of facilities (steam boilers, cooling systems, pumps, and electrically operated safety-controlled mechanisms) causing a disruption in supply chains<br>The current project area lies within a 5km radius from a flood prone area, Kg. Lepau, and is susceptible to flooding risks during the monsoon seasons<br>However, based on climate model projection data obtained from the CCKP (World Bank), annual rainfall patterns in Malaysia showed little variation in both climate scenarios for the years 2030, 2050 and 2080<br>As such, flooding events due to increased precipitation/rainfall events remain of lower risk | L4 | C3 | | L4 | C2 | |
| Floods (Seasonal) | Flooding of project area/facilities, and or buildings | The current project area lies within a 5km radius from a flood prone area, Kg. Lepau and is susceptible to flooding risks during the monsoon seasons<br>Flooding events in this area has occurred almost on an annual basis since 2014, with the most recent event occurring in January 2022<br>Flooding may cause unforeseen shutdowns of facilities (steam boilers, cooling systems, pumps, and electrically operated safety-controlled mechanisms) causing a disruption in supply chains<br>Flooding may cause damage to the aboveground infrastructure such as mechanical equipment, electrical instruments and sensors installed<br>Increase production loss and disruption of supply chain | L1 | C4 | | L2 | C4 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | L | C | R | L | C | R |
| Sea Level Rise (SLR) | Salinisation of surface water and ground water | May cause corrosion to storage tanks and other equipment<br>Erosion, flooding, and corrosion may occur, causing damage storage tanks and other equipment, causing operational disruptions | L3 | C3 | | L4 | C2 | |
| | Damage to physical infrastructure/buildings | Damages to drainage systems, buildings, control rooms, and operation personnel may occur | L3 | C2 | | L3 | C2 | |

**Climate Change Risk Assessment (CCRA) Results (Associated Facilities)**

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | L | C | R | L | C | R |
| Temperature Rise | High temperatures for workforce | Temperature rise may cause an increase in number of consecutive dry days, thus affecting access to jetties for loading and unloading of feedstock and products, due to changes in water depth<br>Temperature rise may also cause a reduction in workforce efficiency<br>Internal structure of pipelines may be affected by changes in temperature, causing changes in pipeline pressure, which results in pipeline leaks | L4 | C2 | | L4 | C1 | |
| Increased precipitation/ rainfall | Flooding of associated facilities, such as storage tanks and jetties | The current project area lies within a 5km radius from a flood prone area, Kg. Lepau, and is susceptible to flooding risks during the monsoon seasons<br>However, based on climate model projection data obtained from the CCKP (World Bank), annual rainfall patterns in Malaysia showed little variation in both climate scenarios for the years 2030, 2050 and 2080<br>As such, flooding events due to increased precipitation/rainfall events remain relatively low risk | L4 | C3 | | L4 | C2 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | L | C | R | L | C | R |
| Floods (Seasonal) | Flooding of associated facilities such as storage tanks and jetties | The current project area lies within a 5km radius from a flood prone area, Kg. Lepau and is susceptible to flooding risks during the monsoon seasons<br>Flooding events in this area has occurred almost on an annual basis since 2014, with the most recent event occurring in January 2022<br>Flooding may affect access to jetties for loading and unloading of feedstock and products, due to changes in water depth<br>Flooding may cause damage to the aboveground infrastructure such corrosion or damage of jetties, storage tanks and pipelines<br>Erosion of foundations and underground pipe supports (scouring), or trigger landslides or subsidence in the sites, leading to accidents to pipelines<br>Damages to the aboveground infrastructure such as valves, pumping stations, etc. Sensors installed might failed causing several issues and leaks to the pipeline system | L1 | C4 | | L2 | C4 | |
| Sea Level Rise (SLR) | Salinisation of surface water and ground water | Erosion, flooding, and corrosion may occur, causing damage storage tanks jetties and pipelines | L3 | C3 | | L4 | C2 | |
| | Damage to physical infrastructure/buildings | Erosion, flooding, and corrosion may occur, causing damage storage tanks jetties and pipelines<br>Sea level rise may also affect access to jetties, due to changes in water depth, affecting the loading and unloading of feedstocks and products<br>Damages to drainage systems, buildings, control rooms, and operation personnel may occur | L3 | C3 | | L3 | C2 | |
| | Supply chain disruption | Disruption of shipment process - Increased wave pressure may affect shipments of incoming condensate feedstock (a blended low-density mixture of hydrocarbon liquids derived from raw natural gas extracted from oil and gas fields) with a subsequent effect on supply chains<br>Sea level rise may also affect access to jetties, due to changes in water depth, affecting the loading and unloading of feedstocks and products | L3 | C3 | | L3 | C2 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | **L** | **C** | **R** | **L** | **C** | **R** |
| | | Disturbance in operational process - Increased backlog of shipment in the third-party storage warehouse | | | | | | |

# 1 INTRODUCTION

## 1.1 Overview

Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), is a change of climate which is attributed, directly or indirectly, to human activity which results in a change in the global atmosphere. Greenhouse gas emissions due to anthropogenic activities may also aggravate the impacts of climate change, resulting in changes to sea-levels, surface air temperatures, as well as precipitation and rainfall patterns. Therefore, organisations, and decision-makers alike will need to enhance their climate-change preparedness and take steps towards risk reduction in anticipation of climate-related risks.

The Climate Change Risk Assessment (CCRA) will be conducted to identify climate hazards and the probability that the climate hazard will occur, the magnitude of the hazard's impact on the project, and the likelihood of the impact occurring. The CCRA report shall provide decision-makers with the ability to prioritise natural hazards for which appropriate mitigation measures need to be developed.

Impacts on business are divided into two categories: physical and transition risks. Physical risks are risks that come from the physical environment such as flooding and drought. Meanwhile, transition risks come from the potential cost to business with the introduction of policy, laws and regulations set to address climate change.

This document presents the CCRA for the Proposed Pengerang Energy Complex (PEC), Pengerang Industrial Park, Mukim Pengerang, Daerah Kota Tinggi, Johor Darul Takzim. The proposed Pengerang Energy Complex is planned as a world-scale condensate splitter and aromatics complex, on a 250-acre site in the Pengerang Industrial Park (PIP) that is situated within the Pengerang Integrated Petroleum Complex (PIPC). The production capacity of the PEC is about 5.844 Million metric tonnes per annum (MMtpa), or 16.7 kilometric tonnes per day (kMtpd), of aromatic petrochemicals and oil products, which will be processed from 6.324 MMtpa of condensate feedstock.

## 1.2 Objectives

The objectives of the Climate Change Risk Assessment (CCRA) report are to assess baseline climate conditions, identify natural hazards that would likely cause an impact on the PEC project, and assess the priority for decision-makers to develop adaptation strategies for natural hazards likely to occur within the project area, to minimise the Physical and Transition risks associated with climate change.

## 1.3 Report Structure

The report is structured as follows:

Chapter 1: Introduction

Chapter 2: Project Overview

Chapter 3: Methodology

Chapter 4: Baseline and Anticipated Climate Change Conditions

Chapter 5: Risk Assessment and Analysis

Chapter 6: Built-in Adaptation and Mitigation Measures

Chapter 7: Conclusion

Appendix A

## 1.4 Scope of Work

The CCRA is prepared based on credible publicly available climate data and existing project data extracted from the Environmental Impact Assessment (EIA) and the Environmental & Social & Health Impact Assessment (ESHIA) of the PEC project. This CCRA is to be prepared for the purpose of managing any foreseeable risks pertaining to climate change, ensuring that climate-related risks are minimised.

### 1.4.1 Limitation

This CCRA assesses climate-related risks on a high level, due to limitations in project area specific climate data. A detailed version of this CCRA may need to be developed at a later stage, should there be any updated information on project area specific climate data.

## 1.5 Reference Standards

### 1.5.1 Equator Principles

Equator Principles are a set of voluntary guidelines adopted by financial institutions to ensure large scale development or construction projects appropriately consider the associated potential impacts on the environment and the affected communities. The Equator Principles are intended to serve as a common baseline and framework for financial institutions to identify, assess and manage environmental and social risks when financing Projects.

The Equator Principles apply globally and to all industry sectors. The Equator Principles apply to the four financial products described below when supporting a new project:

- **Project Finance Advisory Services** where total Project capital costs are US$10 million or more.
- **Project Finance** with total Project capital costs of US$10 million or more.
- **Project-Related Corporate Loans** (including Export Finance in the form of Buyer Credit) where all four of the following criteria are met:
  - The majority of the loan is related to a single Project over which the client has Effective Operational Control (either direct or indirect).
  - The total aggregate loan amount is at least US$100 million.
  - The EPFI’s individual commitment (before syndication or sell down) is at least US$50 million.
  - The loan tenor is at least two years.
- **Bridge Loans** with a tenor of less than two years that are intended to be refinanced by Project Finance or a Project-Related Corporate Loan that is anticipated to meet the relevant criteria described above.

### 1.5.2 IFC PS

In the context of climate change, the IFC aims to support economic development in countries and plays a substantial role in enhancing the interaction between global climate change initiatives and local development, by promoting sustainable investments. The IFC helps private companies to mitigate climate change risks and advises them on managing associated impacts through quantifying carbon footprints, considering the best available technologies, and recommending tools to offset carbon emissions. It puts efforts to overcome poverty in developing nations, facilitate sustainable growth, and balance between supporting economic development in host countries and addressing climate change. The IFC is a well-developed leader positioned to recognize the importance of the private sector in achieving climate-friendly investments in developing countries.

Compliance with the applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards). Project to determine whether one or more of the IFC PS could be used as guidance to address those evaluated specific risks, in addition to host the country laws.

The IFC Sustainability Framework - as applicable standards under PS 3 on “Resource Efficiency and Pollution Prevention” - Introduces a resource efficiency concept for energy, water, and core material inputs; strengthens focus on energy efficiency and greenhouse gas measurement; reduces greenhouse gas emissions thresholds for reporting to IFC from 100,000 tons $CO_2$ to 25,000 tons of $CO_2$ per year; and requires determination of accountability with regards to historical pollution.

### 1.5.3 Malaysia National Policy and Planning Framework

#### *1.5.3.1 National Physical Plan 3 (2010-2020)*

Malaysia’s National Physical Plan (NPP) provides a long-term strategic framework for national spatial planning and includes measures required to shape the direction and pattern of land use, biodiversity conservation and development in Peninsular Malaysia. It is a set of guidelines for the Federal and State governments to control development and land administration. The Malaysia’s National Physical Plan 3 (NPP3) aimed at providing the best spatial planning policies to ensure continued sustainable development as well as addressing the issues of climate change that may pose a risk to the natural environment and human settlement. The NPP3 highlighted five main natural disasters that need to give priority; flooding, landslides, earthquake and tsunami and sea level rise.

#### *1.5.3.2 National Policy on Climate Change*

Malaysia’s National Policy on Climate Change, approved by the Cabinet in 2009, provides the framework to mobilise and guide Government agencies, industry, communities, as well as other stakeholders in addressing the challenges of climate change in an effective and holistic manner. Its overriding aim is to ensure climate-resilient development to fulfil national aspirations for sustainable development. The objective of the National Policy on Climate Change is to mainstream climate change through wise management of resources and enhanced environmental conservation. This should integrate responses into national policies, plans and programmes, and strengthen institutional and implementation capacity resulting in improved economic competitiveness and quality of life.

Five principles set the national direction in responding to the challenges of climate change. The adverse effects and impacts of climate change are recognised and national responses that consolidate economic, social and environmental development goals are mainstreamed based on the following principles:

i. Development on a sustainable path:

- To integrate climate change responses into national development plans to fulfil the country's aspiration for sustainable development.

ii. Conservation of environment and natural resources:

- To strengthen implementation of climate change actions that contribute to environmental conservation and sustainable use of natural resources.

iii. Coordinated implementation:

- To incorporate climate change considerations into the implementation of development programmes at all levels.

iv. Effective participation:

- To improve participation of stakeholders and major groups for effective implementation of climate change responses.

v. Common but differentiated responsibilities and respective capabilities:

- International involvement on climate change will be based on the principle of common but differentiated responsibilities and respective capabilities.

#### *1.5.3.3 Twelfth Malaysia Plan*

The Twelfth Malaysia Plan (2021-2025) takes these efforts further by having a strategic thrust on Pursuing Green Growth for Sustainability and Resilience. The fundamental shift is towards a development model that views resilient, low-carbon, resource-efficient and socially inclusive development as an investment that will yield future gains. Some of the key climate-related initiatives pursued under the 12$^{th}$ Malaysia plans are as follows:

- Developing a Nationally Determined Contribution Roadmap specifying emissions needed to be reduced from key emitting sectors, as well as conducting feasibility studies on carbon tax, carbon pricing and carbon offsetting schemes
- Increase Renewable Energy (RE) installed capacity from large hydro, solar, biomass and biofuel
- Increase conservation of natural areas and maintain at least 50% of forest cover over the total land area.
- 120 cities and districts are expected to achieve sustainable status by 2025
- Green procurement is targeted to increase to 25% by 2025 (20.7% in 2016 – 2019)

The selected performance indicators for the Twelfth Malaysia Plan are as follows:

- Reduced GHG emissions intensity to GDP of up to 45% by 2030 based on emissions intensity in 2005.
- 31% RE target of total installed capacity by 2025

#### *1.5.3.4 National Green Technology Policy*

The National Green Technology Policy was launched in 2009 to spearhead the development of the green technology sector in the country. The Policy has the following five main objectives:

i. Decreasing growth of energy consumption while enhancing economic development.

ii. Facilitating growth of the green technology industry and enhancing its contribution to the national economy.

iii. Increasing national capabilities and capacity for innovation in green technology development and enhancing Malaysia's green technology competitiveness in the global arena.

iv. Ensuring sustainable development and conserving the environment for future generations.

v. Enhancing public education and awareness of green technology and encouraging its widespread use.

#### *1.5.3.5 National Energy Efficiency Action Plan*

The National Energy Efficiency Action Plan focuses on tackling issues pertaining to energy supply by managing the country's energy demand.

The plan highlights energy efficiency measures for industrial, commercial, and residential sectors, which will lead to reduced energy consumption and economic savings for the consumers and the nation. The target of National Energy Efficiency Action Plan is to save electricity and reduce electricity demand growth. The effective and efficient implementation of the National Energy Efficiency Action Plan supported with sufficient resources will be able to save 52,233 GWh of electricity over the plan period against a business-as-usual (BAU) scenario.

#### *1.5.3.6 National Land Public Transport Master Plan (2012-2030)*

With road transport being a significant greenhouse gaseous (GHG) emitter, much effort has been channelled to mitigate this significant source of GHGs. The National Land Public Transport Master Plan (2012−2030) was launched to enhance planning of public transportation and manage increasing private vehicles. "Low-carbon mobility" to boost public transport usage was also included in the Eleventh Malaysian Plan while the use of compressed natural gas as fuel for taxi and buses, and the promotion of energy-efficient vehicles have been scaled up.

#### *1.5.3.7 National Policy on Biological Diversity (2016-2025)*

The National Policy on Biological Diversity (2016 – 2025) published by the Ministry of Natural Resources and Environment, Malaysia (KETSA) stated that the Malaysian government aims to classify at least 20% of terrestrial areas and inland waters, as well as 10% of coastal and marine areas under a representative system of protected areas and other effective area-based conservation measures by the year 2025 under Target 6 of the policy.

## 1.6 Reference Documents

List below are all the referred documents that will be reviewed and utilised within in this CCRA Report:

- The Equator Principles, July 2020
- IFC's Sustainability Framework
- IFC's Definitions and Metrics for Climate-Related Activities
- IFC's Climate Risk and Financial Institutions- Challenges and Opportunities
- IFC's Performance Standards and Sustainability Policy

- World Bank Group's Strategic Framework-Technical Report: Development and Climate Change
- United Nations Framework Convention on Climate Change
- IPCC Synthesize Report
- National Policy on Climate Change of Malaysia 2010

# 2 PROJECT OVERVIEW

## 2.1 Project Location

The proposed PEC project is located in the Mukim of Pengerang, District of Kota Tinggi, State of Johor, within Small Planning Block (*Blok Perancangan Kecil, BPK*) 1.1 that has an area coverage of 34,283.4 acres and is located under Planning Block BP 1 which covers 125,601.2 acres or 9.7% of Kota Tinggi District. The Project is approximately 250 acres in size, out of which one third will be left vacant for future expansion. As shown in Figure 2.*1*, the Project is located in the vicinity of settlement areas and industrial sites within Pengerang Integrated Petroleum Complex (PIPC) that was allocated by Johor State Government's to develop the south-east Johor area into an industrial area for both heavy and light industries.

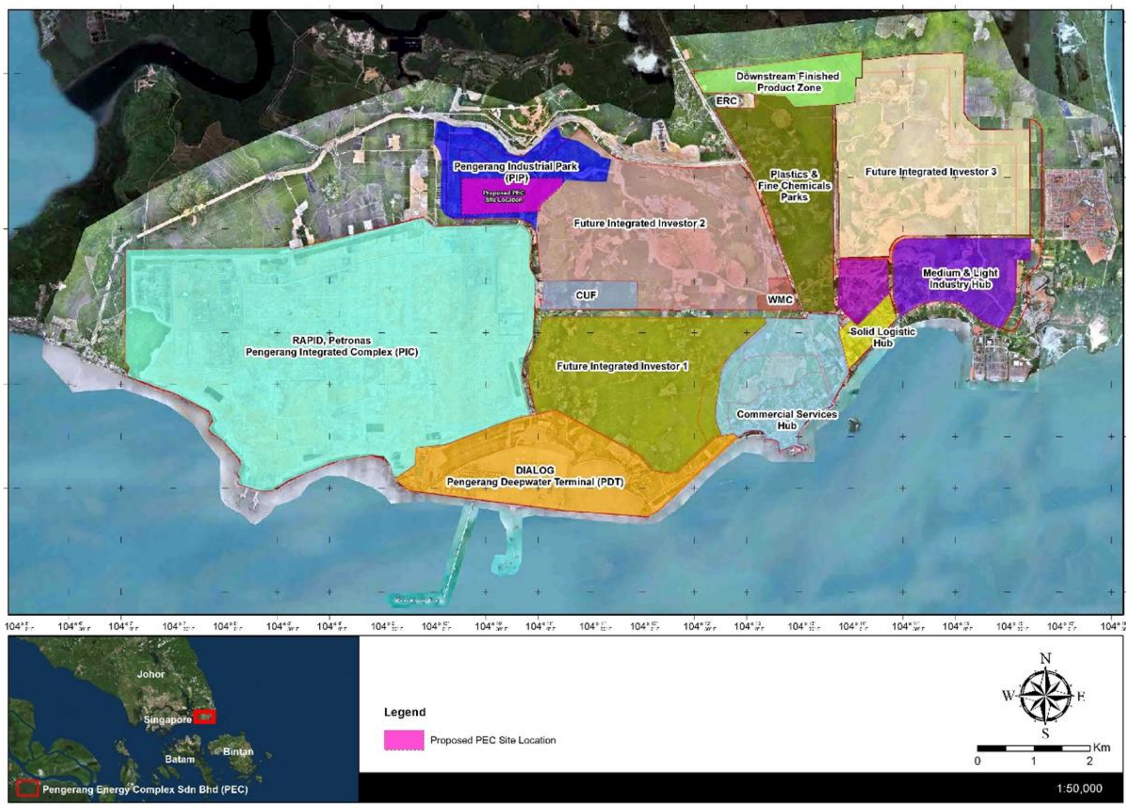


**Figure *2*.1: Proposed PEC Site Location within the Pengerang Masterplan**
*Source: JPDC*

The proposed project is located within the industrial plot of Pengerang Industrial Park (PIP) in the larger PIPC. The PIPC phase 1 comprises the on 6,77 acre, Pengerang Integrated Complex (PIC) or also known as Petronas RAPID project and DIALOG Pengerang Deepwater Terminal (PDT). The PIC is located approximately 270 m (south) from proposed PEC project. Meanwhile, PDT is located at the coastal line, 4.3 km (south) from the proposed project. There are other industries and trades located within 4 km from the proposed PEC project as shown in *Table 2.1* below.

**Table 2.1: Identified Industries Surrounding the Proposed PEC**

| Industries | Distance from Proposed Site | Status in 2019 |
|---|---|---|
| Peri Formwork Malaysia Sdn Bhd | ± 100 m (N) | Closed |

| Industries | Distance from Proposed Site | Status in 2019 |
|---|---|---|
| Inactive Chicken Farms | ± 120 m (S) | Closed |
| Rapid, Petronas | ± 270 m (S) | Operational |
| Axianergy | ± 400 m (N) | Operational |
| Active Chicken Farms | ± 750 m (NE) | Operational |
| TLH Hardware & Machinery Sdn Bhd | ± 800 m (W) | Operational |
| SISSPA 1 | ± 1000 m (E) | Operational |
| Pengerang Substation | ± 1200 m (NW) | Operational |
| Celcon Sollutions Sdn Bhd | ± 1600 m (E) | Operational |
| Quarry | ± 1700 m (E) | Operational |
| Industry in front of Bukit Pelali Housing | ± 3000 m (NE) | Operational |
| Ace Sepakat | ± 3000 m (SE) | Operational |
| Industry/ Trade near Kg Bukit Buluh | ± 3000 m (SE) | Operational |
| PMU Teluk Ramunia | ± 3800 m (E) | Operational |
| Industry/ Trade near Kg Bukit Raja | ± 4000 m (SE) | Operational |

There are no large population centres near (< 5 km) to the PEC other than workers housing at the PIC. The nearest residential settlements/ occupied premises, comprise several small villages (Kg. Lepau being the closest), two resorts, one with residential units under development, and an ongoing residential/ commercial development. *Table 2.2* shows the list of settlements within a 5 km radius from the proposed PEC site. Figure 2.*2* shows the location of the residentials and industries located within 5 km from the proposed project.

**Table 2.2: Identified Settlements Surrounding the Proposed PEC**

| Settlement | Distance from Proposed Site | Status in 2019 |
|---|---|---|
| Sebana Mixed Development | ± 1,200 m (N) | Populated |
| Kg. Lepau | ± 2,000 m (W) | Populated |
| Bukit Pelali Housing | ± 2,500 m (NE) | Populated |
| Kg. Bukit Gelugor | ± 3,300 m (NE) | Populated |
| Lakeview Terrace Resort | ± 3,500 m (E) | Populated |
| Kg. Bukit Buluh | ± 3,500 m (SE) | Populated |
| Kg. Sg Buntu | ± 4,700 m (SE) | Populated |
| Kg. Bukit Raja | ± 4,800 m (S) | Populated |

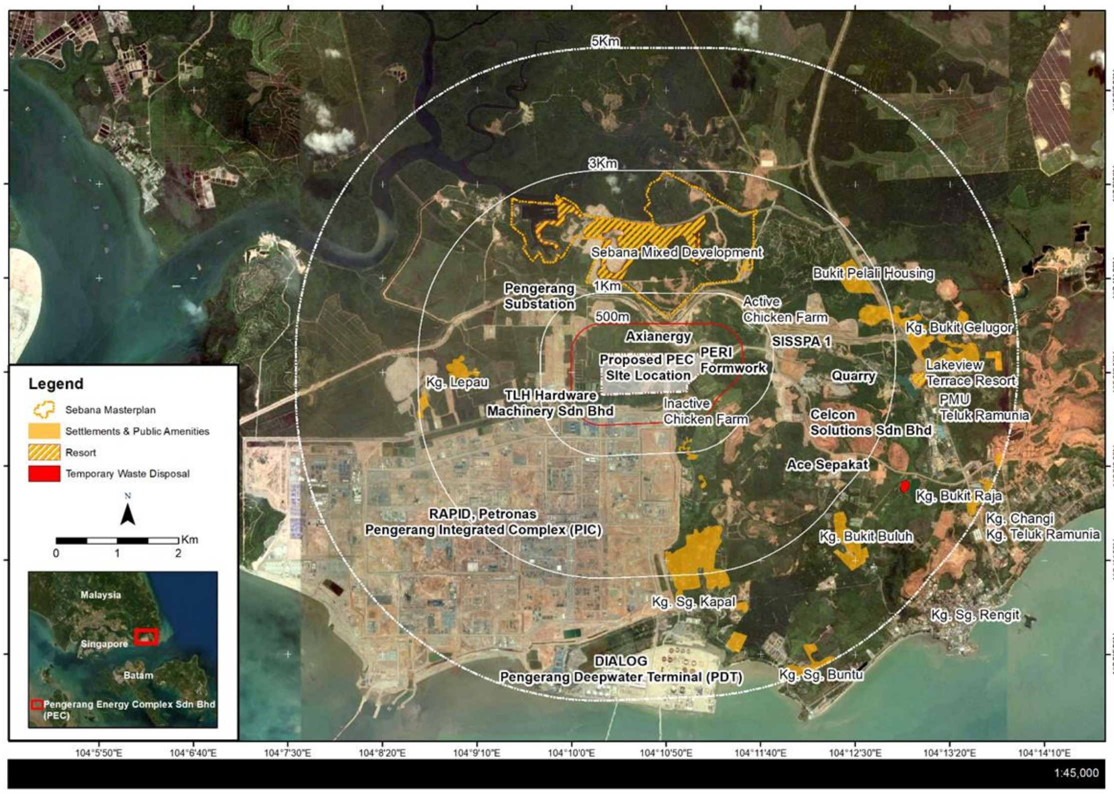


**Figure *2.2*: Residentials and Industries within 5 km from Proposed PEC Project**

## 2.2 Topography

The PEC site is situated in a generally low-lying area although the site is hilly and undulating. To the east of the temporary RAPID Access Road the site topography varies less from 10 to 40m amsl though the 30m difference is still comparable to a 10-storey building. The elevation on the small eastern part of the site varies considerably more perhaps as much as 80 m from 10 – 90 m amsl. Note however these contours in Figure 2.*3* dated from 2011 and may have been modified for previous plantation activities and changed due to the construction activities associated with the temporary RAPID Access Road.

For the use of topography analysis, the project location can be divided into 2 areas, which are west side and east side of the unnamed road (that cuts through the Proposed Project site). Based on the Digital Elevation Model (DEM) from ASTGTM2_N01E104 which uses data from 2011, the elevation in the west side of the road ranges from 10 – 40 m amsl, while the east side of the road ranges from 10 – 90 m amsl.

The topography will change when JCorp develops the land for PIP. The site will be prepared as a pre-prepared platform with levels ranging from 10 to 14 m amsl.

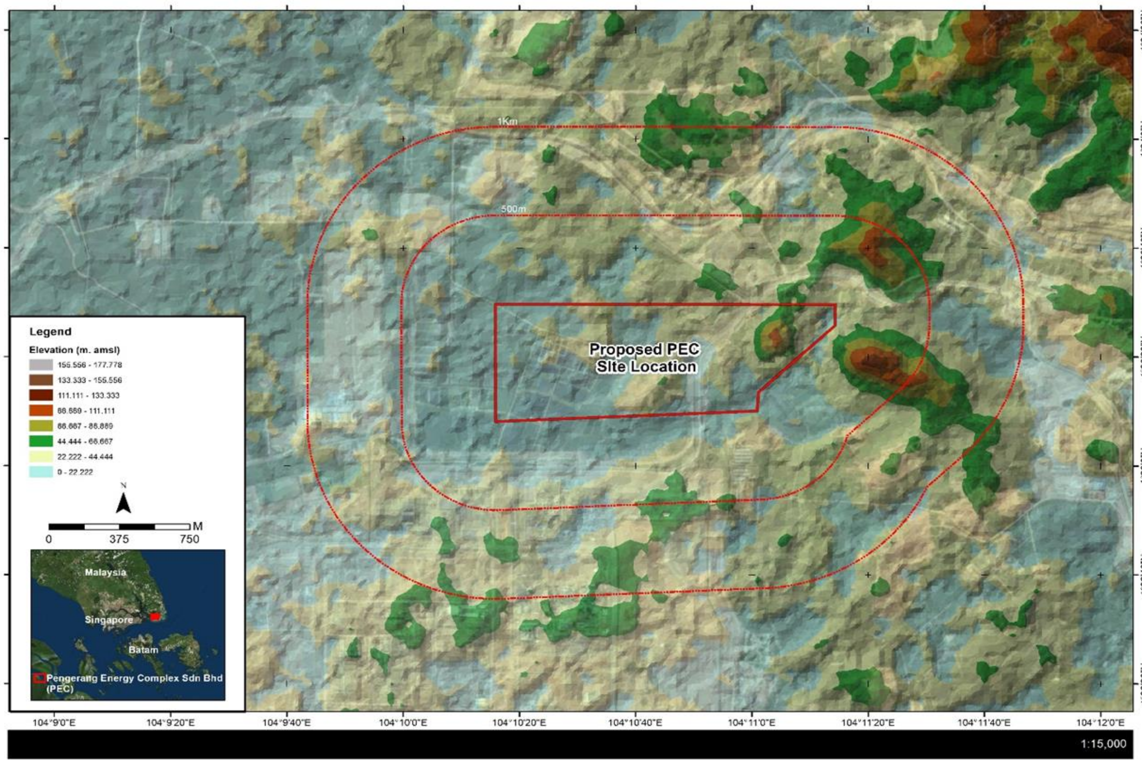


**Figure 2.3: Topography within 1 km Radius from Proposed PEC Site**

## 2.3 Hydrology

Based on remote sensing data sourced from the DEIA report for RAPID, the closest river to the proposed project site is Sungai Lepau, located at the southern boundary of the site and flows in the Northeast direction into Sungai Santi (Figure *2.4*). Sg. Lepau is a tributary of Sg. Santi, which ultimately flows into the Straits of Singapore, to the south. Other tributaries in Sg Santi include Sungai Sebina, Sungai Pelantar, and Sungai Jelutong.

The site is located with the Sg. Lepau sub-catchment, which is approximately 12 km$^2$ in size. Sg Lepau is part of the Sg. Santi river basin, which comprise a total area of 137 km$^2$, and flows to the southern boundary of the site and exits west and northwest and flows northwest before draining to mangroves and Sg Santi near its estuary and on to the Singapore Strait. Sg. Santi and Sg. Lepau are influenced by tidal effects.

Kampung Lepau is the nearest residential area, situated approximately 3 km northwest of the site. Based on site observations, locals in Kg. Lepau do not use the river water as a source of potable water as the village is provided with city water supply. According to locals, there are several aquaculture farms along Sg. Santi. According to research studied on the conservation of Sungai Santi, the river is covered by mangrove forests along the riverbank of Sungai Santi and Sungai Sebana. The same has been reported in the RAPID DEIA report however, the extent of degradation of the mangrove forest has not been assessed past the RAPID and Sebana Mixed Development projects.

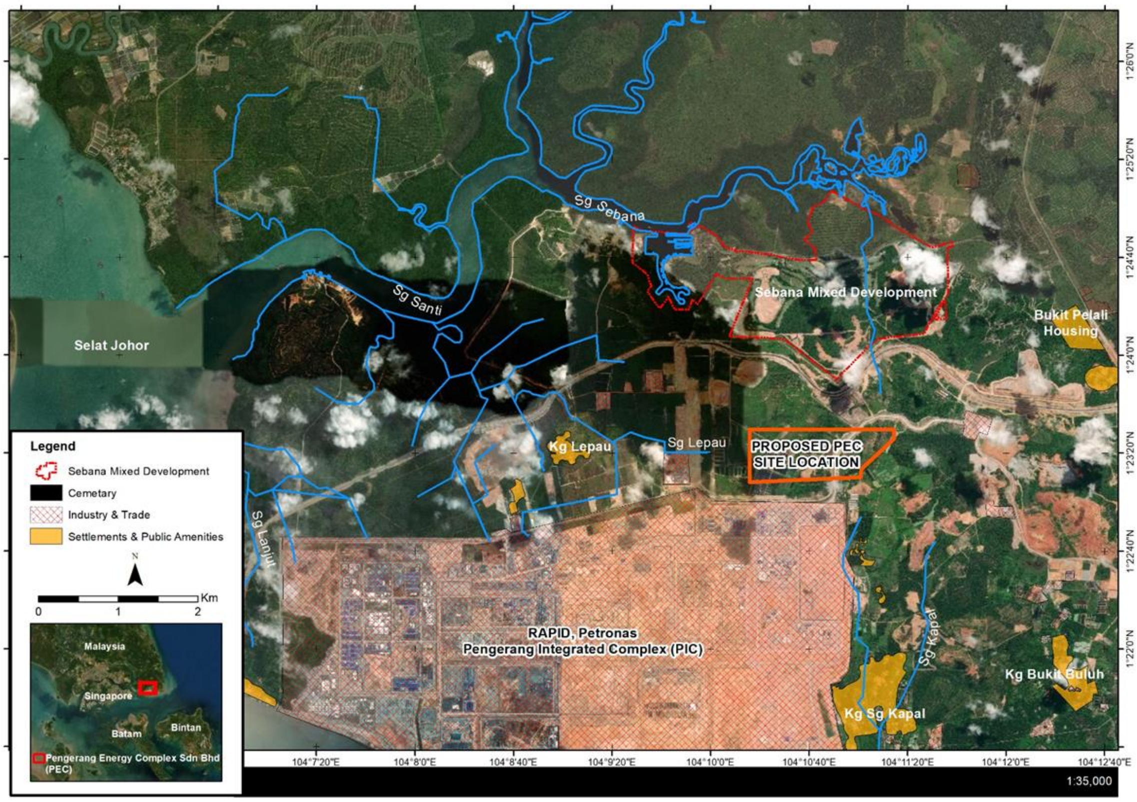


**Figure 2.4: Tributaries in Surrounding PEC Site**

# 3 METHODOLOGY

## 3.1 Introduction

Investments in the oil, gas, and mining sectors are vulnerable to numerous climate impacts, ranging from more intense and frequent extreme weather events to gradual permafrost melt. These impacts pose a risk to companies' and could result in significant losses for businesses if they are not incorporated into risk management plans, asset design and construction, and management-level decision making.

As such, the objectives of this section are to consider climate-related hazards, and how these hazards may impact the proposed PEC project, as well as to analyse how these impacts could change in the future because of climate change, to improve the identification of opportunities and threats and effectively allocate and use resources for climate change related risk treatment.

## 3.2 Climate Change Risk Assessment (CCRA) Methodology

The proposed Climate Change Risk Assessment (CCRA) methodology aids in assessing climate-related risks and priority for developing mitigation strategies for addressing climate-related risks based on the likelihood and consequences of the identified risk on the PEC and its associated facilities. The steps in conducting the CCRA is summarised below:

- Step 1: Evaluation of historic data to identify existing natural hazards and the magnitude of these identified natural hazards, whereby the potential impact of each natural hazard is evaluated based on its potential impact on built and natural environments, considering the intensity, magnitude and or frequency of the hazard
- Step 2: Evaluation of climate change model projections to assess the extent of change of climatic variables, that may have an impact on operations in the future
- Step 3: Evaluation and identification of the risk to the PEC project and its associated facilities for each identified climate hazard
- Step 4: Identify alternatives and mitigation measures to mitigate the risk
- Step 5: Implement options and monitor and evaluate the effectiveness. Adjust based on new data.

This CCRA report shall cover steps 1 through to step 4 and shall serve as a guide for decision-makers for decision-makers to develop adaptation strategies for natural hazards likely to occur within the project area, to minimise the Physical and Transition risks associated with climate change.

### 3.2.1 Climate Change Risk Assessment Matrix

The Climate Change Risk Assessment Matrix is adopted from the New York City Panel on Climate Change, the **magnitude** of the hazard's impact on the proposed project and **likelihood** of the impact occurring, before assigning a priority rating for action in developing climate adaptation strategies. The two-dimensional hazard ranking risk matrix that will be used for the purpose of this report is shown in Figure *3.1* below.

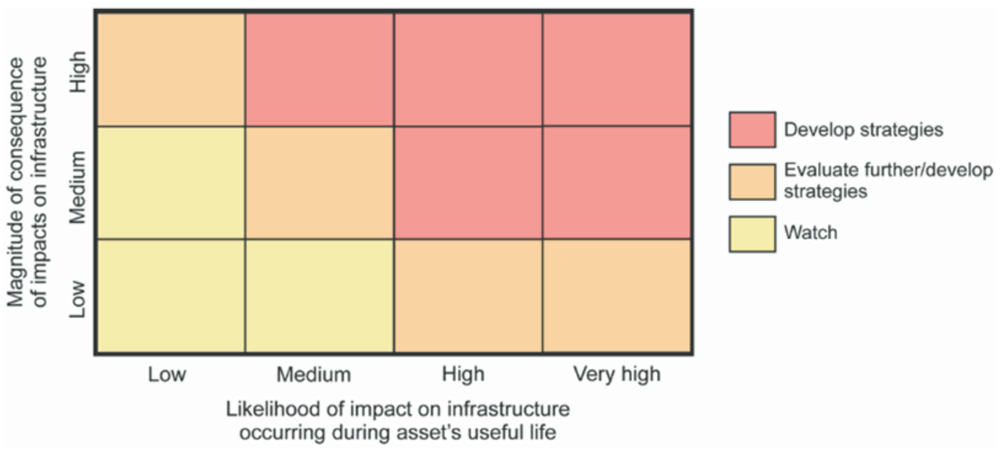


**Figure 3.1: Two-dimensional Risk Matrix**

#### *3.2.1.1 Consequence of impact*

The consequence of a natural hazard's impact on the PEC project and its associated facilities is assessed based on consequences that fall within six (6) categories, namely internal operations, capital and operating costs, number of people affected, public health and worker safety, economy, and the environment.

- Internal operations, including the scope and duration of service interruptions, reputational risk and the potential to encounter regulatory problems.
- Capital and operating costs, including all capital and operating costs to the project proponent and revenue implications caused by the climate change impact
- Number of people impacted, including considerations relating to vulnerable populations
- Public health, including worker safety
- Economy, including any impacts to the city's economy, the price of services to customers and clean-up costs incurred by the public
- Environment, including the release of toxic materials and impacts on biodiversity, the city's ecosystem, and historic sites

Table *3.1* shows the categories for assessing the consequences of a natural hazard's impact on the proposed project.

**Table 3.1: Consequence of Risk table**

| Consequence | Efficiency of Operations | Maintenance Requirements | Safety |
|---|---|---|---|
| Extreme (C5) | Significant losses in terms of operations efficiency | There is significant increase in maintenance requirements. Damage to infrastructure due to adverse weather events exceed capacity to conduct repairs. | Fatality occurs due to adverse weather conditions |
| Major (C4) | There are major losses in terms of operations efficiency | There is significant increase in maintenance requirements. Major damage to critical infrastructure due | Multiple major injuries or permanent disabilities |

| Consequence | Efficiency of Operations | Maintenance Requirements | Safety |
|---|---|---|---|
| | | to adverse weather events at least once over the next 50 years | due to adverse weather conditions |
| Moderate (C3) | Moderate losses in terms of operations efficiency | There is an increase in maintenance requirements. Major damage to non-critical infrastructure or minor damage to critical infrastructure due to adverse weather events over the next 50 years. | Single major injuries or several minor injuries due to adverse weather conditions |
| Minor (C2) | Minor damages in terms of operations efficiency | There is no change in maintenance requirements. Minor damage to infrastructure due to adverse weather events over next 50 years. | Minor injury due to adverse weather conditions |
| Negligible (C1) | Negligible damage or losses in terms of operations efficiency | There is a reduction in maintenance requirements. Negligible damage to infrastructure due to adverse weather events during life of asset. | Minimal risk of injury to personnel |

#### *3.2.1.2 Likelihood of the impact occurring*

'Likelihood' ratings shall be assigned based on consideration of the historical occurrence, as well as the level of confidence associated with the climate change projections, for the key hazards.

The likelihood of impact occurrence refers to the likelihood that a given climate variable will result in impacts to the proposed project, should climate change impacts occur. The likelihood of impact occurrence is defined by the Task Force into the following categories, as shown in *Table 3.2* below.

**Table 3.2: Likelihood of Risk Table**

| Likelihood | Description | Recurrent or Event Risks |
|---|---|---|
| Almost Certain (L1) | Expected to occur in most circumstances | Could occur several times a year |
| Likely (L2) | Will probably occur in most circumstances | May occur once every year |
| Possible (L3) | May occur at some time | May arise once in 5 years |
| Unlikely (L4) | May occur at some time, but considered unlikely | May arise once in 5 to 50 years |
| Rare (L5) | Could occur in exceptional circumstances | Unlikely during the next 50 years |

#### *3.2.1.3* Probability of Climate Hazards

The probability of climate hazards is defined as the general probability for change in a climate hazard, such as temperatures or extreme precipitation events occurring over the course of the project. The probability of climate hazard occurrence is assigned based on assessment of baseline climate data, and climate model projections obtained from the World Bank, which will be segregated into the following categories:

- **High**: High probability of the climate hazard occurring
- **Medium**: Medium probability of the climate hazard occurring
- **Low**: Low probability of the climate hazard occurring

#### *3.2.1.4* Risk Assessment Matrix for Hazard Rating

Each risk event shall be assigned an overall level of risk determined as a function of the probability (or likelihood) of the event occurring and the consequence if the event occurred, as shown in the Table below.

**Table 3.3: Risk Assessment Matrix**

| Likelihood | Consequence | | | | |
|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 |
| L1 | Low | Moderate | High | Extreme | Extreme |
| L2 | Low | Moderate | Moderate | High | Extreme |
| L3 | Low | Low | Moderate | High | Extreme |
| L4 | Low | Low | Moderate | Moderate | High |
| L5 | Low | Low | Low | Moderate | Moderate |

| Risk Rating | Description |
|---|---|
| Extreme | Present-day or imminent risks for which adaptation strategies should be evaluated and developed as necessary |
| High | Risks for which adaptation strategies may need to be developed in the near future or which further information is needed |
| Moderate | Risks for which impacts should be monitored but may not need action at this time |
| Low | Risks predicted to occur after the climate planning time horizon; may be re-evaluated in the future |

# 4 BASELINE AND ANTICIPATED CLIMATE CHANGE CONDITIONS

## 4.1 Introduction

This chapter details the current climatic condition of PEC project site and the anticipated impact of global warming throughout the project lifecycle of PEC. The baseline climatic condition of PEC project site will be established based on the information as provided in PEC EISHA as well as other related information that are publicly available.

For the assessment of the anticipated climate change scenarios, the assessment will be conducted based on publicly available data and information.

### 4.1.1 Climate Change in Malaysia

The 2020 Status Report on Disaster Risk Reduction in Malaysia, published by the UN Office for Disaster Risk Reduction highlighted that Malaysia, despite being relatively sheltered from natural hazards originating from tectonic movements (such as volcanic eruptions and earthquakes), faces threats arising primarily from natural hazards such as cyclones, floods, landslides, droughts, epidemics, and environmental degradation due to natural and anthropogenic stressors. The report also highlighted that these natural hazards may increase in intensity under the effects of climate change.

The World Bank's Climate Change Knowledge Portal[1] summarised the key natural disasters that occur in Malaysia, shown in Figure *4.1* below.

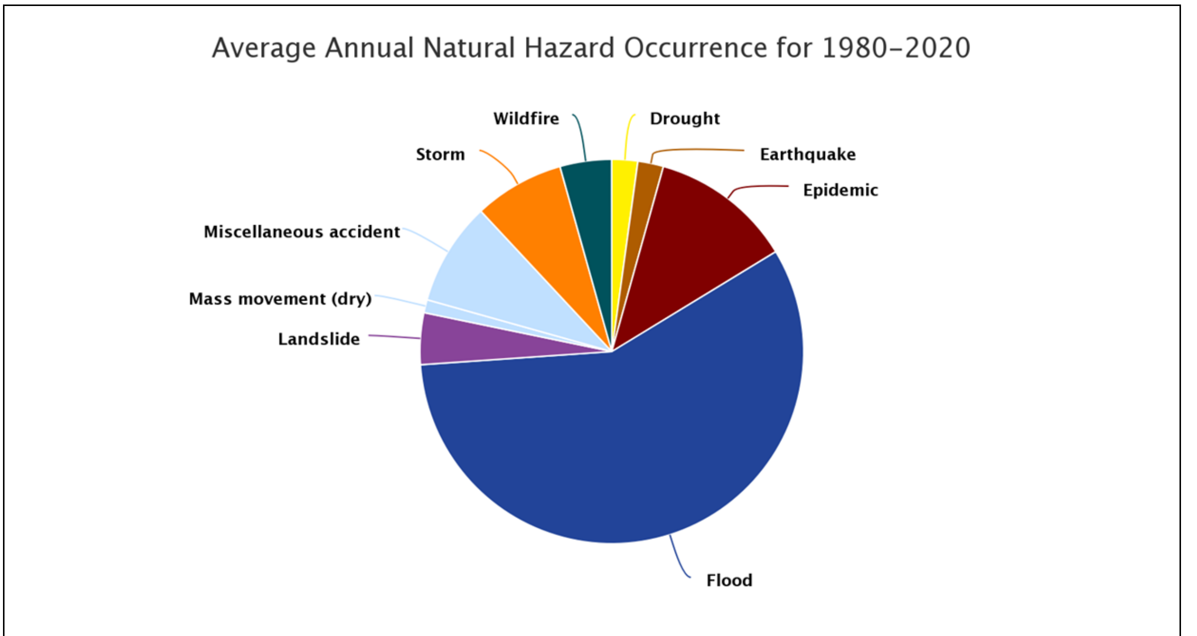


**Figure 4.1: Summary of Natural Hazards in Malaysia (1980 – 2020)**
*Source: World Bank*

[1] Bank *Climate Change Knowledge Portal - Malaysia Climate Change Vulnerability.* [Online] Available at: https://climateknowledgeportal.worldbank.org/country/malaysia/vulnerability [Accessed 28 April 2022].

As shown in Figure *4.1*, throughout the years 1980 – 2020, flooding events make up most natural hazards occurring in Malaysia (57.61%), followed by health-related epidemics (11.96%), storm events (7.61%) and landslides (4.31%).

This is consistent with findings of commonly occurring natural hazards within the state of Johor, where the project site is located. The proposed project area, located in the district of Kota Tinggi, Johor is a flood prone area. In January this year (2022), The News Straits Times[2] reported that a total of 2,022 victims were evacuated to 37 relief centres across the state of Johor, where majority of the victims were from the district of Kota Tinggi. Within the same day, The Star[3] also reported a severe landslide incident occurring in Pengerang, Kota Tinggi, due to increased rainfall associated with the Monsoon season.

Based on these findings, the commonly occurring natural hazards within the project area such as flooding, landslides, and severe storm events seem to be associated with intense rainfall patterns during the Monsoon season.

As such, Malaysia is currently in the process of developing a flood disaster risk assessment based on climate change forecasts, to enhance the country's preparedness for climate change induced flooding events. The risk assessment shall be carried out through the mapping of flood prone areas under the Department of Irrigation and Drainage (DID), covering 36 major river basins. The DID is also implementing a Flood Warning and Prediction Programme aimed at delivering early warnings to agencies related to disaster management and the general public, issuing early warnings to local communities' days ahead, for locations forecasted to be hit by floods.

Taking this into consideration, this Climate Change Risk Assessment (CCRA) shall assess how climate change would impact the severity of these commonly occurring natural hazards within the project area.

## 4.2 Baseline Climate Conditions

### 4.2.1 Rainfall and Wind Condition

The climate in Pengerang is typical of tropical equatorial climate with abundant rainfall, high and uniform temperatures, and high humidity all year round.

Meteorological data from 2015 to 2017 was sourced from the Malaysian Meteorological Department. The nearest meteorology monitoring station is the Felda Sg. Mas (Station No. 47125). This station is located approximately 26 km from the proposed project site and is the closest station compared to Senai Meteorological Station, which is located approximately 63 km from the proposed project site. The coordinates to the Felda Sungai Mas meteorology monitoring station is 01$^{o}$ 37' N, 104$^{o}$ 09' E. The station monitors parameters such as Temperature, Humidity, Wind and Rainfall as discussed below and summarized as follows:

---

[2] Hammim, R., 2022. *Flood hits Kota Tinggi, two relief centres activated.* [Online] Available at: https://www.nst.com.my/news/nation/2022/01/759744/flood-hits-kota-tinggi-two-relief-centres-activated-nsttv [Accessed 28 April 2022].

[3] Nordin, R., 2022. *Floods: Landslide occurs in Pengerang, no injuries occurred.* [Online] Available at: https://www.thestar.com.my/news/nation/2022/01/02/floods-landslide-occurs-in-pengerang-no-injuries-occurred [Accessed 28 April 2022].

- The average annual temperature in the area was recorded at 26.7°C with little seasonal variation.
- Rainfall trends for the area show an irregular distribution. High with rainfall was recorded during the months of November, December, February, May and August. There is no dry season however the average annual rainfall was recorded to be 59.3 mm.
- The monthly mean relative humidity ranged from 81.3% to 86.6%, with an average of 84%. The highest mean relative humidity was in November and the lowest in March.

Wind was predominantly from northeast and south directions consistent with Malaysia's monsoons *(Figure 4.2).* Wind speeds typically range from 0.3 to 3.3 m/s. Maximum wind speed was recorded at 3.4 to 5.4 m/s.

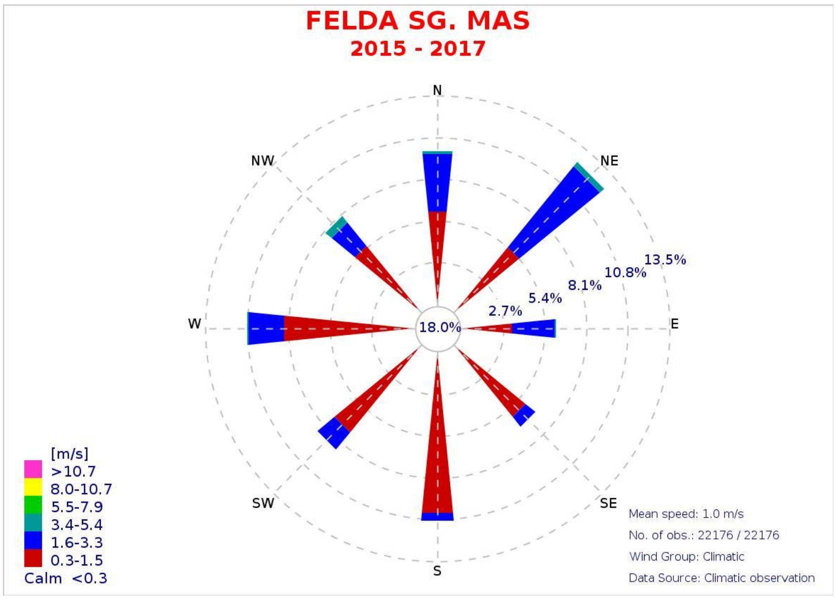


**Figure 4.2: Windrose from Felda Sg. Mas Station**

### 4.2.2 Flood

Based on flood data provided by Department of Drainage (DID), the area most prone to flooding incidents within vicinity to the project area is Kg. Lepau, which is located within 5 km radius from the project area. There were records of flood cases in Kg. Lepau in the year of 2014, 2015, 2016, and 2017, as highlighted in the table below.


Figure 4.3: Location of Kampung Lepau

**Table 4.1: Flooding Cases in Kg. Lepau**

| Date | Duration of flood (day) | Area ($km^2$) | Depth of Floodwater (m) | No. of People Displaced |
|---|---|---|---|---|
| 26/12/2014 | 1 | 2.5 | 0.3 | 143 |
| 13/12/2015 | 1 | 0.3 | 1 | - |
| 3/1/2016 | 1 | 0.3 | 0.5 | 6 |
| 24/1/2017 | 2 | 1.5 | 1.0 | 5 |

*Source: DID, 2018.*

The flood in Kg. Lepau usually occurs between the month of December and January, during the monsoon season. This is due increased rainfall intensity within the area, coupled by the tidal conditions in Sungai Lepau, and the poor drainage infrastructure of the river. Additionally, Kg. Lepau is also located in the lowland area which makes it more prone to flooding events.

The Department of Irrigation and Drainage (DID) has also reported that tidal gates near Kg. Lepau have not be functioning, causing the access road to Kg. Lepau and the oil palm plantation to be flooded. During site visits conducted in July 2018, plans to widen the river along Sg. Lepau was underway, to reduce the occurrence of flooding events within the area.

### 4.2.3 Occurrence of Tropical Typhoons

There were several recoded cases of typhoon that occurred in Malaysia since 2001. For most of these cases, the impacts from the typhoon were merely residual as the full brunt of the impacts were felt in the neighbouring countries such as Vietnam and Thailand.

The summary of each recoded cases of Typhoon in Malaysia is shown below.

**Table 4.2: Typhoon Cases in Malaysia**

| Name | Year | Magnitude | | Affected Areas in Malaysia | Description |
|---|---|---|---|---|---|
| | | 10-Minutes Sustained | 1-Minutes Sustained | | |
| Typhoon Vamei | 2001 | 85 km/h | 120 km/h | Johor and Pahang | Typhoon Vamei made landfall in Desaru, which is approximately 20 km from the project site, merely 12 hours after it was initially formed in the South China Sea.<br><br>The typhoon severely affected the state of Johor and Pahang causing the displacement of over 13,000 people from both states due to flood and landslides. The damage due to the flooding cause by the typhoon was estimated at RM 13.7 million in which 40% of it were due to the destruction of crops in Kota Tinggi district of Johor. |
| Typhoon Utor | 2013 | 195 km/h | 240 km/h | West Coast of Peninsular Malaysia and Sabah | Typhoon Uton severely impacted Hog Kong and China. However, the residual impact of the typhoon was felt in Malaysia causing increased rainfall in Sabah and increased drier weather in West Peninsular Malaysia |
| Typhoon Doksuri | 2017 | 150 km/h | 175 km/h | Penang | Typhoon Doksuri caused the increased in rainfall in Penang with recorded rainfall of 100 mm to 270 mm in just four hours. |
| Typhoon Mangkut | 2018 | 205 km/h | 285 km/h | Sabah | Typhoon Mangkut severely impacted Guam, Philippine and south of China. The tail winds from the typhoon also affected the parts Peninsular Malaysia as well as the state Sabah. |
| Typhoon Lekima | 2019 | 195 km/h | 240 km/h | Kedah, Penang and Perlis | Typhoon Lekima severely impacted the Philippines and China. However, the tail front of the typhoon stretched out to the northern part of Peninsular Malaysia causing severe structural damage specifically in the state of Penang, Perlis and Kedah amounted to RM 20 million as well as one fatality. |

### 4.2.4 El Nino-Southern Oscillation (ENSO)

The current status of ENSO of Malaysia is based on the latest information available on MET Malaysia. This information was last updated on the 21st July of 2020. The summary of the ENSO status is as follows:

- The ENSO neutral condition is currently in progress and is expected to continue until August 2020 with the probability of 60%;
- The probability of the formation La Nina to occur in September is approximately 50 – 55%;
- Oceanic Nino Index (ONI) for April – June 2020 is 0.0°C and the latest weekly sea surface temperature anomaly in the El Nino (Nino 3.4) monitoring area is -0.2°C;
- The Southwest Monsoon phase has started on May 18, 2020 and is expected to continue until September 2020. During this period, the wind will be blowing generally from west/southwest and Malaysia is expected to experience wet weather condition for the next few days with the exception of the east coast as well as the interior of the peninsular Malaysia and Sabah; and
- The maximum daily temperature recorded at most meteorological stations for the period of 14 - 20 July 2020 is between 29 – 35°C.

## 4.3 Anticipated Climate Change Conditions

Climate change possesses significant and potentially irreversible impact globally. In response to the imminent threat of global warming, 195 nations across the globe have adopted the Paris Agreement in December 2015. The main objective for the of the agreement is to limit the global temperature rise to 1.5 °C. As such, the Intergovernmental Panel on Climate Change (IPCC) has established a Special Report (SR 1.5) on the impacts of global warming of 1.5 °C above pre-industrial levels to fully assess the potential impact of global warming of 1.5 °C and the pathway by which global temperature rise could be limited to 1.5 °C as well as to the assess the strategy to further strengthen the global response to the threat of climate change, sustainable development and efforts to eradicate poverty. In alignment with the 2017 Guidance issued by the G20 Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD), two scenarios shall be considered for the purpose of the scenario analysis in this CCRA.

### 4.3.1 Anticipated Climate Change Variables

#### *4.3.1.1 Sea Level Rise*

A study by Rashidi et. Al (2021) assessed the current and potential impacts of sea level rise in coastal areas in Malaysia using data obtained from the National Coastal Erosion study (2015) published by the Department of Drainage and Irrigation, which showed that 1348 km from a total of 8840 km or 15% of Malaysia's shoreline is currently facing erosion problems under three categories, namely, critical, significant, and acceptable level of erosions.

Johor's coastline of 813.6 km was found to have 64.7 km of total eroded coastline, with 38.1km of the eroded coastline falling under the critical and significant erosion category.

The National Water Research Institute of Malaysia (NAHRIM) published a study in 2017 on the projection of sea-level rise in Malaysia for RCP 8.5 in the year 2100, whereby the projected maximum SLR value for the east coast of Johor was projected between 0.67-0.71m/year. This finding is consistent with the IPCC's global projections for sea-level rise (2018), whereby the global mean sea level rise in 2100 is projected to be between 0.26 to 0.77 m by 2100 for 1.5°C of global warming.

Based on the information above, it can be assumed that PEC may be affected by sea level rise. This is mainly due to PEC project site, as well as the location of storage facilities and terminals, being situated in the coastal area, approximately 5 km to the north of the shoreline of Pengerang, along the Johor coast. Additionally, the results obtained from the study also suggests that the state of Johor, in which the proposed PEC location is to be installed, is categorised as one of the states that has a higher proportion of critical and significant erosion events, further illustrating the possible impacts of sea-level rise within the area.

A study conducted by Mohd. et. Al. in 2017 modelled the impact of sea level rise in the state of Johor, focusing on the Batu Pahat area. Due to the lack of data availability for modelled sea level rise impact data for the proposed project area, data obtained from the Batu Pahat study shall be used as a guide in assessing the likely impacts within the project area. Detailed assessments focused on the project site is recommended for future studies.

The primary inputs of the model include tidal data, current and water level data, wind data as well as bathymetry - obtained primarily through hydrodynamic models, as well as Acoustic Wave and Current Profiler (AWAC) instruments.

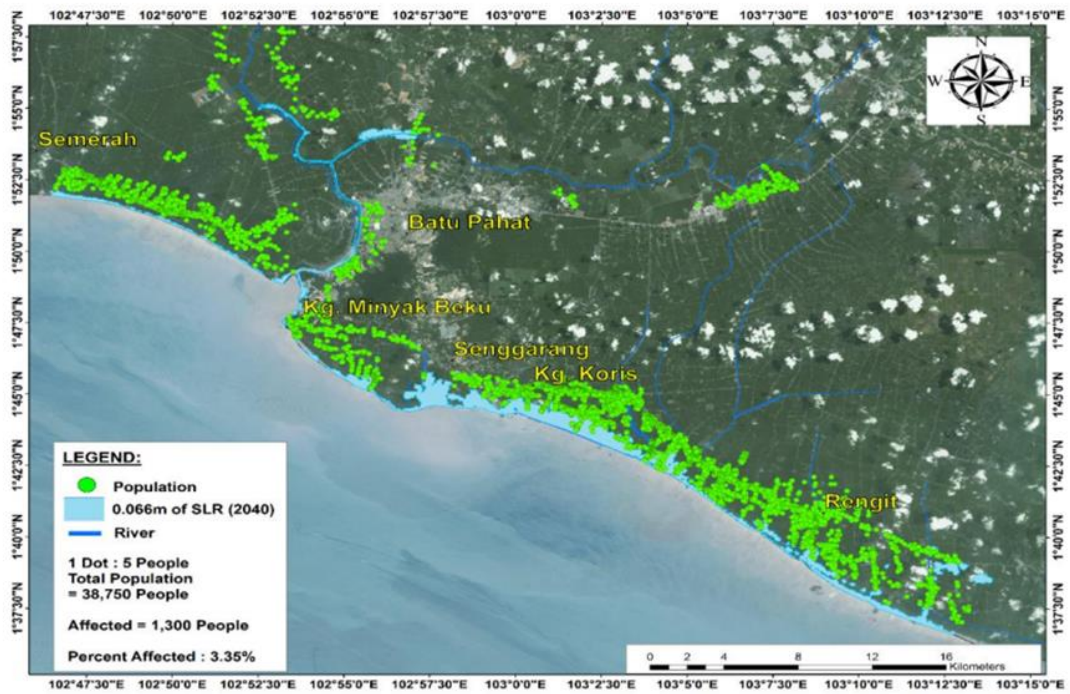


**Figure 4.4: Projected impact of sea-level rise of 0.66M in the year 2040.**

The result from the MIKE 21 model illustrates the SLR projection in the year 2040, and areas that will be inundated or affected by the sea-level rise of 0.66M by the year 2040. As such, the proposed project area is likely to be affected by sea-level rise and necessary prevention measures must be taken into consideration for the purpose of this report.

### 4.3.2 Increase in Surface Air Temperature

Based in IPCC SR 1.5, a global warming of 1.5 °C – 2 °C will result in a significant difference in the projected temperature means and extremes of all regions globally. This will potentially lead to more frequent and intense hot extremes and less cold and frequent cold extremes in all regions.

Temperature increases of extreme hot days in mid-latitudes are predicted to be twice the increase of the Global Mean surface Temperature (GMST). The highest increment of temperature for extreme hot days will most likely to occur in the central and eastern North America, central and southern Europe, the Mediterranean, western and central Asia, and southern Africa. This is due to the soil condition of the region possessing strong soil-moisture-temperature qualities which will reduce the evaporative cooling capability of the region when exposed to prolong dryness.

Furthermore, global warming of 1.5 °C – 2 °C will also lead to increased number of hot days (NDS). The areas in the tropics is expected to be severely impacted by this event due to the low interannual temperature variability in the region. This will consequently lead to extreme heatwaves to emerge in the region much earlier than the rest of the regions.

According to the Malaysia's Third Biennial Update Report to the UNFCCC, the surface air temperature in Peninsular Malaysia has been showing an increasing trend within recent years. The surface mean temperature increased by 0.13°C to 0.24°C per decade, whilst the surface maximum temperature increased by 0.17°C to 0.23°C per decade, as illustrated in *Figure 4.5*, extracted from the Third Biennial Update Report.

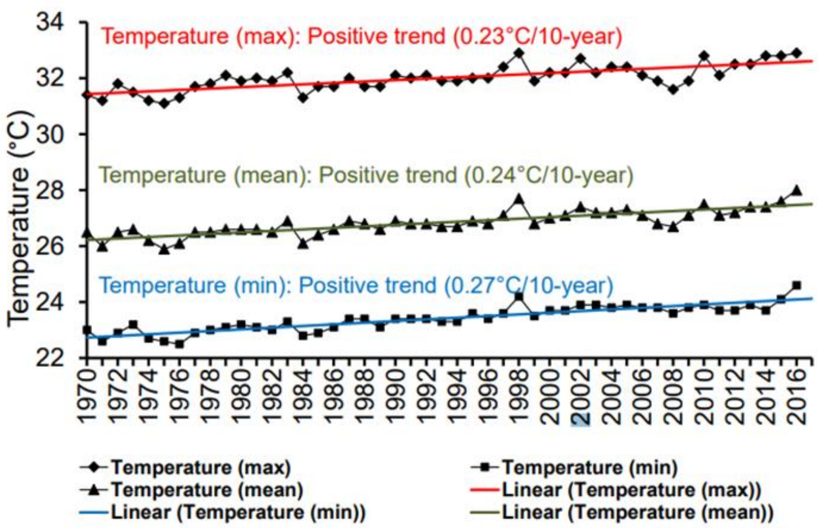


**Figure 4.5: Positive trend in Surface Air Temperature increase in Peninsular Malaysia**
*(Source: Malaysia's Third Biennial Update Report to the UNFCCC)*

The projected increase in the surface air temperature was assessed by conducting the RegHCM-PM modelling based on medium range emission scenario. The result of the modelling indicated that the surface air temperature of peninsular Malaysia is expected to increase by 1.5 °C to 2.0 °C by 2050.

#### *4.3.2.1 Anticipated Climate Change Scenario of Increased Surface Air Temperature On-site*

Based on the information discussed above, it can be assumed that PEC may potentially be affected by the increase in the surface air temperature throughout its operation phase. As mentioned previously, IPCC SR 1.5 predicted that impact of the increase of surface air temperature in the event of global warming of 1.5C° – 2°C will be prominent in all regions globally. Furthermore, the result of the modelling conducted as part of Malaysia's Third Biennial Update Report to the UNFCCC further supports this prediction by indicating that the surface air temperature of peninsular Malaysia is expected to increase by 1.5 °C to 2.0 °C by 2050.

### 4.3.3 Rainfall

Malaysia's Third Biennial Update Report (2020) to the UNFCCC showed that Malaysia's Annual Rainfall averages at about 2,000mm to 4,000mm and is mainly influenced by topography and monsoon winds. In recent years, there have been a slight downward trend in annual rainfall for Peninsular Malaysia. However, overall, rainfall patterns showed little variation throughout the years 1952 through to 2016. Additionally, climate model projections extracted from the Climate Change Knowledge Portal (CCKP) from the World Bank also showed that annual rainfall patterns in Malaysia showed little variation in both climate scenarios (Business-as-Usual, and Mitigation scenarios) for the years 2030, 2050 and 2080 (Table *5.3*).

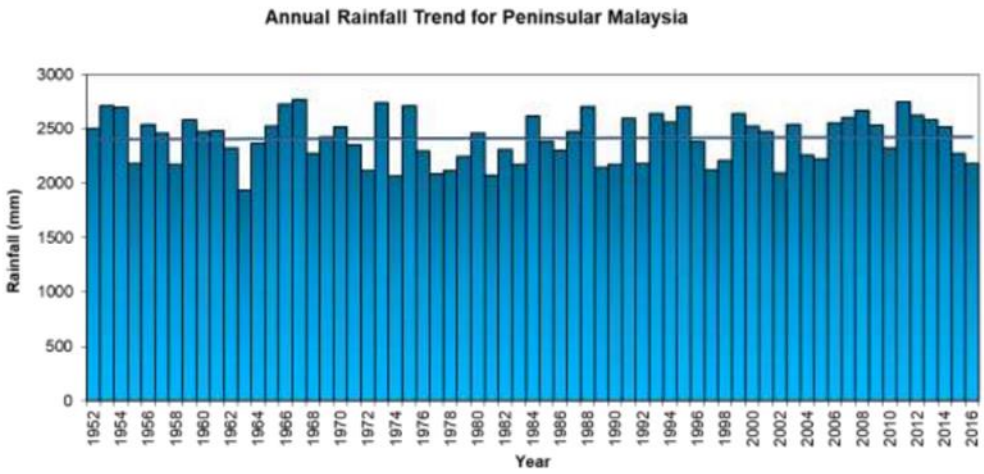


**Figure 4.6: Annual Rainfall Trends in Peninsular Malaysia**
*(Source: Malaysia's Third Biennial Update Report to the UNFCCC)*

#### *4.3.3.1 Anticipated Climate Change Scenario of Rainfall On-site*

Based on the information discussed above, there will be low possibility that PEC will be affected by an increase in rainfall and precipitation levels throughout the operation phase. This is because annual rainfall trends analysed in Malaysia's Third BUR to the UNFCCC shows that rainfall patterns typically do not differ much on a year-to-year basis, and projections based on the Climate Change Knowledge Portal (CCKP) by the World Bank also showed similar results.

Despite the low likelihood that the proposed project area would be affected by an increase in rainfall patterns, it is important to note that based on the baseline study conducted for PEC ESHIA, there have been several flooding incidents recorded in Kg. Lepau in the past, which is located within vicinity of the proposed PEC site. This shows that existing rainfall patterns already have the possibility of causing flooding events within the project site and should be taken into consideration during the planning and operational phases of the PEC.

### 4.3.4 Monsoon and Tropical Cyclone

Based on IPCC SR 1.5, the predicted changes in the intensity and frequency of monsoon cycle globally due to global warming of 1.5 °C – 2 °C is expected to be low. Furthermore, the assessment in the report further clarified that there is limited evidence that any changes in the monsoon would manifest under global warming of 1.5 °C – 2.0 °C.

However, as mentioned previously, current monsoon patterns have resulted in significant flooding and landslide events within Kota Tinggi, Johor, at which the project site is located. As such, monsoon and tropical cyclone events still serve as a relatively important natural hazard to consider as part of the CCRA.

### 4.3.5 Flood

Based on the IPCC SR 1.5, a global warming of 1.5 °C – 2 °C will potentially lead to the increase in runoff and flood hazard in certain regions. This is because, the predicted changes in runoff and flood hazard varies differently on a regional scale and is generally influenced by the spatial extent of a particular region.

For 2 °C global warming, regions such as the Southeast Asia, East Africa and north-eastern Europe may undergo increase runoff due to increase precipitation, while certain regions such as the Mediterranean, southern Australia and Central America may potentially undergo less runoff due to a decrease in precipitation. In coastal regions, an increase in precipitation associated with tropical cyclones and rising sea levels may lead to increased flooding.

Besides that, the RegHCM-PM modelling conducted as part of the study of Malaysia's Second National Communication to the UNFCCC further illustrated the potential impact of changing rainfall patterns due to global warming to the potential increase of flood cases in Malaysia. The study showed that increased rainfall level will consequently leads to the increase in frequency and severity of flood in previously affected areas as well as increase in the likelihood of flood to occur in areas that were previously unaffected.

#### *4.3.5.1 Anticipated Climate Change Scenario of Flood On-site*

Based on the information gathered from the available data, it can be assumed that the potential of flood risk in the area surrounding PEC may increase in the future during its construction and operation phase. This is because the PEC and its associated storage facilities will be located in coastal areas, and as stated previously in IPCC SR 1.5, the increase in the precipitation levels associated with tropical cyclones and rising sea levels may lead to increased flooding in coastal areas. This is further supported by the study conducted in Malaysia's Second National Communication to the UNFCCC which stated that increased rainfall patterns would result in an increase in frequency and severity of flooding events in previously affected areas. Furthermore, based on the baseline study conducted for PEC ESHIA, there have been several recorded flood cases in Kg. Lepau in the past, which is located approximately 2 km to the west of PEC project site. The projected increased in rainfall in the area due to climate change may cause the number of flooding incidents to increase in the area, especially Kg. Lepau which is already prone to flooding. This may subsequently affect PEC as it is located within proximity of the project site.

# 5 Risk Assessment and Analysis

## 5.1 Introduction

Based upon the outcomes of the analysis of the baseline and anticipated climate conditions presented above, the proposed project location may be subjected to the following potential impacts as a result from climate change:

- sea level rise;
- erosion of soil lines;
- increased flood intensities;
- tidal inundation of coastal areas;
- loss of biodiversity.

Accounting for the location of the project (i.e. part of a large industrial park situated at the Southern part of Peninsular Malaysia), the main climate change risks that could reasonably be expected to be experienced on the site over the Projects lifetime are (i) higher temperature, (ii) large variations of rainfall and (iii) sea level rise (SLR).

## 5.2 Risk Categories and Definition

The Task Force Climate-Related Financial Disclosure (TCFD) has divided climate-related risks into two major categories: (1) Physical risks which is related to the physical impacts of climate change and (2) Transition risks which are risks associated with the country's transition to a lower-carbon economy.

### 5.2.1 Physical Risks

Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply chain disruption. Organizations' financial performance may also be affected by changes in water availability, sourcing, and quality; and extreme temperature changes affecting organizations' premises, operations, supply chain, transport needs, and employee safety.

a. **Acute Risk**: Acute physical risks refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.

b. **Chronic Risk**: Chronic physical risks refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves.

### 5.2.2 Transition Risks

The transition risk which is transitioning to a lower-carbon economy may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organisations.

The climate change physical risks and transition risk for PEC project have been categorized into four (4) main potential aspects that are identified during operations phase and the description of each aspect are summarized in Table *5.1* below:

**Table 5.1: Categories of Physical and Transition Risks of Climate Change**

| Categories | Description | Potential impacts |
|---|---|---|
| ***Physical Risks*** | | |
| Project/asset integrity | Risk that may impact the operation process of the project, the structure and integrity of project assets such as pipelines, operation asset etc. | This impact the project capital costs, efficiency of the operation asset (e.g., associated with down time required to rectify damage, and potential environmental pollution associated with emissions and leaks caused by loss of asset integrity. |
| Workforce health and safety | Risk that may impacted the workers well-being and safety during operation phase of the project | The health and safety of workers are the responsibility of the operation of a project, thus any risks that affects workforce health and safety is deemed crucial. |
| Surrounding facilities and receptors | Risk that may impacted the building infrastructure and nearest localities to the site | • Disturbance in efficiency of the operation processes<br>• Affect local communities' livelihood and health should a loss of asset integrity led to unplanned emissions to the environment. |
| ***Transition Risk*** | | |
| Policy and Legal Risks | Policy and legal Risks associated with industries with high GHG emissions within their value chains, where policy actions, technology or market changes related to emissions reductions or energy efficiency, subsidies or taxes etc would have a direct effect on their operations. | • Increased operating costs such as costs associated with compliance or insurance fees<br>• Decreased market demand for services provided |
| Supply chain | Risk that may impacted the cycle of supply chain from incoming raw materials to operation and finally to product import and export | • Climate change may also directly affect the operations of a company's suppliers over both the short and long term. For example, extreme weather events may shut down supplier facilities, or chronic heat waves may decrease a supplier's production efficiency and increase cost due to additional wear and tear on production lines.<br>• Transportation costs will rise as climate impacts damage infrastructure and regulation increases the price of high-carbon transport. Changes to transportation infrastructure |

| Categories | Description | Potential impacts |
|---|---|---|
| | | will also affect speed of delivery goods and products. |
| Market | Changes in customer behaviour and increasing of raw material cost. | • Increase production costs and energy costs due to changing of sources price such as increasing of energy and water price; and<br>• Reduced consumers demand due to changes in goods and services pricing due to increase of raw material and energy source prices. |

## 5.3 Climate Change Risk Assessment Framework

### 5.3.1 Description

This section considers climate-related hazards, and how these hazards may impact the proposed PEC project, as well as how these impacts could change in the future because of climate change. This section aims to assist decision makers in: (1) compliance with rules to mitigate climate change, and (2) coping with the risk of severe damage to project related assets due to climate change.

The identified climate change risks and the associated ratings were derived based on assessment of baseline conditions and available data detailed in in Section 3, as well as Climate models obtained from the Climate Change Knowledge Portal (CCKP) by the World Bank (*Table 5.3*).

Climate Change models were obtained from the Climate Change Knowledge Portal (CCKP) by the World Bank, which provides global data on country-specific climate modelling based on historical baselines, assessing future climates, vulnerabilities, and impacts.

Modelled projections from the CCKP are based on the Shared Socioeconomic Pathways (SSP) scenarios from the IPCC Sixth Assessment Report. The categories and criteria for these scenarios are defined in Table *5.2* below.

**Table 5.2: IPCC Share Socioeconomic Pathways (SSP) and corresponding scenarios from the IPCC Sixth Assessment Report**

| SSP | Scenario | Estimated warming (2041-2060) | Estimated warming (2081 - 2100) |
|---|---|---|---|
| SSP 1 - 1.9 | Very low GHG emissions: CO2 emissions cut to net zero around 2050 | 1.6 | 1.4 |
| SSP 1 - 2.6 | Low GHG emissions: CO2 emissions cut to net zero around 2075 | 1.7 | 1.8 |
| SSP 2 - 4.5 | Intermediate GHG emissions: CO2 around current levels until 2050, then falling but not reaching net zero by 2100 | 2 | 2.7 |
| SSP 3 - 7.0 | High GHG emissions: CO2 emissions double by 2100 | 2.1 | 3.6 |
| SSP 5 - 8.5 | Very high GHG emissions, CO2 emissions triple by 2075 | 2.4 | 4.4 |

For this study, two GHG scenarios shall be explored, representing two possible future scenarios. The first scenario, SSP 2 – 4.5 represents a Business-as-Usual approach, in which GHG emissions continue around current levels until 2050, then falling but not reaching net zero by 2100, and a conservative Mitigation Scenario (SSP 1 – 2.6), whereby CO2 emissions cut to net zero around 2075.

Table *5.3 s*hows the modelled climate indicators based on data obtained from the Climate Change Knowledge Portal (CCKP) by the World Bank [4] based on the following scenarios and time periods:

- Historical baseline, spanning years 1995 – 2014
- SSP 2 – 4.5, spanning years 2030, 3050 and 2080
- SSP 1 – 2.6, spanning years 2030, 2050, and 2080

Climate projection data from the CKMP is modelled from the global climate model compilations of the Coupled Model Inter-comparison Projects (CMIPs), overseen by the World Climate Research Program. The CMIPs form the data foundation of the IPCC Assessment Reports. CMIP6 supports the IPCC's Sixth Assessment Report. Projection data is presented at a 1.0º x 1.0º (100km x 100km) resolution.

Detailed graphs and modelling of this data is available in **Appendix A.**

[4] Bank, T. W., n.d. *Climate Change Knowledge Portal - Malaysia IPCC Climate Data Projections.* [Online] Available at: https://climateknowledgeportal.worldbank.org/country/malaysia/climate-data-projections [Accessed 27 April 2022].

**Table 5.3 Climate Model predictions for Malaysia based on data obtained from the Climate Change Knowledge Portal (CCKP) by the World Bank**

| Categories | Variables | Observed Baseline | Business as Usual Approach | | | Mitigation Approach | | |
|---|---|---|---|---|---|---|---|---|
| | | | SSP 2 - 4.5 | | | SSP 1 - 2.6 | | |
| | | 1995 - 2014 | 2030 | 2050 | 2080 | 2030 | 2050 | 2080 |
| Essential Climate Variables | Annual Mean Temperature (°C) | 26.02 | 26.39 | 26.39 | 26.9 | 26.4 | 26.73 | 26.82 |
| | Annual Maximum Temperature (°C) | 29.94 | 30.35 | 30.85 | 31.45 | 30.37 | 30.68 | 30.8 |
| | Mean Annual Precipitation (mm) | 2992.28 | 2969.04 | 3041.21 | 3082.42 | 2990.85 | 3029.08 | 2988.28 |
| Temperature | Days with Heat Index (>35°C) | 1.14 | 5.39 | 24.89 | 74.15 | 5.59 | 12.14 | 18.9 |
| | Maximum of Daily Max Temperature (°C) | 33.21 | 33.68 | 34.3 | 34.95 | 33.68 | 34.07 | 34.27 |
| | Number of Hot Days (Tmax > 35°C) | 0.1 | 0.34 | 1.27 | 4.74 | 0.24 | 0.84 | 1.37 |
| Precipitation | Max Number of Consecutive Dry Days | 9.11 | 9.49 | 9.78 | 9.96 | 9.49 | 10.04 | 10.52 |
| | Max Number of Consecutive Wet Days | 70.15 | 65.71 | 65.4 | 65.65 | 64.68 | 66.45 | 65.9 |

### 5.3.2 Probability of Climate Hazard Occurrence

Table *5.4* below highlights the probability of occurrence for key climate hazards relating to the PEC project area. These ratings were developed based on considerations of Climate Projection Models by The World Bank in Table *5.3.*

**Table 5.4 Probability of Climate Hazard Occurrence**

| Hazard | Hazard Level | | | |
|---|---|---|---|---|
| | SSP 2 - 4.5 (Business as Usual Approach) | | SSP 1 - 2.6 (Mitigation Approach) | |
| | 2030 | 2050 | 2030 | 2050 |
| Sea Level Rise | High | High | Moderate | Low |
| Increased Temperatures | High | High | Moderate | Low |
| Increased Precipitation/Rainfall | Low | Low | Low | Low |
| Floods | Moderate | High | Moderate | Moderate |
| Extreme Heat | Moderate | High | Moderate | Low |

### 5.3.3 Risk Assessment Matrix

Each identified risk for the proposed PEC project shall be assigned an overall level of risk, determined as a function of the **probability (or likelihood)** of the event occurring and the **consequence** if the event occurred.

**Likelihood of Risk**

'Likelihood' ratings shall be assigned based on consideration of the historical occurrence, as well as the level of confidence associated with the climate change projections, for the key hazards.

The likelihood of impact occurrence refers to the likelihood that a given climate variable will result in impacts to the proposed project, should climate change impacts occur. The likelihood of impact occurrence is defined by the Task Force into the following categories:

**Table 5.5: Likelihood of Risk Table**

| Likelihood | Description | Recurrent or Event Risks |
|---|---|---|
| Almost Certain (L1) | Expected to occur in most circumstances | Could occur several times a year |
| Likely (L2) | Will probably occur in most circumstances | May occur once every year |
| Possible (L3) | May occur at some time | May arise once in 5 years |
| Unlikely (L4) | May occur at some time, but considered unlikely | May arise once in 5 to 50 years |
| Rare (L5) | Could occur in exceptional circumstances | Unlikely during the next 50 years |

**Consequence of Risk**

The magnitude of consequence is assessed based on consequences that fall within six (6) categories, namely internal operations, capital and operating costs, number of people affected, public health and worker safety, economy, and the environment.

- Internal operations, including the scope and duration of service interruptions, reputational risk and the potential to encounter regulatory problems.

- Capital and operating costs, including all capital and operating costs to the project proponent and revenue implications caused by the climate change impact
- Number of people impacted, including considerations relating to vulnerable populations
- Public health, including worker safety
- Economy, including any impacts to the city's economy, the price of services to customers and clean-up costs incurred by the public
- Environment, including the release of toxic materials and impacts on biodiversity, the city's ecosystem, and historic sites

**Table 5.6: Consequence of Risk Table**

| Consequence | Efficiency of Operations | Maintenance Requirements | Safety |
|---|---|---|---|
| Extreme (C5) | Significant losses in terms of operations efficiency | There is significant increase in maintenance requirements. Damage to infrastructure due to adverse weather events exceed capacity to conduct repairs. | Fatality occurs due to adverse weather conditions |
| Major (C4) | There are major losses in terms of operations efficiency | There is significant increase in maintenance requirements. Major damage to critical infrastructure due to adverse weather events at least once over the next 50 years | Multiple major injuries or permanent disabilities due to adverse weather conditions |
| Moderate (C3) | Moderate losses in terms of operations efficiency | There is an increase in maintenance requirements. Major damage to non-critical infrastructure or minor damage to critical infrastructure due to adverse weather events over the next 50 years. | Single major injuries or several minor injuries due to adverse weather conditions |
| Minor (C2) | Minor damages in terms of operations efficiency | There is no change in maintenace requirements. Minor damage to infrastructure due to adverse weather events over next 50 years. | Minor injury due to adverse weather conditions |
| Negligible (C1) | Negligible damage or losses in terms of operations efficiency | There is a reduction in maintenance requirements. Negligible damage to infrastructure due to adverse weather events during life of asset. | Minimal risk of injury to personnels |

**Risk Assessment Matrix Hazard Rating**

Each risk event shall be assigned an overall level of risk determined as a function of the probability (or likelihood) of the event occurring and the consequence if the event occurred, as shown in the Table below.

**Table 5.7: Risk Assessment Matrix**

| | | Consequence | | | | |
|---|---|---|---|---|---|---|
| | | C1 | C2 | C3 | C4 | C5 |
| Likelihood | L1 | Low | Moderate | High | Extreme | Extreme |
| | L2 | Low | Moderate | Moderate | High | Extreme |
| | L3 | Low | Low | Moderate | High | Extreme |
| | L4 | Low | Low | Moderate | Moderate | High |
| | L5 | Low | Low | Low | Moderate | Moderate |

| Risk Rating | Description |
|---|---|
| Extreme | Present-day or imminent risks for which adaptation strategies should be evaluated and developed as necessary |
| High | Risks for which adaptation strategies may need to be developed in the near future or which further information is needed |
| Moderate | Risks for which impacts should be monitored but may not need action at this time |
| Low | Risks predicted to occur after the climate planning time horizon; may be re-evaluated in the future |

The outcomes of this section would be to improve the identification of opportunities and threats and effectively allocate and use resources for climate change related risk treatment.

### 5.3.4 Project Facilities

Based on project description in ESHIA report, the process plant, inclusive of onsite facilities will occupy an area of ~67.7 ha or ~167 acres (~67% of the total site area, 250 acres), measuring roughly 1,095m in width and 618m in length. The structures and facilities in process plant include the following:

- tank farms – condensate tank farm, immediate tank farm, sphere tank farm, and product storage tank farms
- process area – condensate splitter section comprises of condensate fractionation unit, LPG Merox unit, DHT, sour water stripper, sulphur recovery, amine regeneration and spent caustic treatment units
- aromatics plant – naphtha hydrotreating unit, naphtha splitter, CCR platforming and regeneration unit, reformate splitter, sulfolane unit, benzene/toluene column, Tatoray unit, xylene/Parex unit and isomar unit.
- pipelines – incoming pipelines to the site include condensate from the third-party bulk storage terminal, raw water and natural gas. Outgoing pipelines from PEC may supply other users in the PIPC with light naphtha, C4 LPG and hydrogen.
- other facilities – laboratory, main control building, admin building with canteen and car park, maintenance shop, warehouse, wastewater treatment plant (WWTP) and site's fire station. On-site utilities such as raw water and firewater tanks, raw water treatment and demineralised water system, sites boilers for steam supply, cooling water system and main site electrical switchboard.

### 5.3.5 Associated Facilities (Third-party)

Other than on-site facilities, PEC will utilise facilities owned, operated and maintained by third parties. The list of facilities include:

- Pipelines for transportation of feedstocks and products to and from PEC;
- Offsite storage tanks; and
- Jetties for loading and unloading of feedstocks and products.

## 5.4 Climate Change Risk Assessment (CCRA) Results

The risk assessment findings are documented this section of the CCRA.

Table 5.8 summarises the Climate Change Risk Assessment (CCRA) results for the PEC Project Facilities (Section 5.3.4), whilst

**Table 5.9** summarises the Climate Change Risk Assessment (CCRA) results for the Associated Facilities (Section 5.3.5) such as the transportation pipelines, storage tanks, as well as the jetties for loading and unloading products.

**Table 5.8 Climate Change Risk Assessment (CCRA) Results (PEC Facilities)**

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | **L** | **C** | **R** | **L** | **C** | **R** |
| Temperature Rise | High temperatures for workforce | • May slow down supply chain efficiency<br>• May cause an increase in cooling loads, causing possible shutdowns in the condensate splitter section, and power outages<br>• Reduced efficiency of electricity-producing turbines and compressors<br>• Increased bacterial reactions activity of effluent treatment system | L3 | C2 | | L4 | C1 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | L | C | R | L | C | R |
| Increased precipitation/ rainfall | Flooding of project area/facilities, and or buildings | • Flooding may cause unforeseen shutdowns of facilities (steam boilers, cooling systems, pumps, and electrically operated safety-controlled mechanisms) causing a disruption in supply chains<br>• Flooding may also cause erosion, thus affecting pipelines connecting to the bulk storage, raw water and natural gas terminals<br>• Flooding may cause damage to the aboveground infrastructure such as mechanical equipment, electrical instruments and sensors installed<br>• Increase production loss and disruption of supply chain<br>• The current project area lies within a 5km radius from a flood prone area, Kg. Lepau, and is susceptible to flooding risks during the monsoon seasons<br>• However, based on climate model projection data obtained from the CCKP (World Bank), annual rainfall patterns in Malaysia showed **little variation** in both climate scenarios for the years 2030, 2050 and 2080<br>• As such, **flooding events due to increased precipitation/rainfall events remain of lower risk** | L4 | C3 | | L4 | C2 | |
| Floods (Seasonal) | Flooding of project area/facilities, and or buildings | • The current project area lies within a 5km radius from a flood prone area, Kg. Lepau and is susceptible to flooding risks during the monsoon seasons<br>• Flooding events in this area has occurred almost on an annual basis since 2014, with the most recent event occurring in January 2022. As such, **existing rainfall patterns have the potential to cause severe flooding events**, and remain likely to occur in the future.<br>• Flooding may cause unforeseen shutdowns of facilities (steam boilers, cooling systems, pumps, and electrically operated safety-controlled mechanisms) causing a disruption in supply chains<br>• Flooding may also cause erosion, thus affecting pipelines connecting to the bulk storage, raw water and natural gas terminals<br>• Flooding may cause damage to the aboveground infrastructure such as mechanical equipment, electrical instruments and sensors installed<br>• Increase production loss and disruption of supply chain | L1 | C4 | | L2 | C4 | |
| Sea Level Rise (SLR) | Salinisation of surface water and ground water | • Erosion, flooding, and corrosion may occur, causing damage storage tank, pipelines and the process area and other equipment, causing operational disruptions | L3 | C3 | | L4 | C2 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| Future (Climate Change) Risks | | | L | C | R | L | C | R |
| | Damage to physical infrastructure/buildings | • Damages to drainage systems, buildings, control rooms, and operation personnel may occur | L3 | C2 | | L3 | C2 | |

**Table 5.9 Climate Change Risk Assessment (CCRA) Results (Associated Facilities)**

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| Future (Climate Change) Risks | | | L | C | R | L | C | R |
| Temperature Rise | High temperatures for workforce | • Temperature rise may cause an increase in number of consecutive dry days, thus affecting access to jetties for loading and unloading of feedstock and products, due to changes in water depth<br>• Temperature rise may also cause a reduction in workforce efficiency<br>• Internal structure of pipelines may be affected by changes in temperature, causing changes in pipeline pressure, which results in pipeline leaks | L4 | C2 | | L4 | C1 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | **L** | **C** | **R** | **L** | **C** | **R** |
| Increased precipitation/ rainfall | Flooding of associated facilities, such as storage tanks and jetties | • The current project area lies within a 5km radius from a flood prone area, Kg. Lepau, and is susceptible to flooding risks during the monsoon seasons<br>• However, based on climate model projection data obtained from the CCKP (World Bank), annual rainfall patterns in Malaysia showed little variation in both climate scenarios for the years 2030, 2050 and 2080<br>• As such, flooding events due to increased precipitation/rainfall events remain of low risk | L4 | C3 | | L4 | C2 | |
| Floods (Seasonal) | Flooding of associated facilities such as storage tanks and jetties | • The current project area lies within a 5km radius from a flood prone area, Kg. Lepau and is susceptible to flooding risks during the monsoon seasons<br>• Flooding events in this area has occurred almost on an annual basis since 2014, with the most recent event occurring in January 2022<br>• Flooding may affect access to jetties for loading and unloading of feedstock and products, due to changes in water depth<br>• Flooding may cause damage to the aboveground infrastructure such corrosion or damage of jetties, storage tanks and pipelines<br>• Erosion of foundations and underground pipe supports (scouring), or trigger landslides or subsidence in the sites, leading to accidents to pipelines<br>• Damages to the aboveground infrastructure such as valves, pumping stations, etc. Sensors installed might failed causing several issues and leaks to the pipeline system | L1 | C4 | | L2 | C4 | |
| Sea Level Rise (SLR) | Salinisation of surface water and ground water | • Erosion, flooding, and corrosion may occur, causing damage storage tanks jetties and pipelines | L3 | C3 | | L4 | C2 | |
| | Damage to physical infrastructure/buildings | • Erosion, flooding, and corrosion may occur, causing damage storage tanks jetties and pipelines<br>• Sea level rise may also affect access to jetties, due to changes in water depth, affecting the loading and unloading of feedstocks and products<br>• Damages to drainage systems, buildings, control rooms, and operation personnel may occur | L3 | C3 | | L3 | C2 | |

| Hazard | Potential Impact | Description | Risk Category SSP 2 – 4.5 (Business-as Usual Approach) | | | Risk Category SSP 1 – 2.6 (Mitigation Approach) | | |
|---|---|---|---|---|---|---|---|---|
| **Future (Climate Change) Risks** | | | **L** | **C** | **R** | **L** | **C** | **R** |
| | Supply chain disruption | • Disruption of shipment process - Increased wave pressure may affect shipments of incoming condensate feedstock (a blended low-density mixture of hydrocarbon liquids derived from raw natural gas extracted from oil and gas fields) with a subsequent effect on supply chains<br>• Sea level rise may also affect access to jetties, due to changes in water depth, affecting the loading and unloading of feedstocks and products<br>• Disturbance in operational process - Increased backlog of shipment in the third-party storage warehouse | L3 | C3 | | L3 | C2 | |

## 5.5 Priority Hazards

Table *5.10* and Table *5.11* summarises the priority hazards based on the hazard's likely impacts on the PEC project and the associated facilities, respectively.

**Table 5.10 Hazard Priority table based on likely impacts on PEC project due to Climate Change**

| Hazard | Baseline | SSP 2 - 4.5 (Business as Usual Approach) | | SSP 1 - 2.6 (Mitigation Approach) | |
|---|---|---|---|---|---|
| | | 2030 | 2050 | 2030 | 2050 |
| Sea Level Rise | | | | | |
| Increased Temperatures | | | | | |
| Increased Precipitation/Rainfall | | | | | |
| Floods | | | | | |

**Table 5.11 Hazard Priority table based on likely impacts on Associated Facilities due to Climate Change**

| Hazard | Baseline | SSP 2 - 4.5 (Business as Usual Approach) | | SSP 1 - 2.6 (Mitigation Approach) | |
|---|---|---|---|---|---|
| | | 2030 | 2050 | 2030 | 2050 |
| Sea Level Rise | | | | | |
| Increased Temperatures | | | | | |
| Increased Precipitation/Rainfall | | | | | |
| Floods | | | | | |

| Hazard Rating | Level of Recommended Action |
|---|---|
| | Present-day or imminent hazards for which adaptation strategies should be evaluated and developed as necessary |
| | Hazards for which adaptation strategies may need to be developed in the near future or which further information is needed |
| | Hazards for which impacts should be monitored but may not need action at this time |
| | Hazards predicted to occur after the climate planning time horizon; may be re-evaluated in the future |

Based on the Climate Change Risk Assessment (CCRA), it can be concluded that floods were identified to be the highest priority for the development of adaptation strategies, as flooding events have occurred on an annual basis, with the most recent event occurring in January 2022, within a 5 km radius from the proposed project area. As such, adaptation and mitigation strategies for flooding events should be prepared to enhance the PEC and its associated facilities climate change preparedness, in the event that these natural hazards increase in intensity in the future.

Additionally, climate hazards such as increased precipitation/rainfall, as well as sea-level rise were rated as hazards that need to be monitored, and adaptation strategies may need to be developed in the future. This is because although climate model projections of rainfall patterns show that variation in rainfall patterns is not likely to occur through to the year 2080, existing rainfall patterns have already resulted in severe flooding events and would likely cause detrimental impacts to the PEC project and its associated facilities, in the event that climate change increases rainfall intensity.

Consequently, sea-level rise was also given a higher risk rating due to the high likelihood of occurrence. Thus, climate adaptation strategies for sea-level rise induced risks may also need to be developed in the near future.

## 5.6 Transition Risks - Policy and Legal Risks

### 5.6.1 GHG Emissions

Transition risk scenarios are particularly relevant for resource-intensive organizations with high GHG emissions within their value chains, where policy actions, technology, or market changes aimed at emissions reductions, energy efficiency, subsidies or taxes, or other constraints or incentives may have a particularly direct effect.

### 5.6.2 National Greenhouse Gas Inventory

In 2019, $CO_2$ emissions for Malaysia was 248.8 million tonnes. Between 1970 and 2019, $CO_2$ emissions of Malaysia grew substantially from 14.2 to 248.8 million tonnes rising at an increasing annual rate that reached a maximum of 19.93% in 1991 and then decreased to 0.24% in 2019. The $CO_2$ emissions in Malaysia is 7.67 tons of $CO_2$ per capita.

The latest national greenhouse gas (GHG) inventory reported and compiled for Malaysia is for the year 2016. Data was extracted from Malaysia's Third Biennial Update Report submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2020. Estimations of anthropogenic emissions and removals were carried out for four sectors, namely the energy; industrial processes and product used (IPPU); agriculture forestry and other land use (AFOLU), and waste sectors. The inventory also contains time series estimates from 1990 to 2016 for each of these sectors.

### 5.6.3 $CO_2$ Emissions (Greenhouse Gases)

#### *5.6.3.1 Scope 1*

The main sources of carbon dioxide ($CO_2$) emission from PEC during the operational phase are from the hydrocarbon or fuel-burning equipment such as the boilers, reboilers, heaters, and flare stacks. It is of utmost importance that the emissions from these sources are monitored and recorded as $CO_2$ are considered as the most common GHG emitted in the energy sector. The estimated total fuel consumption of PEC during the operational phase is shown in Table *5.12*.

**Table 5.12: Estimated Total Fuel Consumption of PEC**

| Source of Emission | Amount of Fuel (MMBTU) |
|---|---|
| Condensate Fractionation | 313.50 |
| Platforming | 865.09 |
| Xylene Fractionation | 182.54 |
| Tatoray | 47.62 |
| Parex | 900.81 |
| Isomar | 126.99 |
| Naptha Hydrotreating | 71.43 |
| Kerosene Unionfining | 7.94 |
| Diesel Unionfining | 87.30 |

Based on the estimated annual total fuel consumption of PEC, an estimation of the GHG emission is calculated by utilising GHG Protocol Calculation Tool. The purpose of the conceptual calculation is to estimate the GHG emission of PEC during its operational phase from an estimated total working hour of 8,400 per year. Based on the conceptual calculations, approximately 1,330,200.15 tonnes of $CO_2e$ will be generated in a year during the operational phase of PEC. The estimated total emission of Scope 1 for PEC is shown in

*Table* **5.13**.

**Table 5.13: Estimated Total Emission of Scope 1 Emission of PEC**

| Source of Emission | Amount of Fuel (MMBTU) | GHG Emissions (tonnes) | | | |
|---|---|---|---|---|---|
| | | $CO_2$ | $CH_4$ | $N_2O$ | All GHGs (tonnes $CO_2e$) |
| Condensate Fractionation | 313.4973 | 19.052 | 3.308E-04 | 3.308E-05 | 19.070 |
| Platforming | 865.0938 | 52.575 | 9.128E-04 | 9.128E-05 | 52.625 |
| Xylene Fractionation | 182.54274 | 11.094 | 1.926E-04 | 1.926E-05 | 11.104 |
| Tatoray | 47.61984 | 2.894 | 5.024E-05 | 5.024E-06 | 2.897 |
| Parex | 900.8087 | 54.746 | 9.504E-04 | 9.504E-05 | 54.797 |
| Isomar | 126.9862 | 7.717 | 1.340E-04 | 1.340E-05 | 7.725 |
| Naptha hydrotreating | 71.4297 | 4.341 | 7.537E-05 | 7.537E-06 | 4.345 |
| Kerosene Unionfining | 7.9366 | 0.482 | 8.374E-06 | 8.374E-07 | 0.483 |
| Diesel Unionfining | 87.30305 | 5.306 | 9.211E-05 | 9.211E-06 | 5.311 |
| Total Scope 1 GHG Emission (tonnes $CO_2e$)/hr | | | | | 158.357 |
| Total Scope 1 GHG Emission (tonnes $CO_2e$)/yr | | | | | 1,330,200.15 |

Note that the calculations do not take into consideration usage of any GHG emissions minimisation measures.

### 5.6.3.2 *Scope 2*

Scope 2 emissions are calculated from purchased or acquired electricity, steam, heat and cooling. For PEC, only 2 sources of energy are utilised, namely electricity and steam. Electricity is purchased from the national grid while steam is generated utilising electricity also from the national grid. Note that the calculation for steam assumes that none is acquired from the PEC processes. This may change during Detailed Design which will significantly reduce the consumption data.

For the assessment of the emissions from usage of electricity, the location-based method was utilised. As such the emission factor for Peninsular Malaysia from the 2017 Clean Development Mechanism (CDM) Electricity Baseline for Malaysia, published by Malaysian Green Technology Corporation for the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) was applied. The emission factors from CDM were previously used for the study of Malaysia's GHG emission and are considered as the national emission factor. However, only the $CO_2$ values are available and therefore reported. The activity data and the emission factor used for the calculation of scope 2 emission of electricity is as shown in *Table 5.14.*

For the calculation of the scope 2 GHG emission, the following formula, based on GHG Protocol Scope 2 Guidance, was applied:

*Emission = Activity Data x Emission Factor*

**Table 5.14: Estimated Total Emission of Scope 2 Emission of PEC**

| Source of Emission | Activity Data (mWh) | Emission Factor (tonnes $CO_2e$) | Calculated Emission |
|---|---|---|---|
| Steam | 194.04 | 0.667 | 129.43 |
| Electricity | 80.38 | 0.667 | 53.61 |
| Total $CO_2e$ Emission (tonnes $CO_2e$/hr) | | | 183.04 |
| Total $CO_2e$ Emission (tonnes $CO_2e$/yr) | | | 1,537,528.78 |

Based on the conceptual calculation, PEC will be emitting approximately 1,537,528.78 tonnes $CO_2e$ of scope 2 emission annually. However, as of the writing of this report, only these set of data are available. Additional data will be included once the detail design of PEC has been finalised.

#### *5.6.3.3 Total GHG Emission*

The total estimated GHG emission of Scope 1 and Scope 2 of PEC is 2,867,727.93 tonnes $CO_2e$ per year. This corresponds to less than 1.1% of Malaysia's total carbon emission in 2018 (BP Statistical Review of World Energy 2019) which amounted to 250.3 million tonnes. The estimated total GHG emission of PEC is summarised in *Table 5.15.*

**Table 5.15: Estimated Total Emission of Scope 1 and Scope Emission of PEC**

| Type of Emission | Calculated Emission (tonnes $CO_2e$) |
|---|---|
| Scope 1 | 1,330,200.15 |
| Scope 2 | 1,537,528.78 |
| Total Emission | 2,867,727.93 |

Note that the calculations do not take into consideration usage of any GHG emissions minimisation measures.

### 5.6.4 Transition Risks Associated with Policies and Legal Frameworks

Malaysia submitted its amended Nationally Determined Contributions (NDC) to the UNFCCC on 27th of November 2015, whereby the updated NDC stated Malaysia's intention to reduce its economy-wide carbon intensity (against GDP) of 45% in 2030 compared to 2005 levels. The updated NDC also includes increased ambition whereby (1) the 45% carbon intensity reduction is unconditional, (2) the target is an increase of 10% from the earlier submission; and (3) the GHG coverage is expanded to seven greenhouse gasses: Carbon dioxide ($CO_2$), Methane ($CH_4$), Nitrous oxide ($N_2O$), Hydrofluorocarbons (HFCs), Perfluorocarbon (PFCs), Sulphur hexafluoride ($SF_6$) and Nitrogen trifluoride ($NF_3$).

Based on the emission calculations done in Section 4.8.3, whereby the proposed PEC project is estimated to produce 2,867,727.93 tonnes $CO_2e$ per year (based on conservative calculation measures), the proposed project may be subjected to some level of transition risks associated with changes in policies and legal frameworks in this scenario if emission reduction technologies are not adopted. Where possible, technologies and emission reduction strategies should be adopted to reduce GHG emissions from the PEC project, to align with Malaysia's climate change targets and policies moving forward, ensuring that emissions from the proposed project are kept at a minimum, and transition risks associated with the PEC project are reduced.

In line with this goal, The PEC project plans to adopt an Aromatics Complex design that is as close to steam neutral as practical. This design is the lowest in fuel consumption and would result in the least CO2 emissions as practicable.

Table *5.16* shows the emission reduction technologies to be used for the PEC project to reduce carbon emissions, as well as the associated transitional risks.

**Table 5.16: Emission Reduction Technologies for the PEC project's Aromatics Complex design and their corresponding emission levels**

| | ChemOne PEC Case High $H_2$ in FG Case | ChemOne PEC Case 2 Normal FG Case | Aromatic Complex Next Best Alternative (NBA) |
|---|---|---|---|
| Total $TCO_2e$/year | 749,186 | 1,032,171 | 1,193,426 |
| Total Aromatic products* T/year | 2,457,000 | 2,457,000 | 2,014,000 |
| Total $TCO_2e$/T Aromatic Products | 0.3049 | 0.4200 | 0.5926 |

In conclusion, based on the comparison between conservative GHG emission calculations conducted in Sections 5.7.3.1 and 5.7.3.2, and the emission reduction technologies to be adopted by PEC, emissions and transition risks associated with these emissions from the proposed project would be greatly reduced.

# 6 Built-In Adaptation and Mitigation Measures

As reference to the ESHIA report, PEC facility will design, construct, and operate these facilities that leads to climate changes tolerances and adaptations:

- Plant design is flexible enough to take various blends of condensate and/or imported naphtha as feedstock, including potentially from other oil refineries to avoid out of feedstock and incoming raw material supply due to supplier's operational disruption issues;
- A flare system for emergency flaring of raw materials (i.e. Condensate, semi-finished and finished product) will be located in the site to prevent the unexpected extreme climate incidents such as higher in the average temperature; and
- The product export is via the same pipelines back to the dedicated PEC jetty of for storage at the third-party bulk storage terminal pending export due to extreme weather events.
- Rainwater collected within tank bund areas is temporarily stored within the tank bund, each with an inspection pit. Prior to release (via valve) the contained water is inspected and only if it meets requirements for discharge to stormwater drainage is it allowed to be released into the site stormwater drainage system, if not it shall be pumped to the WWTP and can be used for emergency as a preparation towards unexpected climate events such droughts;
- The plant will be covered by a fire water ring main. Water from the fire water reservoir will be charged and pressurized in the ring main using a combination of motor and diesel driven fire water pumps as a prevention to unexpected extreme events such high temperatures;
- The storage tank will be equipped with heat detectors connected to automatic fire alarm system as a precaution measure towards unexpected extreme weathers incidents; and
- The main control building and process substation will be built with blast resistance material as a protection step towards extreme climate events and incidents.

### 6.1.1 Recommended Mitigation / Monitoring Measures

The mitigation hierarchy is the process whereby a company works towards mitigating climate change impacts by avoiding impacts as much as possible, minimizing those which cannot be avoided, restoring areas where required, and finally offsetting any residual impacts.

With respect to the statement, PEC should implement climate change impact avoidance/ impact reduction strategy and if necessary, to change their standard operating procedure and/or activities whenever found to affect the PEC business activity. This strategy is important during planning/ implementation/ decommissioning as to reduce impacts that cannot be avoided to acceptable levels.

#### *6.1.1.1 GHG Emissions Mitigations Measures*

PEC facility shall meet the IFC Performance Standard III in relation to CO2 emission of more than 100,000 tons per year for the aggregate emission of both facilities within the physical boundary of PEC (direct sources) as well as its associated facilities (indirect sources). The monitoring and reporting of PEC's GHG emission will be conducted annually in accordance with internationally recognised methodologies such as those provided by the Intergovernmental Panel on Climate Change (IPCC). Besides that, PEC will also continually evaluate the feasibility and the cost-effectiveness of various alternatives from both the technical and financial perspective to further reduce its GHG emission during the design and operation stage of PEC.

The alternative options to reduce the GHG emission that will be, but is not limited to, considered by PEC are as follows:

- Continuous enhancement of energy efficiency and consumption;
- Protection and enhancement of sinks and reservoirs of greenhouse gases;
- Carbon capture and storage technologies;
- Carbon Financing; or
- Adoption of other mitigation measures such as the reduction of fugitive emission and/or the reduction of gas flaring.

PEC will promote the reduction of project-related greenhouse has (GHG) emission in a manner that is appropriate to the nature and scale of the project operations and impacts. Furthermore, as the design of the process units have not been finalised, the fuel required is estimated based on recent similar complexes. The accuracy and detail of this estimate will be improved as the project progresses.

The following aspects will be considered by PEC in finalising the detail design to ensure inclusion of BAT:

- Minimizing energy consumption for the site, as a whole, by using process models and pinch techniques;
- Optimizing the hydrogen network by evaluating the process conditions for the hydrogen sources, hydrogen consumers, and overall hydrogen recovery and reuse;
- Minimizing water consumption by designing the process units, sour water stripping and utilities to maximize water reuse.;
- Optimization of shared process systems such as sour water stripping and amine treating; and
- Reducing $CO_2$ generation by minimizing fired heater duty, electricity consumption and steam usage and maximizing process heat recovery.

### 6.1.2 Residual Risk Levels

***6.1.3*** The residual risk is the number of risks or danger associated with an action or event remaining after natural or inherent risks have been reduced by risk controls. The residual risk is evaluated and rated with either "Low", "Medium" or "High" after considering the recommended mitigation and monitoring measures as detailed out in

*Table* to control the climate change related risks to the project operation.

Table *6.1* below summarizes the risk evaluation for four climate change risks during operation phase of the project.

**Table 6.1 Climate Change Risks Evaluation, Recommendation and Residual Risk Level**

| Categories | Built-In Mitigation | Recommended Mitigation /Monitoring Measures |
|---|---|---|
| Climate change risk to **project/asset integrity** | • Project site is above predicted sea-level rise | • Waterproofing equipment and buildings, securing of equipment and adequate emergency-response and contingency plan to minimize downtime |

| Categories | Built-In Mitigation | Recommended Mitigation /Monitoring Measures |
|---|---|---|
| | | • Increase storage capacity for vital equipment and supplies<br>• Development of External Lightning Protection System (ELPS)<br>• Implementation of measures related to lightning protection<br>• Review design structural thresholds considering climate change risks<br>• Reassess equipment and facilities design<br>• Focus on maintenance of pipelines sited at ultra-shallow water, at arid and semiarid areas where mudflows can be created and pipelines with diameters below 0.1mm and platform. |
| Climate change risk to **workplace health and safety** | • Health and Safety Management in place | • Improve health and safety policies considering climate change risks<br>• Monitor or track number of reported cases of mosquito-borne diseases within the area/site boundary<br>• Adaptation of nation's Vector-borne disease control programme |
| Climate change risk to **supply chain** | • Plant is designed flexible to take various blends of condensate;<br>• A Flare system for emergency flaring of raw materials; and<br>• The product export back via same pipelines for storage due to pending export. | • Prepared an emergency preparedness plan for climate change risk on supply change;<br>• Plan for scheduling incoming raw materials and feedstock to avoid backlog at the storage warehouse and at the third-party jetty according to climate projection; and<br>• Modification needs on plant design, equipment requirement and materials used to withstand climate change risks tolerance; |
| Climate change risk to **surrounding facilities and receptors** | • Rainwater collected within tank bund storage area;<br>• The plant will be covered by a fire water ring main;<br>• The storage tank will be equipped with heat detectors connected to automatic fire alarm system;<br>• The main control building and process substation will be built with blast resistance material | • Prepared an emergency preparedness plan for climate change risk for utilising alternative sources for such renewable energy, reusable and water harvesting systems, etc;<br>• Plan for scheduling importing and exporting raw materials shipments and products to avoid backlog at the storage warehouse and at the third-party jetty according to climate projection; and<br>• Modification needs on plant design, equipment requirement and materials used to withstand climate change risks tolerance;<br>• Design and choosing the right materials for ICT equipment and electrical instrument that have high tolerance towards climate changes risk |

#### *6.1.3.1 GHG Emissions Residual Impacts*

If stipulated control measures are followed, the significance of residual impacts has been identified as Low based on an assessed low impact severity and low receptor sensitivity.

## 6.2 Policies and Processes to Adaptation

Generally, the factors of adaptation in Malaysia are captured in the National Policy on Climate Change and the Malaysia Plans. The areas that require adaptation has been recognized in 2011 such as draught, flood and erosion, health, agricultural, forest and biodiversity.

These are the recommendations of policies and processes of adaptation in Malaysia which can be adapted by the project proponent as additional mitigation measures to leverage climate change response during operation phase:

- Recommendation of active physical planning involving consultants and stakeholders in preparation of local development plans by the Federal Department of Town and Country Planning, which incorporate disaster resilience;
- Vector-Borne Disease Control Programme was initiated by the Ministry of Health Malaysia (MOH) which control malaria, dengue, filariasis, typhus and yellow fever, among others;
- Participation of Malaysia in the Asia Pacific Climate Change Adaptation Project Preparation Facility (ADAPT) to enhance accessibility of funding of climate change adaptation and promote regional knowledge sharing;
- To increase communication on flooding via real time, the Department of Irrigation and Drainage Malaysia (DID) launched an official website of “Public *Infobanjir*” to show alert and warning levels based on the record of its flood gauges across nation in facilitating emergency response, flood forecasting and warning system program;
- The Malaysia Meteorological Department (MET) posts warning of earthquake and tsunami, strong wind, rough sea, thunderstorm, heavy rains and tropical cyclones on its website to increased frequency of EWE associated with climate change;
- The disaster management centre of the Public Works Department Malaysia maintains a website which relays weather warning from the MET Department; and
- Adaption of urban stormwater management manual from National Water Resources Policy in 2012 to improve water usage efficiency during project operation.

In addition to the above policies and processes, it is recommended that the project proponent to adapt the Climate-related Financial Disclosure (international Task Force) which led to the inclusion of the CCRA component within the latest Equator Principles.

# 7 CONCLUSION

Based on the analysis conducted as part of this CCRA report, it can be concluded that floods were identified to be the highest priority for the development of adaptation strategies, as flooding events have occurred on an annual basis, with the most recent event occurring in January 2022, within a 5 km radius from the proposed project area. As such, adaptation and mitigation strategies for flooding events should be prepared to enhance the PEC and its associated facilities climate change preparedness, in the event that these natural hazards increase in intensity in the future.

Additionally, climate hazards such as increased precipitation/rainfall, as well as sea-level rise were rated as hazards that need to be monitored, and adaptation strategies may need to be developed in the future. This is because although climate model projections of rainfall patterns show that variation in rainfall patterns is not likely to occur through to the year 2080, existing rainfall patterns have already resulted in severe flooding events and would likely cause detrimental impacts to the PEC project and its associated facilities, in the event that climate change increases rainfall intensity. Consequently, sea-level rise was also given a higher risk rating due to the high likelihood of occurrence. Thus, climate adaptation strategies for sea-level rise induced risks may also need to be developed in the near future.

*Table 7.1* below shows the hazard priority table based on likely impacts on the PEC project and its associated facilities due to climate change.

**Table 7.1 Hazard Priority table based on likely impacts on PEC project and associated facilities due to Climate Change**

| Hazard | Baseline | SSP 2 - 4.5 (Business as Usual Approach) | | SSP 1 - 2.6 (Mitigation Approach) | |
|---|---|---|---|---|---|
| | | 2030 | 2050 | 2030 | 2050 |
| Sea Level Rise | | | | | |
| Increased Temperatures | | | | | |
| Increased Precipitation/Rainfall | | | | | |
| Floods | | | | | |

| Hazard Rating | Level of Recommended Action |
|---|---|
| | Present-day or imminent hazards for which adaptation strategies should be evaluated and developed as necessary |
| | Hazards for which adaptation strategies may need to be developed in the near future or which further information is needed |
| | Hazards for which impacts should be monitored but may not need action at this time |
| | Hazards predicted to occur after the climate planning time horizon; may be re-evaluated in the future |

## APPENDIX A

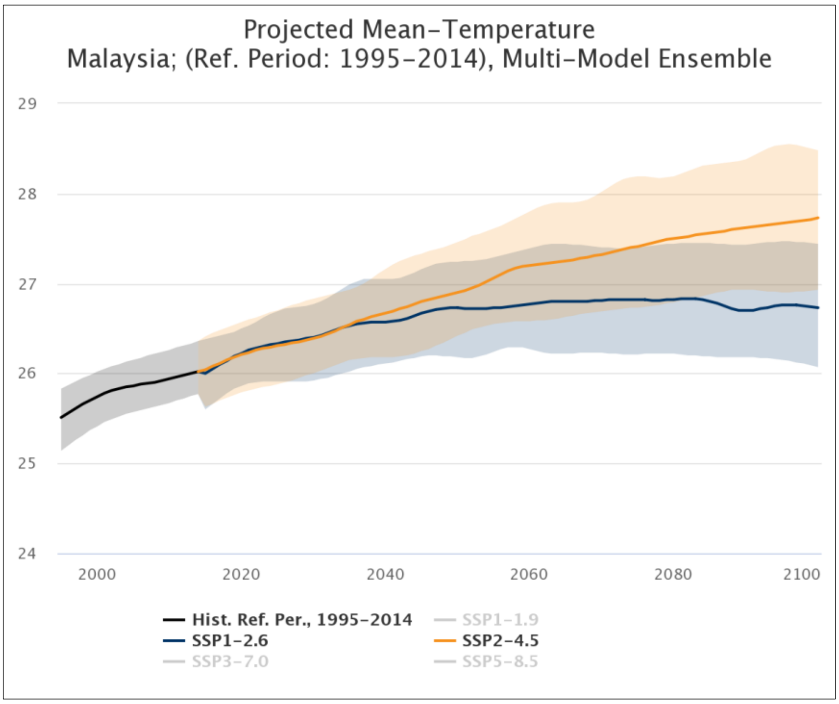


**Figure A: Climate Model for Mean Temperature projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

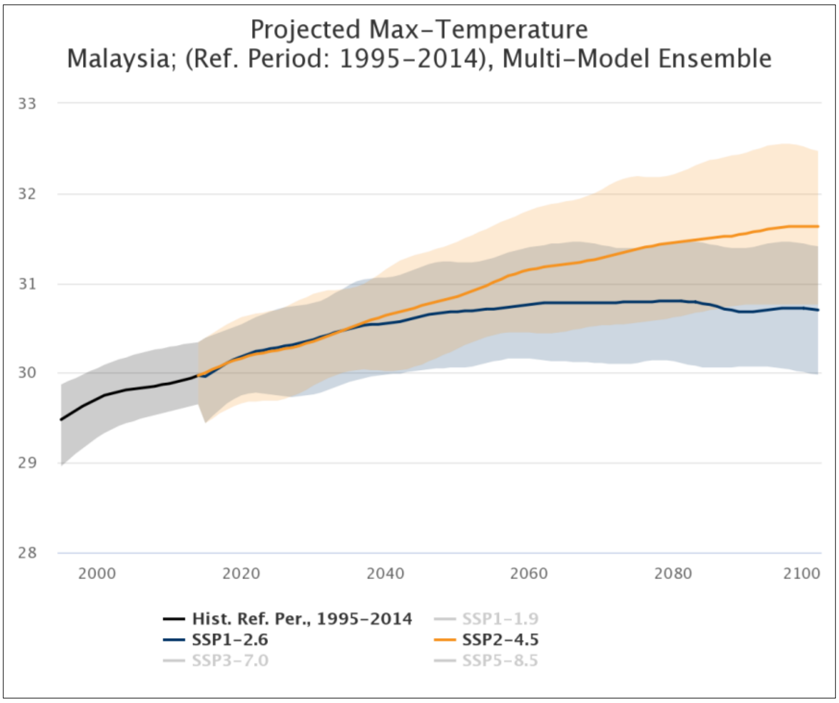


**Figure B: Climate Model for Max Temperature projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

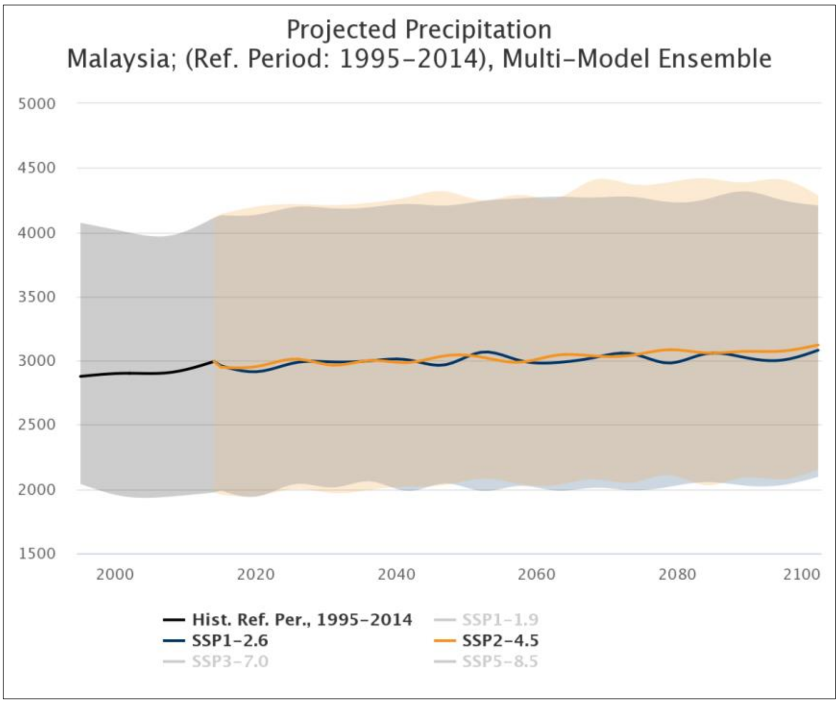


**Figure C: Climate Model for Precipitation projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

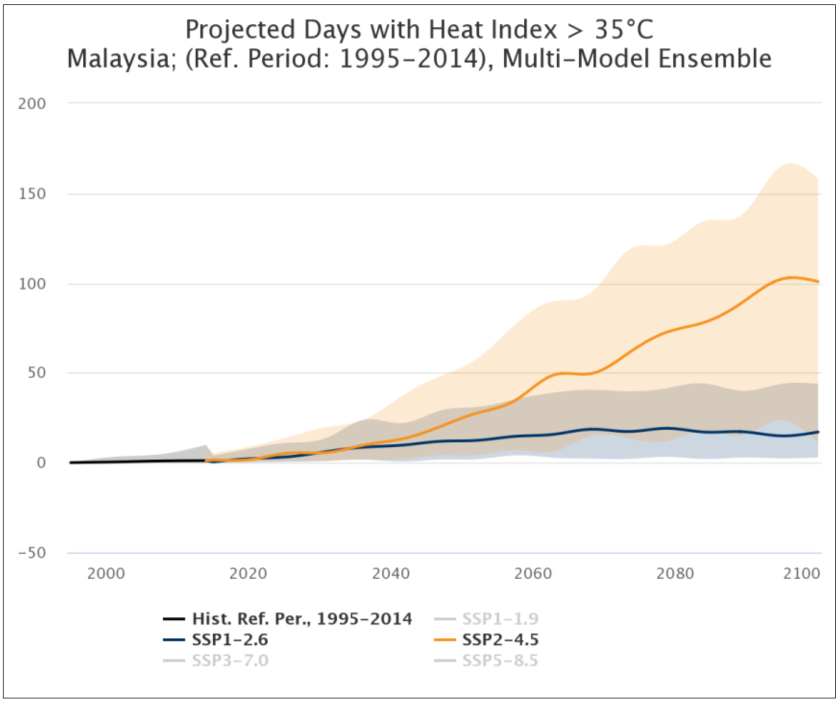


**Figure D: Climate Model for Days with Heat Index of >35°C projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

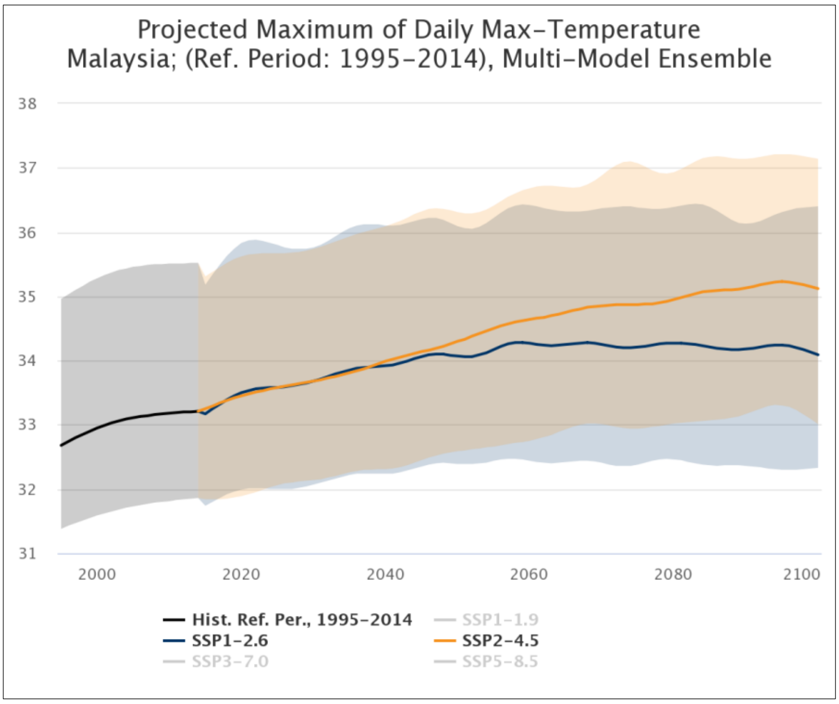


**Figure E: Climate Model for Daily Maximum Temperature projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

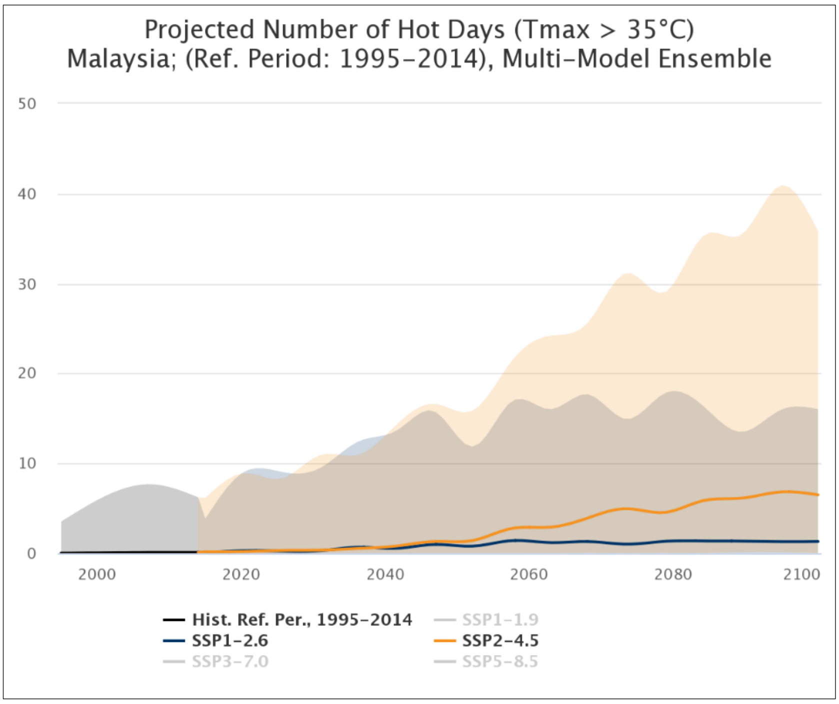


**Figure F: Climate Model for Number of Hot Days (TMax > 35°C) projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

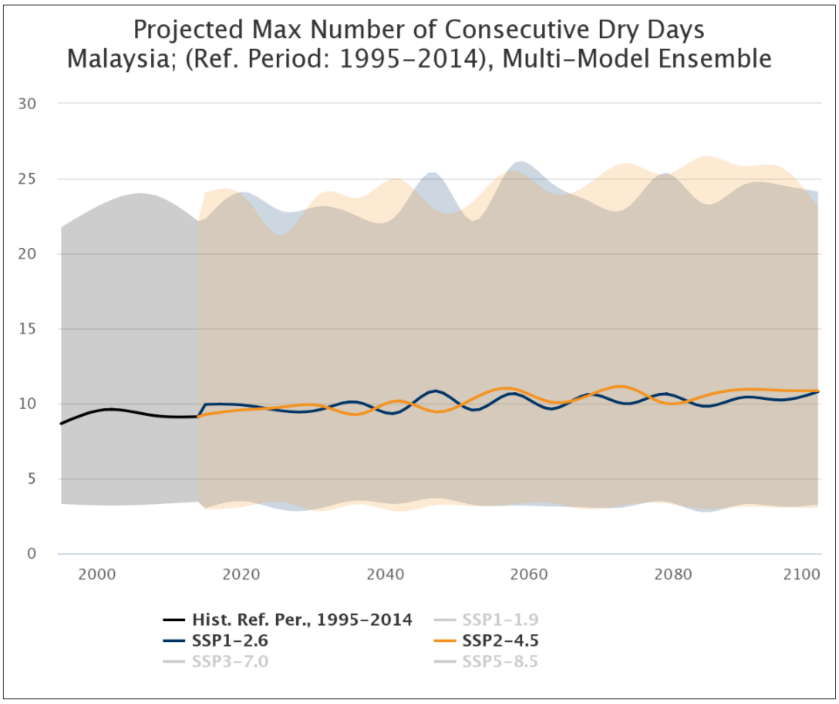


**Figure G: Climate Model for Max Number of Consecutive Dry Days projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**

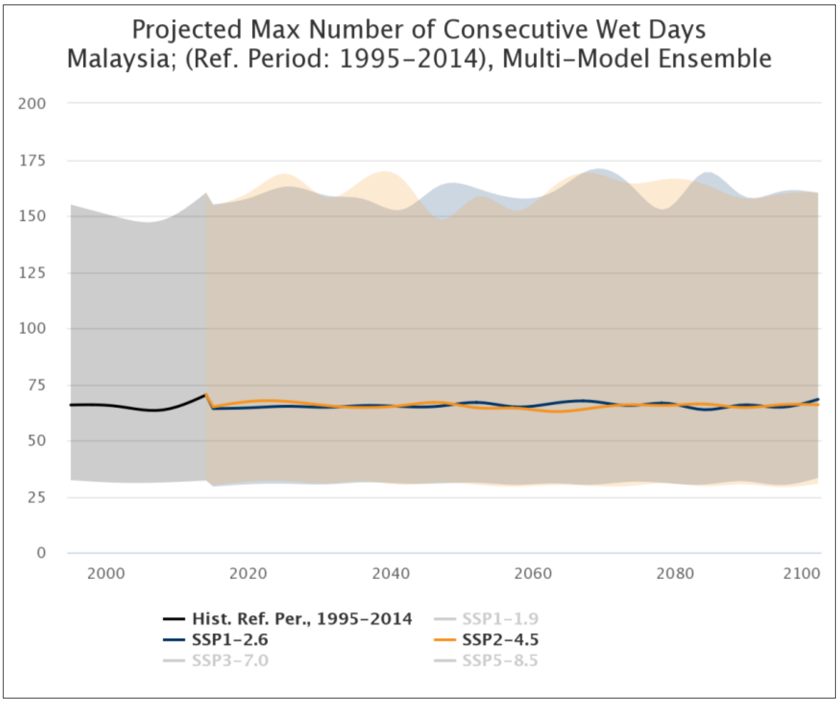


**Figure H: Climate Model for Max Number of Consecutive Wet Days projections for Malaysia, between a Business-as-Usual Scenario (SSP 2 – 4.5) and a Mitigation Approach scenario (SSP 1 – 2.6).**