REPORT

Climate Change Risk Assessment

OlefinsIII Project PKN Orlen

Client: PKN Orlen

Reference: BI5466I&BRP001F01
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1 Executive summary

PKN Orlen is the Poland region's leading producer of petrochemicals used as basic feedstocks by a large number of chemical companies. PKN Orlen operates seven refineries and processes crude oil into gasoline, diesel oil, fuel oil and aviation fuel. PKN Orlen wants to expand their business in Płock Poland. The Olefins III expansion Project (further referred to as The Project) involves the expansion of an existing Olefins facility, adjacent to the north of an existing Olefins Complex.
For this expansion, the company is required to prepare for climate change and the associated risks.

This Climate Change Risk Assessment (CCRA) is divided into two overarching categories: Physical Risks and Transition Risks. The aim of this research is to identify and assess current and anticipated physical and transition risks for the Olefins III project (ISBL scope) and water inlet of PKN Orlen with climate change projections to determine the vulnerability to climate-based risk
The basis for predicting future climate situations and the associated risks are the scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). The IPCC is currently in its sixth Assessment Cycle (IPCC 6th).
IPCC 6th assesses the climate response to five illustrative scenarios that cover the range of possible future development of anthropogenic drivers of climate change found in the literature.

In this assessment, multiple plausible projections are considered to cover the uncertainty and define a bandwidth of future climate scenarios. The climate change scenarios used follow three shared socioeconomic pathways (SSP) scenarios for atmospheric greenhouse gas concentrations:

- **SSP1-2.6 – sustainability scenario:** Moderate scenario leading to a warming at the end of the 21st century of probably less than 2°C relative to the pre-industrial period (1850–1900);
- **SSP2-4.5 – stabilization scenario**: Intermediate scenario leading to a warming at the end of the 21st century of more than 2°C relative to relative to the pre-industrial period (1850–1900);
- **SSP4-8.5 – business-as-usual**: Most severe scenario leading to a warming at the end of the 21st century of probably more than 4°C relative to the pre-industrial period (1850–1900).

Transition risk and physical risk are generally assumed to have a negative correlation. This means that when transition risk is high, physical risk is low, and vice versa. To assess both physical risk and transition risk the following scenarios are applicable for this CCRA:

Risk	SSP	Scenario
Transition Risk	SSP1-2.6	Sustainability Scenario: orderly transition leading to short, medium and long term transition risks
	SSP2-4.5	Stabilization Scenario: late and sudden transition, leading to limited short term transition risk and high and unexpected transition risk in the medium and long term
Physical Risk	SSP2-4.5	Stabilization Scenario: delayed and sudden transition, leading to increasing physical risks
	SSP4-8.5	Business-as-usual: very limited transition, leading to high likelihood of physical risks

Both physical and transition risks have been evaluated for the short term period (2020-2040) and midterm period (2040-2060).

The physical climate change risk assessment is broken down into the following steps:

1. **Hazard identification**: identify physical hazards and determine critical climate variables - which climate variables are critical to performance and durability.
2. **Determine exposure of the project to climate change related hazards**: assess how the critical climate parameters are expected to change in the future and in what way the area is already being affected by increasing variability and extremes under the current climate.
3. **Determine the risk of the project to climate change:** assess to which degree a system is susceptible to and unable to cope with adverse effects of climate change considering the local conditions

The TCFD reporting framework has been used to structure the transition risk analysis. It builds on 4 categories, Policy and Legal, Technology, Markets and Reputation.
The transition risk assessment of this CCRA has been performed in 5 steps
Step 1: Desk Research
Step 2: Questionnaire
Step 3: Findings
Step 4: Workshop
Step 5: Report

Based on all the assessments following main risks have been identified:

Climate related Hazards	Risk Score	Time Horizon (ST/MT)	Management Action PKN Orlen
Physical risks			
Acute (event-driven extreme weather)			
Wildfires	M	ST-MT	Accept / mitigate
Flooding	L	ST-MT	Accept / mitigate
Storms	L	ST-MT	Accept / mitigate
Chronic (shift in climate patterns)			
Increase in precipitation	L	MT	accept
Decrease in precipitation (drought)	L	MT	accept
Extreme Heat	L	MT	Accept / mitigate
Sea level rise/coastal flooding	L	MT	accept
Transition Risks			
Policy and Legal			
Pricing of GHG emissions	H	ST-MT	Accept
Enhanced emissions-reporting	L	ST	Accept
Mandates/regulation	M	ST-MT	Accept
Exposure to litigation	L	ST-MT	Control
Technology			

Climate related Hazards	Risk Score	Time Horizon (ST/MT)	Management Action PKN Orlen
Substitution of existing products/services	M	MT	Accept
Unsuccessful investment new technology	L	MT	Accept
Costs transition to lower emissions	H	ST-MT	Mitigate
Market			
Changing customer behaviour	L	MT	Mitigate
Uncertainty in market signals	M	ST-MT	Mitigate
Raw materials construction/maintenance	M	MT	Accept
Reputation			
Stigmatization of sector	L	MT	Control
Increased stakeholder concern	L	MT	Control

Figure 1-1 Overview of physical and transition risks

2 Introduction

PKN Orlen is the region's leading producer of petrochemicals used as basic feedstocks by many chemical companies. PKN Orlen operates seven refineries and processes crude oil into gasoline, diesel oil, fuel oil and aviation fuel. PKN Orlen wants to expand their business in Płock, Poland. The Olefins III expansion Project (further referred to as The Project) involves the expansion of an existing Olefins facility, adjacent to the north of an existing Olefin Complex. The Project includes the development of a new olefins complex that will be integrated within the existing facilities.
For this expansion, the company wants to prepare for climate change and the associated risks.

Royal HaskoningDHV was asked to carry out a Climate Change Risk Assessment (CCRA), following the Environmental and Social Due Diligence (ESDD) report by Ramboll.

The CCRA is divided into two overarching categories. These are:

1 **Physical Risks:** which relate to the physical impacts of climate change.
   - Acute physical climate risks can include increased severity and frequency of droughts, storms, floods, heat waves and wildfires.
   - Chronic physical climate risks can include sea level rise and longer-term temperature increase.

2 **Transition Risks** which relate to the transition to a lower-carbon economy.
   - Policy and legal risks – impact of policy and regulatory actions that seek to constrain the adverse effects of climate change or promote adaptation or transition.
   - Technology risks – technological improvements that support the transition to a lower emissions economy and lead to demand shifts and market advantage for operators who adapt faster.
   - Market risks - shifts in supply and demand for certain commodities, products and services as climate-related risks and opportunities are acted on.
   - Reputation risks - changing customer or community perceptions of an organisation's positive or negative impact on the transition to a lower emissions economy.

The aim of this research is to determine the physical risks and transition risks of climate change and to evaluate the awareness of and preparation for climate-related risks to the project's success.

This research was carried out based on the CCRA Guidance (Equator Principles, 2020). For the transition risk analysis the Taskforce for Climate-Related Financial Disclosures (TCFD) framework has additionally been used (TCFD, 2017).

2.1 Background on Climate Change Risks

The basis for predicting future climate situations and the associated risks are the scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). The IPCC is currently in its sixth Assessment Cycle (IPCC 6th). The Assessment Report 6 (AR6) is expected late 2022 or early 2023.

The 6th IPCC report introduces actual approaches and scenarios. The new assessment is based on a new set of five emissions scenarios, called Shared Socio-economic Pathways (SSPs). These differ slightly from the previous representative concentration pathways (RCPs),
IPCC 6th assesses the climate response to five illustrative scenarios that cover the range of possible future development of anthropogenic drivers of climate change found in the literature. They start in 2015, and include scenarios with high and very high GHG emissions (SSP3-7.0 and SSP5-8.5) and CO_2 emissions that roughly double from current levels by 2100 and 2050, respectively, scenarios with intermediate GHG

emissions (SSP2-4.5) and CO_2 emissions remaining around current levels until the middle of the century, and scenarios with very low and low GHG emissions and CO_2 emissions declining to net zero around or after 2050, followed by varying levels of net negative CO_2 emissions (SSP1-1.9 and SSP1-2.6), as illustrated in the below Figure and table

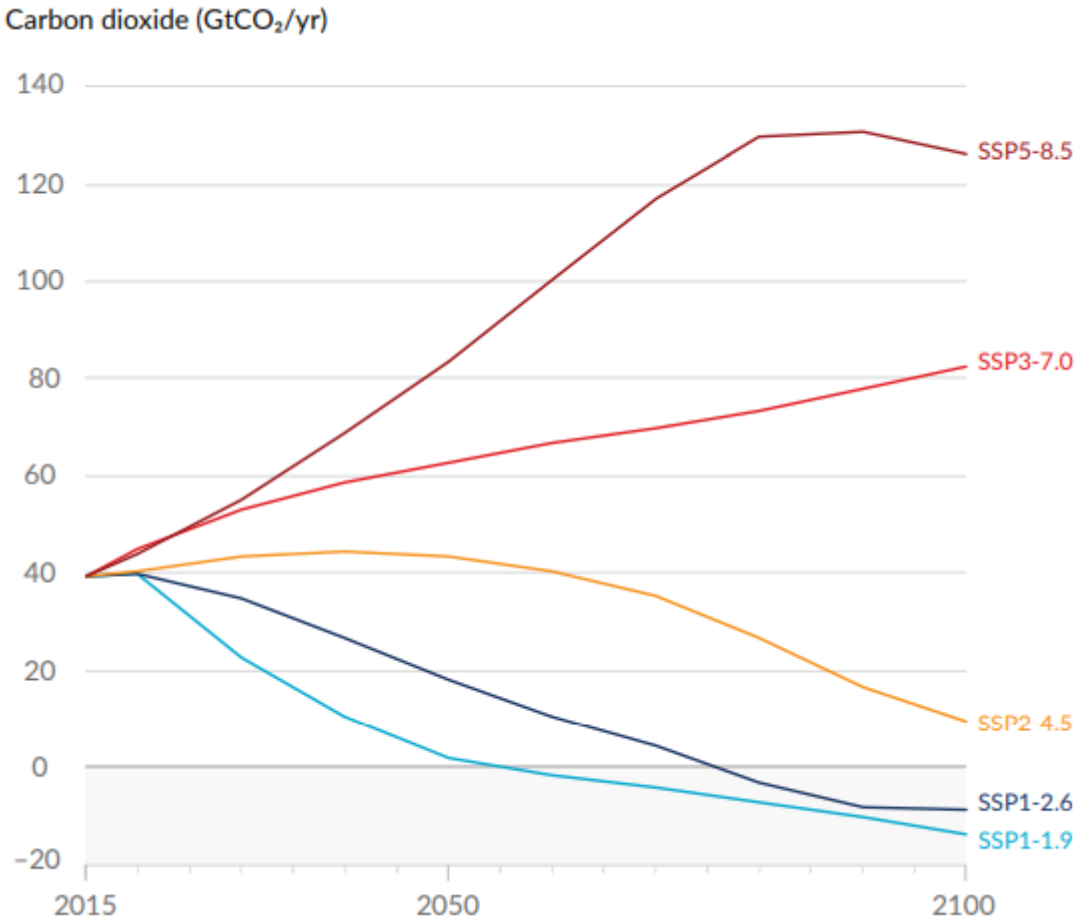

Figure 2-1 Future annual emissions of Co2 across five illustrative scenarios (IPCC, 2021) (source: IPCC 6th Summary for Policy makers)

Regarding emissions scenarios, we are currently somewhere between 4.5 and 7.0, or perhaps already between 7.0 and 8.5 W/m^2. The last scenario is also called business as usual, where there are no mitigation actions to reduce greenhouse gas (GHG) emissions into the atmosphere and oceans.

	Near term, 2021–2040		Mid-term, 2041–2060		Long term, 2081–2100	
Scenario	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)	Best estimate (°C)	*Very likely* range (°C)
SSP1-1.9	1.5	1.2 to 1.7	1.6	1.2 to 2.0	1.4	1.0 to 1.8
SSP1-2.6	1.5	1.2 to 1.8	1.7	1.3 to 2.2	1.8	1.3 to 2.4
SSP2-4.5	1.5	1.2 to 1.8	2.0	1.6 to 2.5	2.7	2.1 to 3.5
SSP3-7.0	1.5	1.2 to 1.8	2.1	1.7 to 2.6	3.6	2.8 to 4.6
SSP5-8.5	1.6	1.3 to 1.9	2.4	1.9 to 3.0	4.4	3.3 to 5.7

Figure 2-2 Changes in global surface temperature, which are assessed based on multiple lines of evidence (IPCC, 2021) (source IPCC 6th, Summary for Policy makers)

Potential generic and global physical and economic implications of temperature rise are indicated in the below table by The Task Force on Climate-related Financial Disclosures Guidance on Risk Management Integration and Disclosure

Warming by 2100	<2°C		3°C	5°C
Physical Impacts	1.5 °C	2 °C		
Sea-level rise	0.3-0.6 m	0.4-0.8 m	0.4-0.9 m	0.5-1.7 m
Chance of ice-free Arctic summer	1 in 30	1 in 6	4 in 6 (63%)	6 in 6 (100%)
Frequency of extreme rainfall	+17%	+36%	+70%	+150%
Increase in wildfire extent	x1.4	x1.6	x2.0	x2.6
People facing extreme heatwaves	x22	x27	x80	x300
Land area hospitable to malaria	+12%	+18%	+29%	+46%
Economic Impacts				
Global GDP impact (2018: $80tn)	-10%	-13%	-23%	-45%
Stranded assets	Transition: fossil fuel assets (supply, power, transport, industry)		Mixed: some fossil fuel assets and some physical stranding	Physical: uninhabitable zones, agriculture, water-intense industry, lost tourism
Food supply	Changing diets, yield loss in tropics		24% yield loss	60% yield loss, 60% demand increase

Figure 2-3 Possible implications of Temperature decreases[1]

[1] *Task Force on Climate-related Financial Disclosers – Guidance on Risk management integration and Disclosure, October 2020*

2.2 Policy context

Various European and Polish policies and strategies forms the basis of or have a relation with this CCRA for PKN Orlen. A brief overview:

Paris Agreement
The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016.
Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century.
The Paris Agreement is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects.

Polish National Plan on energy and Climate
The National Energy and Climate (ENCP) Plan is a ten-year integrated document mandated by the European Union to each of its member states for the EU to meet its overall greenhouse gases emissions targets. The Energy and Climate Plan addresses all five dimensions of the EU Energy Union: decarbonisation, energy efficiency, energy security, internal energy markets and research, innovation and competitiveness. The plans establish the following central goals :
1) the reduction of greenhouse gas emissions in sectors not covered by the ETS system;
2) to develop a long-term strategy for the renovation of domestic stocks of residential and non-residential buildings, public and private, to ensure energy efficiency;
3) to increase diversification of the energy mix and diversification of directions of supplies of imported fuels;
4) to increase the availability of current cross-border interconnections and integrate the national natural gas transmission system with the systems of Central and Eastern Europe and the countries of the Baltic Sea region;
5) to increase expenditure on research and development in Poland.
(Ministerstwo Klimatu i Środowiska, 2019)

In Poland, IOŚ-PIB is implementing a project entitled "*Knowledge base on climate change and adaptation"* to its effects and its dissemination channels in the context of increasing the resilience of the economy, environment and society to climate change and counteracting and minimising the effects of extreme hazards co-financed from EU funds and called *KLIMADA 2.0*. The project includes a number of activities whose main objective is to provide the necessary knowledge on climate change and to evaluate its impacts in order to improve the efficiency and effectiveness of adaptation measures in sectors vulnerable to climate change. One of the programme objectives is to set up climate scenarios - forecasts of temperature and precipitation changes in the time horizon up to 2100, with particular emphasis on 2050.The majority of financing institutions' studies and guidebooks refer to global IPCC data, which are based on the assumption of the overwhelming influence of the economy on the global climate through greenhouse gas emissions and are characterised by very large differences in climate projections, depending on the assumed policy actions leading to reductions in CO_2 emissions.

Act of 17 July 2009 on the management system of greenhouse gas and other substance emissions
This document contains the regulations regarding greenhouse gas emissions for Poland (Kancelaria Sejmu, 2009).

The investment preparation guidebook, *considering climate change, its mitigation and adaptation to these changes and resilience to natural disasters*, Ministry of Environment Department of sustainable development, October 2015, Warsaw.
The guide presents a set of guidelines and indicates principles aimed at help investors, including beneficiaries of EU funds under the 2014-2020 financial perspective, in preparing project investments) and/or in preparing applications for EU funds in the field of issues related to adaptation and mitigation of climate change and resilience for natural disasters (Ministerstwo Środowiska, 2015).

Regulation of the Minister of Infrastructure of the adoption of the *Droughts Effect Prevention Plan* (Poland's blueprint for dealing with drought). Droughts are set to be the single most important climate change impact for Poland. It states where large-scale water storage can take place and measures to prevent drought (MINISTRA INFRASTRUKTURY, 2021)

Climate change adaptation plan (2019) *for the city of Płock until 2030*
The climate change adaptation plan for the city of Płock until 2030 was created in response to one of the most important environmental protection problems, which is climate change and the need to adapt to the effects of these changes. The plan indicates the vision, overarching objective and specific objectives of the city's adaptation to climate change to be achieved through the implementation of selected adaptation actions in the four most sensitive sectors/areas of the city, i.e. public health/vulnerable groups, transport, water management and cultural heritage (RADY MIASTA PŁOCKA, 2019).

Stop the Droughts report 2020, Polish waters 2021
Polish Waters carry out several tasks aimed at improving the water balance of the country. This report presents information on the hydrological situation in Poland in 2020 and details of the resource management program in river catchments, which contributed to the increase in national retention (Państwowe gospodarstwo wodne wody polskie, 2020).

2.3 Project Description

This CCRA covers the Olefins III expansion project (ISBL) including the water inlet and water treatment plant.

2.3.1 Overview of the Olefins III Expansion Project

The majority of Project facilities are located to the north of the existing PKN Orlen Olefin Complex in Mazowsze Voivodship in the Płock District, which is part of the Stara Biała Municipality in the City of Płock, Poland (Figure 1-2). PKN Orlen is the region's leading producer of petrochemicals used as basic feedstocks by a large number of chemical companies. PKN Orlen operates seven refineries and processes crude oil into gasoline, diesel oil, fuel oil and aviation fuel.

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The process units will require new infrastructure, utility and off-site (UI&O) systems. As such, the PKN Orlen is proposing to construct a new olefins complex comprising inside battery limits (ISBL) and OSBL facilities. The majority of the main Project process units are within the ISBL area, and the OBSL scope largely comprises supporting units, utilities and connections to integrate the Project with the existing complex.

The ISBL scope is carried out under an engineering, procurement, construction, and commissioning (EPCC) contract, while the OSBL scope will be carried out under four separate engineering, procurement and construction (EPC) contract. The EPC Contracts for the OSBL scope had not been let at the time of this report. The Project will be integrated within the existing facilities. Some Associated Facilities will be developed by third parties and will be fully integrated within the Project (including a Butadiene Unit). A process flow diagram is shown in Figure 2-5.

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2.3.2 Inside Battery Limits (ISBL) Scope

The ISBL scope includes:

Olefins Plant: Full range Naphtha / Liquid Petroleum Gas (LPG) Steam Cracker Unit (740 kta ethylene production). Feedstock will largely be from the existing refinery, with provision to process naphtha sourced from the market;

Peripheral Units for processing of the by products from the new Olefins Plant:

- Pygas1 Hydrogenation (PGH);
- Styrene Extraction (SE);
- Ethyl Tert-Butyl Ether (ETBE); and
- Ethylene Oxide (EO)/Glycols;

Support Units providing utilities to the North Location units:

- Steam Generation Unit;
- Cooling Tower and Cooling Water system for the North Location facilities

Auxiliary Units including a control room, power distribution system, main flyovers outside units, roads, lighting and underground systems; and

Combined Heat and Power (CHP) Plant that includes the Steam Generation Unit and that will provide 792 Mg/h of fresh steam at 13.6 MPa, with a thermal capacity of 940 MW.

2.3.3 Outside Battery Limits (OSBL) Scope

CCRA report does not cover OSBL part of the Project. The overall Outside Battery Limit (OSBL) scope more detail includes utilities, feedstock, product and by-product storage, loading/unloading stations and other common facilities or equipment that support several units and is not included in the ISBL (Inside Battery Limit) scope definition. Certain elements of the OSBL scope will be owned by PKN ORLEN. This Unfunded OSBL Infrastructure will not be included in the scope of the financing and are excluded from the Project Costs.
The OSBL procurement process is still ongoing

2.3.4 Wastewater Treatment Plant WWTP

Wastewater treatment is outside the Project Finance envelope.
The following types of wastewater (water) are generated in the Olefin Complex:

- Household;
- Industrial;
- rainwater, meltwater and firewater.

PKN Orlen will upgrade the existing Wastewater Treatment Plant. This upgrade is linked to the Olefins III Complex, but is also associated with requirements from the existing plant. The risk for new Waste Water Plant as a result of climate change are subject this this CCRA.

Emergency Discharge of Wastewater to Jar Brzeźnicy
In the evert of excess rainwater, the pre-treated stormwater (only from ‘clean’ areas) will be sent to Jar Brzeźnicy (Brzeźnica Ravine) under a separate water-law permit held by PKN Orlen. Due to the planned increase in impermeable surfaces within the plant (including due to the Olefins III
Complex), design works to manage the increased possibility of an emergency discharge of stormwater have been initiated. These include appropriate storage reservoirs which supplement the already existing reservoirs in Chełpowo.
Due to the interdependency between the Funded Project and the Emergency Discharge of Wastewater to Jar Brzeźnicy, this project is considered to be an Associated Facility.

2.3.5 Water inlet

Development of the Olefins III Complex will lead to an increase in water demand, as follows and summarized in Table 3:

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2.4 Goal of this CCRA

The goal of the CCRA is to identify and assess current and anticipated physical and transition risks for the Olefins III project (ISBL scope) and water inlet of PKN Orlen with climate change projections to determine the vulnerability to climate-based risk. Based on the characterization of projected climate change risks the CCRA seeks to inform PKN Orlen about key risks and their likely impacts under different climate change scenarios. The CCRA follows the requirements of the Equator Principles (Equator Principles, 2020).

In this assessment risk is defined as the conventional definition of likelihood of an adverse event and its consequence (impact)– the event being the climate hazard, and the consequence depending on the vulnerability of the project. The latter depends on the sensitivity to the impacts and the degree of exposure based on the local conditions. The adaptive capacity is the ability to adjust to potential damage with adaptation measures, to take advantage of opportunities, or to respond to consequence. The relationships of the various risk components are illustrated in Figure 2-22-6.

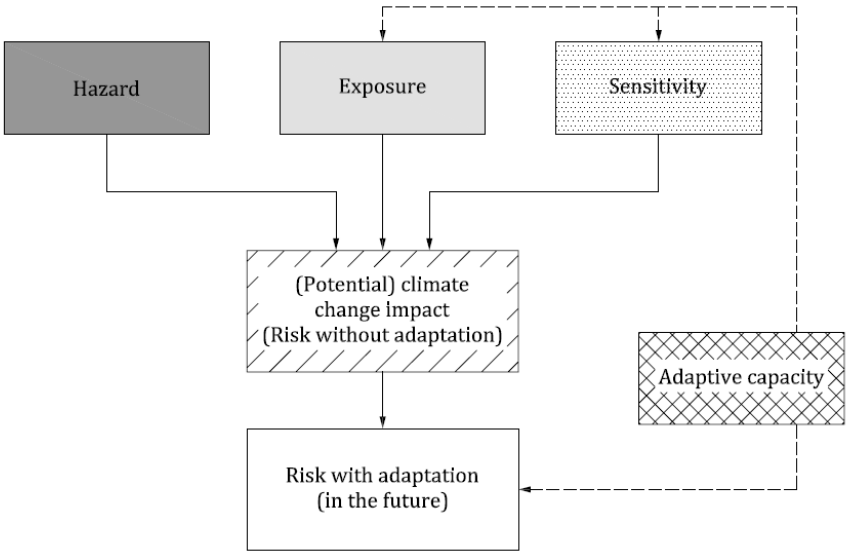


Figure 2-22-6: Relationships of the main components to define climate change risk (ISO 14090, 2021).

2.5 Climate scenarios specific to the Project location

Climate change scenarios are constructed using climate projections from general circulation models (GCMs). GCMs estimate how a climate may change in the future for climate variables, such as temperature and precipitation. However, projections have many uncertainties and are therefore not forecast or predictions but provide possible future scenarios. Evaluation methods should recognize and accommodate uncertainty in the projections as a single or several GCMs may not represent the full range of potential climate changes in a region.

In this assessment, multiple plausible projections are considered to cover the uncertainty and define a bandwidth of future climate scenarios. The climate change scenarios used follow three shared socioeconomic pathways (SSP) scenarios for atmospheric greenhouse gas concentrations:

- **SSP1-2.6 – sustainability scenario:** Moderate scenario leading to a warming at the end of the 21st century of probably less than 2°C relative to the pre-industrial period (1850–1900). For transition risks only.
- **SSP2-4.5 – stabilization scenario**: Intermediate scenario leading to a warming at the end of the 21st century of more than 2°C relative to relative to the pre-industrial period (1850–1900).
- **SSP4-8.5 – business-as-usual**: Most severe scenario leading to a warming at the end of the 21st century of probably more than 4°C relative to the pre-industrial period (1850–1900). For physical risks only.

Transition risk and physical risk are generally assumed to have a negative correlation. This means that when transition risk is high, physical risk is low, and vice versa. To assess both physical risk and transition risk the following scenarios are applicable for this CCRA:

Risk	SSP	Scenario
Transition Risk	SSP1-2.6	Sustainability Scenario: orderly transition leading to short and long term transition risks
	SSP2-4.5	Stabilization Scenario: late and sudden transition, leading to limited short term transition risk and high and unexpected transition risk in the medium and long term
Physical Risk	SSP2-4.5	Stabilization Scenario: delayed and sudden transition, leading to increasing physical risks
	SSP4-8.5	Business-as-usual: very limited transition, leading to high likelihood of physical risks

2.6 Time Frames assessed

For this CCRA following timeframes are evaluated

- short term 2021-2040;
- mid-term 2041-2060.

Long term period has not been assessed because this period exceeds the of lifespan project (25 years).

2.7 Risk matrix

In this CCRA Risk is define as a product op impact and likelihood:

Risk = Likelihood * Impact

The below Risk Matrix is used to indicate the risks from climate change to the project, the transition risks as well as the physical risks. By doing that most significant risks that should be mitigated can be identified.

Table 2-2 risk Matrix

Likelihood	Impact				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	Medium	High	Extreme
Moderate	Low	Low	Medium	High	Extreme
Unlikely	Low	Low	Medium	Medium	High
Very unlikely	Low	Low	Low	Medium	Medium

Table 2-3 Descriptors Likelihood

Likelihood Rating	Description
Almost certain	The event is likely to occur numerous times during the anticipated operational lifespan of the project
Likely	The event is likely to occur on several occasions during the anticipated operational lifespan of the project
Moderate	The event will occur on limited occasions during the anticipated operational lifespan of the project
Unlikely	The event will occur once during the anticipated operational lifespan of the project
Very unlikely	The event is not expected to occur during the anticipated operational lifespan of the project

Table 2-4 Descriptors Impact

Impact	Description
Insignificant	No damage to the project. No adverse effect to the surrounding environments
Minor	Small and localised damage to the project. Potential for slight adverse effect to the surrounding environments
Moderate	Limited damage to the project requiring maintenance or minor repairs, resulting in a potential effect to the project to function. Adverse effect to the surrounding environments
Major	Extensive damage to the project requiring major repairs and maintenance, resulting in a severe effect to the project to function. Significant adverse effect to the surrounding environments
Catastrophic	Permanent damage to the project, resulting in a severe lasting effect to the project to function. Very significant adverse effect to the surrounding environs requiring remediation and restoration

Whiting PKN Orlen's risk management measures for each risk should be labelled in line with the Equator Principles' Climate Change Risk Analysis categories (Accept, Mitigate, Transfer or Control).

3 Physical Risk

3.1 Introduction

In this assessment, the climate change-related risks were evaluated in terms of hazards and vulnerabilities. The impacts identified for different hazards were determined qualitatively and were defined independently of the hazards. The hazards were evaluated relative to the climate change scenarios as described in Section 3.1.2. The overall risk ratings for physical climate risks were then evaluated qualitatively based on the outcomes of the hazard assessment and their likely impact. PKN Orlen's risk management measures for each risk was defined through consultation with PKN Orlen and are labelled in line with the Equator Principles' Climate Change Risk Analysis categories (Accept, Mitigate, Transfer or Control).

3.2 Climate change scenarios

CCRA relies on up-to-date climate data to identify and analyse how the climate has changed and is projected to change. Climate projections represent how the climate will evolve in response to greenhouse gas (GHG) concentration trajectories coupled with assumed policy actions leading to reductions in GHG emissions.

3.2.1 Climate projections

The basis to predict the future climate are the scenarios developed by the Intergovernmental Panel on Climate Change (IPCC). The most recent climate projections are provided by the IPCC as published in the Sixth Assessment Report (IPCC AR6, 2022) and provides projections on a global scale.

On a regional scale, climate projections for Poland are also available under the KLIMADA program run by the Ministry of Environment. KLIMADA provides information on the climate change in Poland and its impacts on different sectors (Institute of Environmental Protection, 2022). The climate change scenarios are based on the IPCC Fifth Assessment Report (IPCC AR5, 2013) from regional climate change projections for EUROPE (EURO-CORDEX). In the KLIMADA program the projections are statistically downscaled with local meteorological data to regions with the same topography. The downscaling process adds resolution to the climate projections with additional observations which may not be present in the climate patterns of the global IPCC scenarios. A meteorological station of the Institute of Meteorology and Water Management (IMGW) is present close to the facility and adds valuable data to the KLIMADA projections.

The climate projections available from the KLIMADA program provide the best resolution in climate projections, however, is based on IPCC AR5. One of the key differences between AR5 and AR6 is the climate model data underlying many of the findings and projections, improving the overall quality of the climate projections. In addition, AR6 incorporates a better understanding of factors intrinsically linked to climate change. Together, these advancements point to more reliable models with a reduced range of possible outcomes.

In the choice of climate projections to construct future scenarios, it is essential to work with climate data that can reproduce the climate patterns at the local scale of the project. Spatial differences arise from variances in topography, such as mountainous and coastal areas, where a single pixel does not capture the full range of climate patterns. The topography in the area of Płock is considered uniform with minor spatial differences. Therefore, besides the use of the regional KLIMADA climate projections, the coarser resolution of the recent IPCC AR6 climate projections are also deemed sufficient to properly represent the

climate in the Płock region. In this assessment, both climate projections, KLIMADA and AR6, are considered and compared to provide the best bandwidth in future climate scenarios for the facility.

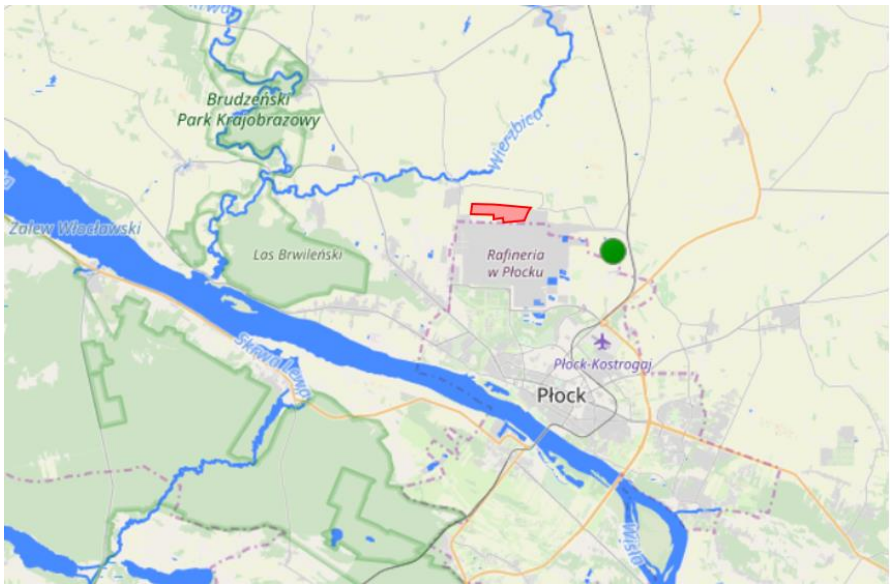


Figure 3-1: IMGW Meteorological station in Płock. In red the plots outside the plant covered by the investment.

3.2.2 Climate baseline

A climate baseline serves as the benchmark against which potential impacts of climate change are measured. The analysis of historical data helps identify trends in the climate variables and allows for the ground-truthing of the climate projections.

A current climate baseline is created to compare with the IPCC AR6 climate projections. The baseline was defined with meteorological data from the ERA5 ECMWF reanalysis model (Hersbach, et al., 2018). ERA5 provides hourly estimates of a large number of climate variables and covers the earth with a 30 km spatial resolution and a 1-hourly temporal resolution. The available resolution provides insights in the varieties over the year on a finer small scale in the past and therefore downscale the climate projections. The baseline was calculated for the period 1995-2014 to match with the changes in climate variables from the IPCC AR6 projections.

3.2.3 Physical Risk Assessment

The physical climate change risk assessment is broken down into the following steps:

1. **Hazard identification**: identify physical hazards and determine critical climate variables - which climate variables are critical to performance and durability.
2. **Determine exposure of the project to climate change related hazards**: assess how the critical climate parameters are expected to change in the future and in what way the area is already being affected by increasing variability and extremes under the current climate.
3. **Determine the risk of the project to climate change:** assess to which degree a system is susceptible to and unable to cope with adverse effects of climate change considering the local conditions. The risk is defined as Likelihood * Impact.

3.3 Hazard identification

The physical hazard exposure and associated risk are categorized in acute and chronic following the categorization provided in the Equator Principles (Equator Principles, 2020). In this categorisation, acute risks relate to extreme weather events, while chronic risks relate to gradual shifts in climate patterns.

The energy sector is particularly sensitive to changes in temperature and rainfall, and increased frequency and intensity of extreme weather events such as floods and drought. Sensitivity being the degree to which the facility is affected, either adversely or beneficially, by climate variability or climate change. All of these changes have consequences for the design of energy investment projects. The potential impacts of projected climate change of the new plot and increased water intake for the production include the following:

Table 3-1 Climate change impacts without adaptation

Climate variable	Potential climate change impacts (without adaptation)
Extreme heat	
Increases in very hot days	• Increases in water temperature are likely to reduce generation efficiency where water is used for cooling purposes. • Reduced generation efficiency and output as well as an increase in customer cooling demands • Stressing the capacity of generation and grid networks; • Hydrological changes, especially in river basins fed by melting snow and glaciers. • Increased risk of wildfire which disrupts business continuity. • Increased risk of ignition of substances released into the air. • Stressing operation of combustible gas compressors. • Disruption of supply of raw materials and finished products with restrictions in road and rail transport. • Deterioration of working conditions in production installations (apparatus, electricians, etc.), which causes absent personnel or increased number of errors and accidents.
Precipitation	
Increase in intensity and frequency of precipitation events	• Alternate discharge of river systems which may higher/lower the water level and the reliability of water intake for cooling purposes. • Increased extent and intensity of waterlogging which denies transport or access to installations. • Increased risk of run-off of pollutants/contaminants on site due to bund/pumping/drainage failure. • Disruption of availability of external utilities. • Changes in the water quality used for cooling purpose which influenced the water treatment.
Increases in drought conditions	• Increased risk of wildfires which disrupts business continuity.

Climate variable	Potential climate change impacts (without adaptation)
	• Reduce water availability from increased competition over water use for production, irrigation, and in-stream flow protection.
Extreme wind	
Increase in the intensity and frequency of storms	• Reduce the supply of raw materials and finished products with restrictions in road and rail transport. • Damage generation and limited access to the installations. • Increase fine particle matter in the air which reduce operation of combustible gas compressors and wear down the outdoor physical assets. • Increase air emission (odour or particulate) extent

To determine how climate change may affect the facilities, i.e., which climate variables are critical to performance and durability, and in what way is the area already being affected by increasing variability and extremes in these variables under the current climate, the following climate variables were chosen to assess the exposure of the identified hazards:

- Extreme heat:
  - Number of very hot days (daily maximum temperature above 35 ˚C).
- Heavy precipitation:
  - Number of intense precipitation days (1-day rainfall event exceeding 20 mm).
  - Total amount of precipitation for 1-day and 5-days.
- Drought:
  - Cumulative rainfall deficit > 300 mm.
  - Maximum consecutive dry days (days with precipitation less than 1mm/day).
- Storms:
  - Occurrence of wind speeds > 30 m/s

3.4 Acute Risks: Exposure and Risk

3.4.1 Wildfires

The overall risk score for wildfires is **Medium.**

Risk	Medium
Likelihood	Unlikely
Impact	Major

Exposure

Weather has a significant impact on the occurrence of wildfires – how a fire starts, how aggressively it spreads, and how long it burns. The exposure to wildfires is based on meteorological conditions favourable to the start, spread and sustainability of fires. The exposure to wildfires is based on the European Forest Fire Information System (EFFIS) ‘high’ classification, higher than 30.

No wildfires are experienced over the last 20 years in the direct region of Płock. The area was however exposed to an average of 10 days per year to a ‘high’ fire weather index. With no prolonged drought conditions or increased maximum temperatures, no change in intensity and frequency of favourable fire weather conditions are expected. It is unlikely the effect of climate change makes the facility increasingly exposed to wildfires.

Impact
Potential impacts of wildfires include:

- Impeded access to and operation of installations causing the process to stop partially or completely.
- Risks of transport to and from the installation. Risks associated with disruption of dispatch.
- Risks of disruption of external utilities, liability. Environmental damage because of systems failure during power interruption.

Risk management
Orlen's risk management action for wildfires is to **mitigate** and **accept**.
The installation and adjacent areas are concreted over and there is no way to transfer fire from a litter/meadow fire, etc. No tall forests are maintained around the plant and there are no trees in the area where fire could spread through the crowns. Other than that, PKN ORLEN has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.

Given this Risk Management measure, the likelihood of wildfires is expected to be Unlikely.

3.4.2 River flooding

The overall risk score for river flooding is **Low**.

Risk	Low
Likelihood	Very unlikely
Impact	Moderate

The Olefin facility is close to the Vistula River located 3 km in the south. The source of water supply for the production plant is from the Vistula River located on river km 635 in a bay. The Vistula River floods with a seasonal character, in spring floods occur due to rapid melting of large amounts of ice and snow in the mountains. The accumulation of large amount of ice often leads to ice jams resulting in high water stages.

Since the beginning of the operations of the water intake facility in the 1960's two floods occurred in the Płock region in 1979 and 2010 from rapid snow melt. The flood of March 2010 caused high water from the breakup of ice upstream which resulted in a sudden water damming (Figure 3-3). Both floods had a river discharge considered with a return period of 100 year and did not impact the water inlet facility. The facility was not flooded as it is equipped with embankments and the operations were not interrupted as the pumping stations are equipped with additional high-water protection to pump water from leaks with basic process pumps.

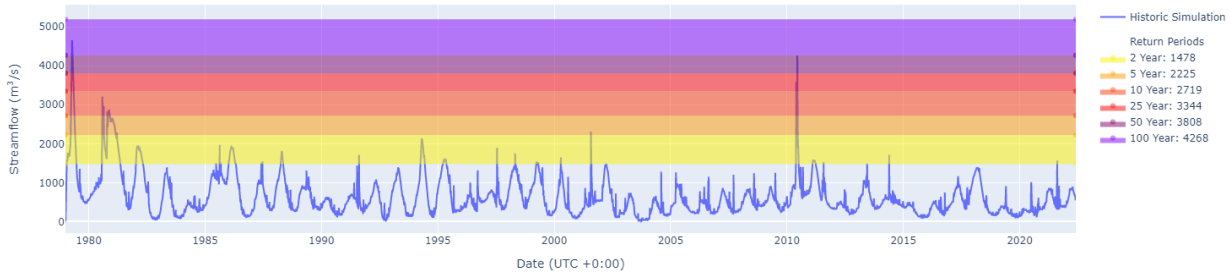


Figure 3-2: Historic discharge (m^3/s) of the Vistula River. The floods of 1979 and 2010 show a discharge considered with a return period of 100 years (GEOGloWS ECMWF, 2021).

Figure 3-3: The flooded area on the right bank of the Vistula River in Płock during the ice jam on 3 March 2010.

Exposure

Flood hazard maps are available from the national water management institute Wody Polskie (Wody Polskie, 2022) for both river and coastal floods from high to low probability (Return Period of 10, 100, 500 years). The use of return periods aims to attach probabilities to the flood events. No flood hazard maps are provided under future climate conditions.

The Olefin facility and water intake facility including the new plot do not fall within the flood hazard area and both are therefore not directly exposed to river floods up to a return period of 500 years (low probability of flooding). The flood extent is confirmed as the locations were not flooded in the past floods of 1979 and 2010.

If the peak river discharge is increased by climate change, the frequency of the most extreme event, return period 500 years, is expected to increase, resulting in a higher probability (e.g. return period changes from 500 to 300 years). As the facilities do not flood up to a return period of 500 years, it is very unlikely the effect of climate change makes the facility exposed to river flooding.

Impact

Potential impacts of river flooding include:

- Reliability of water intake for cooling purposes at the water inlet.
- Impeded transport to and from the installation (including rail, road transport, pipeline) impacting on reliability of supply chain.
- Risks related to the availability of external utilities (including energy, e.g. damage to HV transmission lines, power system blackout).

Risk Management

Orlen's risk management action for river flooding is to **mitigate** and **accept**.

The current flood protection measures in place of the water inlet facility, both embankments and pumping stations, are at least designed to withstand 100-year flood events as can be proven from the past. The facility also does not flood for a 500-year flood event based on the Wody Polskie flood hazard data. Therefore, it is unlikely that future flood levels will impact the water inlet facility and the consequence of climate change is considered minor.

Orlen has explained in its risk mitigation measures that onsite power generation capacity and supply chain resilience strategies manage for other risks related to impeded transport and availability of external utilities.

Given this Risk Management measure, the likelihood of river flooding is expected to be Very Unlikely.

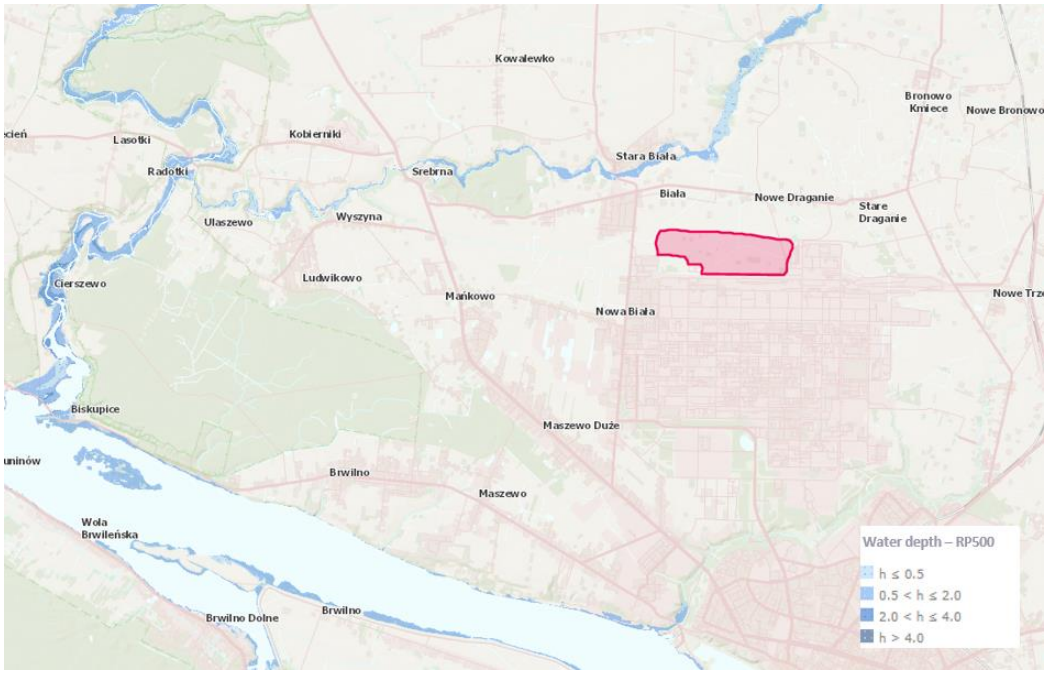


Figure 3-4: River flood hazard map for a RP500. In red the plots outside the plant covered by the investment (Wody Polskie, 2022).

Figure 3-5: River flood hazard for RP10 (left), RP100 (middle) and RP500 (right) for the water intake facility (Wody Polskie, 2022).

3.4.3 Storms

The overall risk score for storm events is **Low.**

Risk	Low
Likelihood	Very unlikely
Impact	Moderate

Exposure

The intensity and frequency of the current and climate projections of the existing wind speed conditions are based on the wind speeds from the KLIMADA program. Wind speed differences are highly dependent on the local topography to capture the abrupt increase in wind and its turbulent signature. Therefore, the wind speeds from the KLIMADA program, which includes observational data from the IMGW Meteorological station in Płock, are deemed the best representative for the facility.

Wind speeds thresholds with considerable damage to buildings (e.g. by large branches) and chance for business interruption are:

- 20 m/s - slight damage to buildings and disruption of traffic and outside activities.
- 28 m/s - considerable damage to buildings and dangerous situations for traffic.
- 31 m/s - widespread damage and no travel if not strictly necessary.

No wind speeds are observed above 30 m/s for the current climate and all climate projections. Further, for the category of wind speeds 10-30 m/s, no significant change in wind speed intensity and frequency is expected under any climate projection. It is very unlikely that the effect of climate change exposes the facility to storm events with wind speeds higher than 20 m/s.

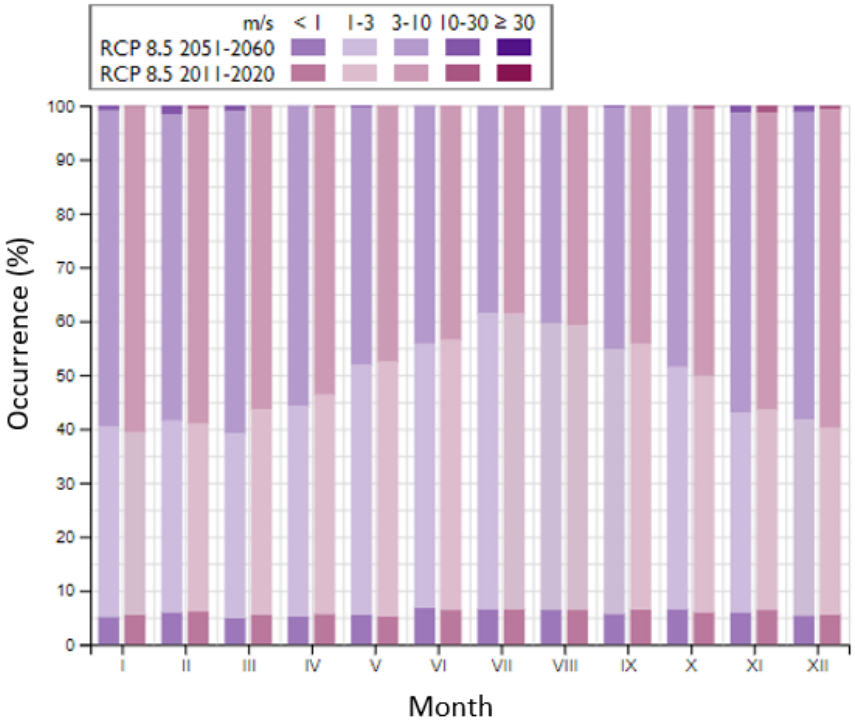


Figure 3-6: Occurrence of wind speeds per month for the baseline and under RCP8.5 2051-2060 (Institute of Environmental Protection, 2022).

Impact

Potential impacts of storm events include:

- Damage to assets and limited access to site. Impact on ability to operate facilities.
- High winds (in combination with) fine particulate matter a major hazard for the operation of combustible gas compressors.
- High wind speeds and gusts (in combination with fine particulate matter) leading to increased wear and damage of all outdoor, physical assets.

- Changes wind dynamics (speed and direction) in the region leading to air emissions (odour or particulate) impacting a larger area of the environment/community.

Risk Management
Orlen's risk management action for storms is to **accept**.
PKN ORLEN has an extensive set of terminals connected to the rail and road network, so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Given this Risk Management measure, the likelihood of storms risk is expected to be Very Unlikely.

3.5 Chronic Risks: Exposure and Risk

3.5.1 Increased precipitation

The overall risk score for increased precipitation is **Low**.

Risk	Low
Likelihood	Unlikely
Impact	Minor

Exposure
Rainfall is experienced year-round with highest day precipitations in the spring and summer months. The intensity of rainfall events is projected to slightly increase with a few mm throughout the year for all climate projections. The rainfall intensities are given for the maximum 1-day rainfall together with the maximum 5-day rainfall in Figure 3-7 and Figure 3-8.

In the baseline the rainfall maximum is 20 mm/day in July. No increase in the monthly number of days with extreme rainfall (>20 mm/day) are projected to significantly increase under all climate projections.

Pluvial flood events can occur from moderate rainfall events if it occurs simultaneously with already elevated water levels. Also, for the maximum 5-day rainfall, no significant changes are projected for all climate projections. This means that the same intensity in rainfall is expected to occur with the same frequency.

The same conclusions are visible in the KLIMADA probability of occurrence of the number of days with a given precipitation. An average of 1.8 days with extreme rainfall (>20 mm/day) are experienced per year. No significant changes are seen for the full rainfall intensity and frequency spectrum under all climate projections.

Based on both datasets, it is unlikely the effect of climate change makes the facility increasingly exposed to increased precipitation events.

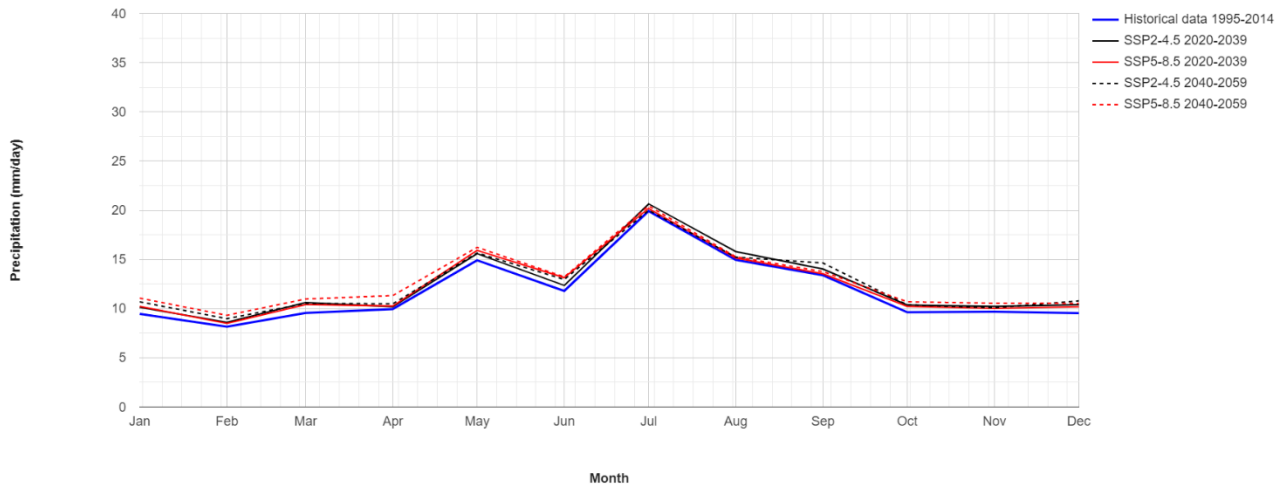


Figure 3-7: Monthly maximum 1-day precipitation

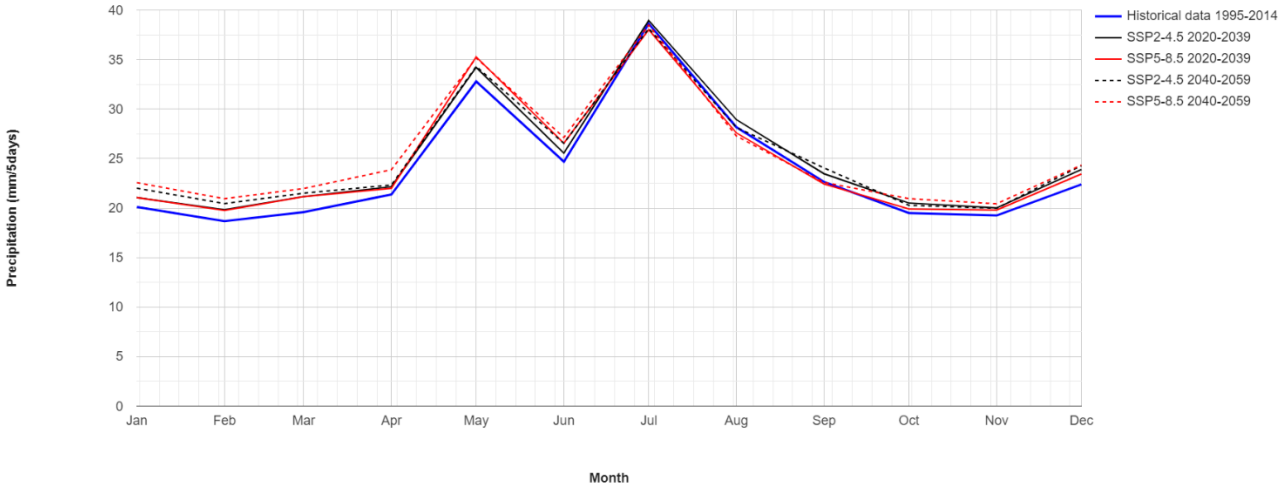


Figure 3-8: Monthly maximum 5-day precipitation

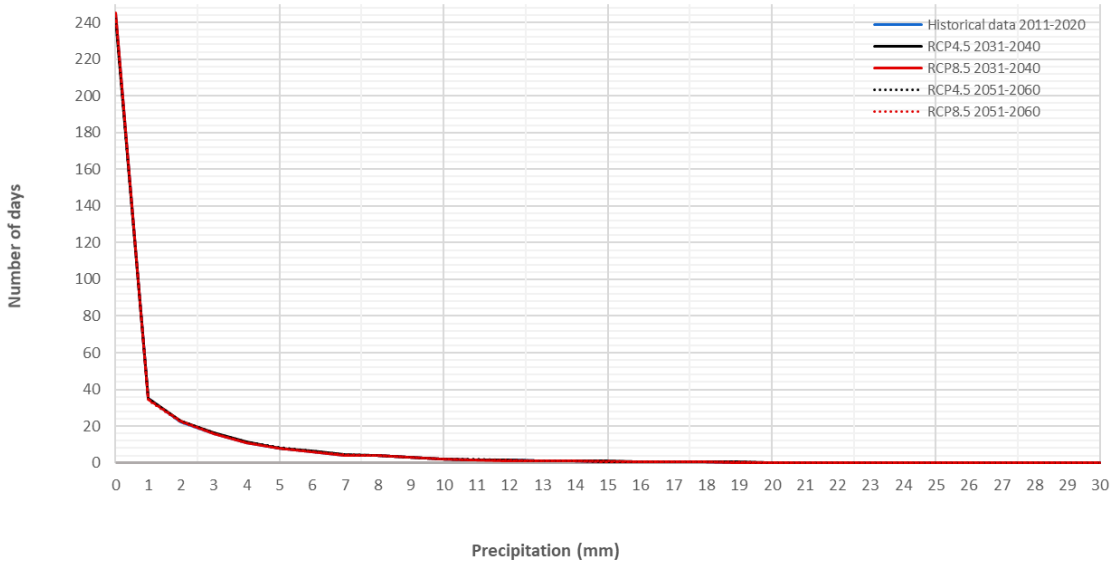


Figure 3-9: The probability of occurrence of the number of days with a given precipitation. Source: KLIMADA

Impact

Potential impacts of increased precipitation include:

- Pluvial flooding on the site resulting in reduced access to equipment and impacts on process control.
- Alternate discharge of river systems which may alter the reliability of water intake points resulting in less availability of process water.
- Increased extent and intensity of waterlogging on site, resulting in soil subsidence.
- Increased flow of water on and around the site, resulting in larger quantities of (polluted) run-off and potential overflow of existing bunds/water management systems.
- Inundation/excess hydraulic load on onsite water treatment systems.

The design standard for the drainage is based on the precipitation recorded in Płock over the period 1991-2020. The future values are not considered to change and therefore the design level is considered sufficient to account for climate change. Therefore, it is unlikely that the intensity and frequency of precipitation is changed and the consequence of climate change is considered minor.

Risk Management

Orlen's risk management action for increased precipitation is to **accept**.

3.5.2 Decreased precipitation

The overall risk score for decreased precipitation is **Low**.

Risk	Low
Likelihood	Unlikely
Impact	Minor

Exposure

Drought in general is quantified by taking the difference between the amount of precipitation and the potential evaporation. This cumulative rainfall deficit is a robust way to quantify droughts as it considers how much 'relief' a rain event brings in the existing hydrologic conditions. A serious drought situation is taken where the cumulative rainfall deficit is above the threshold of 300 mm.

The region around the facility experiences drought conditions a few days per year with an average of 8 days/year. The maximum number of consecutive dry days, days with precipitation less than 1 mm/day, is an average of 19 days. No significant change in the intensity and frequency of severe drought conditions are predicted under all climate projections in the direct region of the facility. It is unlikely the effect of climate change makes the facility increasingly exposed to severe drought conditions.

Impact

Potential impacts of decreased precipitation (increase frequency and duration of droughts) include:

- Increased relative fire hazard to processes, personnel, and supply chain.
- Less water available for key processes, resulting in reduced capacity or shut down during drought periods.
- Risk of reputational damage and loss of licence to operate due to competition with local/downstream populations for use of water.

The source of water supply for the production plant is from the Vistula River located on river km 635 in a bay. The water level of the Vistula River does not fall below 5 m, which guarantees the constant availability of water even during drought and low discharge conditions in the summer months. The current water intake facility is designed to draw water at a much lower water level and has not failed since the start of the water inlet facility in the 1960's. No significant change is expected in severe hydrological drought conditions, therefore it is unlikely that climate change will impact the availability of water and the consequence of hydrological drought is considered low.

Risk Management

Orlen's risk management action for decreased precipitation is to **accept**.
The new wastewater treatment plant helps to mitigate the exposure to decreased precipitation.
Given this risk management measure, the likelihood of droughts is expected to be Unlikely.

3.5.3 Extreme heat

The overall risk score for extreme heat is **Low**.

Risk	Low
Likelihood	Unlikely
Impact	Minor

Exposure

The monthly maximum temperature is projected to increase for all months under all climate scenarios. For the short-term (2020-2039) the increase is 0.5-1.5 ˚C under both SSP4.5 and SSP8.5. Difference between the scenarios is observed for the mid-term (2040-2059), with an increase of 1.3-2.0˚C and 1.8-3˚C, respectively under SSP4.5 and SSP8.5. The highest maximum temperature increase is observed in the summer and winter months. In summer, the projected temperature increase results in days with temperatures above 30˚C, however hot days, days with daily maximum temperature above 35 ˚C, are not expected.

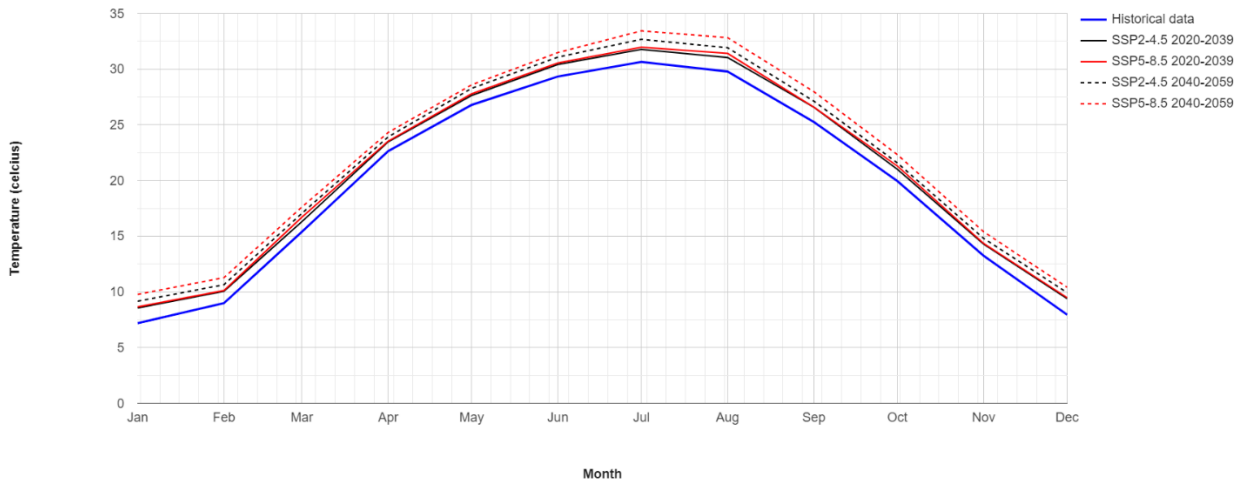


Figure 3-10: Monthly average maximum temperature IPCC AR6

In the KLIMADA data the maximum temperature is considered lower for all months and shows an underestimation of the temperatures in the summer compared to the IPCC AR6 projections. Extreme heat is not experienced with maximum temperatures far under the 30˚C for all months.

Based on both datasets, it is unlikely the effect of climate change makes the facility increasingly exposed to extreme heat.

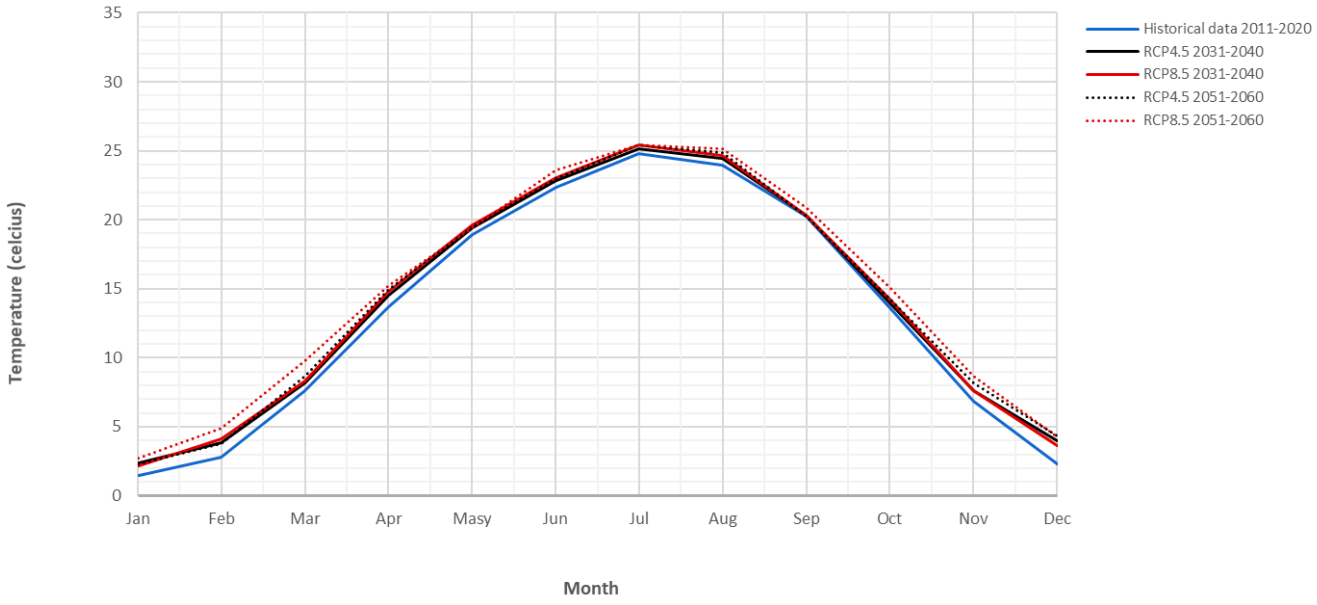


Figure 3-11: Monthly average maximum temperature KLIMADA (Institute of Environmental Protection, 2022)

Impact

Potential impacts of extreme heat include:

- Reduction in the productivity of personnel operating the installation due to excessive heat in the workplace leading to increased errors and accidents.
- Increases in fugitive emissions (and subsequent risk of combustion) of volatile and flammable substances.
- Equipment doesn't operate or malfunctions at higher temperatures.

- Decreased performance or efficiency of wastewater treatment facilities on site resulting in failure to meet treatment requirements.
- Decrease in reliability or availability of external utilities.

Risk Management
Orlen's risk management action for extreme heat is to **accept** and **mitigate**.

3.5.4 Sea level rise

Sea level rise was not evaluated as part of this risk analysis as the facilities are not exposed to coastal flooding in the flood hazard maps from Wody Polskie (Wody Polskie, 2022).

3.6 Summary Physical Risks

Climate change does not seem to cause significant changes in risks for the project. The risks scores are therefore Low, except for wildfires. Even though the likelihood of wildfire is unlikely, the impact can be major!

Table 3-2 Risk scores and mitigation measures

Climate related Hazards	Risk Description	Risk Score (L/M/H/E)	Time Horizon (ST / MT)	Management Action PKN Orlen	Mitigation Measures
Acute (event driven extreme weather)					
Wildfires	>Risks to safety of processes due to presence of flammable compounds on site. >Risks to supply chain if transit routes are affected. >Risks related to the availability of external utilities (incl. energy, e.g. damage to HV transmission lines, power system blackout)	M	ST-MT	Accept / mitigate	General remark: during construction period risk of fire is minor: 1. Surrounding of the Project has little impact on fire transfer [no forests, only lands with fields]. 2. During construction there is no flammable feedstocks. During construction phase: fireproof materials on steel frames [resistant for 1 hour of fire], there are detection and warning systems. PKN Orlen has own Fire safety brigade which can react fast.
Flooding	>Risks of disruption to process and supply chain. >Increased risk of pollution due to run-off of chemicals on site. >Risks related to the availability of external utilities (including energy, e.g. damage to HV transmission	L	ST-MT	Accept / mitigate	Olefins Complex located far from Wistula river and significantly above water level. All drains connected to close drainage system. No on paving.

Climate related Hazards	Risk Description	Risk Score (L/M/H/E)	Time Horizon (ST / MT)	Management Action PKN Orlen	Mitigation Measures
	lines, power system blackout);				
Storms	>Damage to assets and interruption of supply chain due to more extreme storm events and higher wind speeds. >Risk of not meeting regulatory requirements around air emissions, due to changing wind speeds and directions. >Intensifying phenomena of strong wind plus soil erosion may increase the average level of PM 2.5 and silica particles in the air	L	ST-MT	Accept / mitigate	Majority of feedstock comes from other PKN facilities in Płock. Those delivered from others can be substituted Within the scope of ISBL, a retention reservoir is being designed - to take over an extraordinary amount of rainwater
Chronic (shifts in climate patterns)					
Increase in precipitation	>Risks in more frequent pluvial flooding of the site, a greater flow of water on the site (transporting pollutants), and possibility of increased waterlogging and soil subsidence issues over time. >Alternate discharge of river systems which may lower the water level and reliability of water intake	L	MT	accept	All drains connected to closed drainage system. No hydrocarbon on paving.

Climate related Hazards	Risk Description	Risk Score (L/M/H/E)	Time Horizon (ST / MT)	Management Action PKN Orlen	Mitigation Measures
Decrease in precipitation	>Changes in the quality of river water used for cooling and processes requiring more/different treatment. >Wetlands north of Olefins III dry out, increasing fire risk. >Restrictions on raw water abstraction. >Reduced water availability from increased competition over water use for production, irrigation, and in-stream flow protection and risk of reputational damage.	L	MT	accept	Water treatment is being prepared for different pollutants [biological, mechanical and chemical]. Project uses proper equipment and chemical programmes
Extreme Heat	>Risk of increased fugitive emissions, and subsequent fire hazards. >Risk of worsening efficiency/performance of process equipment over the long term. >Heightened rate of corrosion of steel structures resulting in the need for more frequent painting and protection Risks in worsening efficiency of personnel and equipment, safety hazards for personnel and risks in increasing fugitive emissions from "breathing" of tanks. >Risks of reduction in productivity of personnel due to excessive heat in workplace	L	MT	Accept / mitigate	Cooling water tower can be impacted, Plant capacity can be potentially reduced. 1. Personnel protection: personnel staff on site is provided with electrolytes 2. during a heatwave, the tanks are cooled by a sprinkler system [e.g. spherical tanks]

Climate related Hazards	Risk Description	Risk Score (L/M/H/E)	Time Horizon (ST / MT)	Management Action PKN Orlen	Mitigation Measures
Sea level rise/coastal flooding	>Risk that Vistula River and its tributaries break their banks with greater frequency, leading to flooding of some waterfront areas of Płock.	L	MT	accept	Low risk as Olefins Complex located far from Vistula river and significantly above water level.

Table 3-3 Physical Risks and impacts

Climate Related Risks	Scenarios				Potential Financial				Potential Impact on					Potential Opportunities			
	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Delayed Transition SSP 7 (3.0°C)	Limited Transition SSP 8.5 (4.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (Asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Acute (event driven extreme weather)																	
Wildfires		X		X		X		X		X	X	X	X				
Flooding		X		X		X		X		X	X	X	X				
Storms		X		X		X		X	X	X	X	X	X				
Chronic (shifts in climate patterns)																	
Increase in precipitation		X		X		X					X	X					
Decrease in precipitation		X		X		X			X	X	X	X	X	X			
Extreme heat		X		X		X			X	X		X					
Sea level rise/coastal flooding		X		X		X					X	X					

4 Transition risk

4.1 Introduction

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 organizations.

4.1.1 Scope and limitations

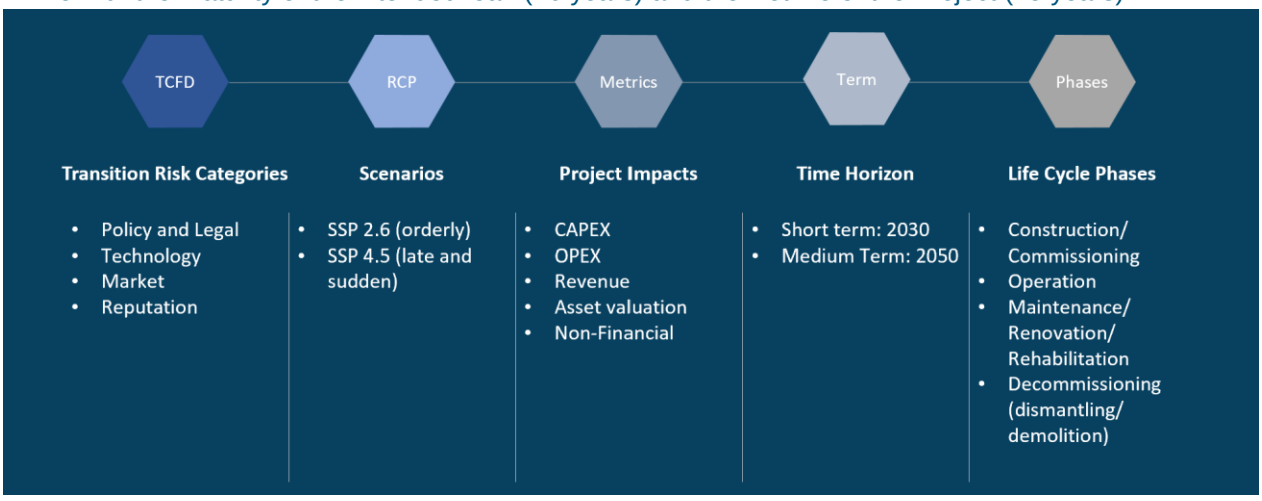
Transition risk in this report is limited to The Project. Transition risks of the wider PKN Orlen are out of scope. This CCRA is a qualitative assessment. Quantitative analysis used was performed by PKN Orlen, or has been estimated based on literature, research and empirical information.

When interpreting the results of the transition risk assessment in this CCRA, it is critical to understand its background and limitations.

4.1.2 Methodology

The TCFD reporting framework has been used to structure the transition risk analysis. It builds on 4 categories, Policy and Legal, Technology, Markets and Reputation. Scenarios used to assess transition risk are SSP 2.6 (orderly transition) and SSP 4.5 (late and sudden transition).

Transition risk impact is measured by financial (CAPEX, OPEX, Revenue, Asset valuation) and non-financial project impacts. Time horizons investigated are short term (around 2030) and medium term (around 2050). These cover the first three life cycle phases (decommissioning left out of scope), which is in line with the maturity of the intended loan (16 years) and the lifetime of the Project (25 years).



4.1.3 Process

The transition risk assessment of this CCRA has been performed in 5 steps
Step 1: Desk Research
Step 2: Questionnaire
Step 3: Findings
Step 4: Workshop
Step 5: Report

Desk research

Relevant transition risk documents received and reviewed:

The Project
- ESDD Ramboll, July 2022
- CCRA Multiconsult, 6 June 2022
- Project Olefiny III INFORMATION MEMORANDUM, draft 1.0, 5 July 2022

PKN Orlen
- PKN Orlen Website
- ORLEN Group's 2030 Strategy
- Integrated Report 2020
- Integrated report 2021
- Non-Financial Statement 2021
- Green Finance Framework, May 2021 (incl Second Party Opinion and CBI Verification Report)
- Report PPZ: Extract from PKN „climate risk analysis" for Petrochemical Units
- Slide (1): Identification, assessment and management of climate change risks in the short, medium and long term - risks of the energy transition. Note: date of report unclear, scope PKN Orlen before merger with Lotos
- Slides (2): McKinsey market projections

Questionnaire

A questionnaire consisting of 63 questions was used for assessing all identified transition risks. The Royal HaskoningDHV version V202211.1 CCRA transition risk questionnaire has been used, which was customized for The Project.

Calls and workshop

PKN Orlen: project management, legal, engineering, finance and risk, sustainability, regulatory, strategy
Ramboll: introduction call on gap findings and approach
SMBC (Sumitomo Mitsui Financial Group): loan structure and transition risk impact

4.2 Assessment

4.2.1 General

TCFD is structured around four thematic areas that represent core pillars of how organizations operate: governance, strategy, risk management, and metrics and targets. Related to this CCRA, the following observations and recommendations can be made for these four pillars in relation to transition risk:

- Governance
  The organization's governance around transition risk is managed by "PKN Orlen Sustainability and Energy Transition Office". They identify and manage transition risks for the whole of PKN Orlen, in cooperation with the regulatory risk management area. This includes The Project.

- Strategy
  PKN Orlen has a clear 2030 strategy as disclosed in the integrated 2021 report. Also a 2050 ambition is stated: become a net zero carbon business. The Project contributes to lowering carbon emissions by 30% and was as such included in the ORLEN2030 business strategy.

  Every strategy also needs a risk strategy. PKN Orlen published a first transition risk analysis for the company in 2021. For The Project no dedicated transition risk strategy was created. The centrally managed transition risk strategy however does not cover all elements which are relevant for The

Project. It is advisable for future projects to include a project-specific transition risk strategy and related financial planning.

- Risk Management

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- Metrics and Targets
  Several metrics and targets used to assess and manage relevant climate-related risks and opportunities for The Project have been shared with Royal HaskoningDHV. This showed several key metrics and targets have been identified (like carbon price, customer demand, etc), but not all components relevant to The Project. Additionally, performed transition risk related stress tests of the project financials were mild and not deemed very realistic for transition risk scenarios SSP 2.6 and SSP 4.5, especially for the medium term. For future projects a more comprehensive, consistent and extreme stress test approach of metrics and targets is advisable.

4.2.2 Key Transition Risks

Below table gives a high-level overview of the key risks investigated in this CCRA. Further detailed findings per risk can be found in the next paragraphs of this chapter.

Type	Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
		Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Transition Risk	**Policy and Legal**																		
	Pricing of GHG emissions	H	ST-MT	Accept	X	X		X	X	X			X				X	X	
	Enhanced emissions-reporting obligations	L	ST	Accept	X	X					X				X				
	Mandates on and regulation of existing products and services	M	ST-MT	Accept	X	X	X		X	X	X		X		X			X	X
	Exposure to litigation	L	ST-MT	Control	X	X			X	X	X				X				
	Technology																		
	Substitution of existing products and services with lower emissions options	M	MT	Accept	X	X	X			X				X		X		X	X
	Unsuccessful investment in new technologies	L	MT	Accept	X	X	X			X				X		X		X	X
	Costs to transition to lower emissions technology	H	ST-MT	Mitigate	X	X	X	X		X				X		X		X	X
	Market																		
	Changing customer behavior	L	MT	Mitigate	X	X			X	X								X	X
	Uncertainty in market signals	M	ST-MT	Mitigate	X	X		X		X				X		X		X	X
	Raw materials for construction and maintenance	M	MT	Accept	X	X	X			X			X	X					
	Reputation																		
	Stigmatization of sector	L	MT	Control	X	X			X			X			X			X	X
	Increased stakeholder concern or negative stakeholder feedback	L	MT	Control	X	X			X						X				

Legend		
	Low Risk	L
	Medium Risk	M
	High Risk	H
	Extreme Risk	E
	Short Term (2030)	ST
	Medium Term (2050)	MT
	Applicable	X

4.2.3 Policy and Legal

Climate-related policies and regulation are continuously evolving. Generally, new policies/regulations attempt to (a) mitigate climate change or (b) promote adaptation to climate change. Additionally legal risks are important to consider, especially in the context of climate-related disclosures, failing action to mitigate or adapt to climate change.

The transition risk type "Policy and Legal" is split into 4 categories for the purpose of this CCRA:

- Pricing of Greenhous Gas (GHG) emissions;
- Enhanced emissions-reporting obligations;
- Mandates on and regulation of existing products and services;
- Exposure to litigation.

Each category is assessed on potential direct effects for The Project, but also the potential second and third order effects on its supply and distribution chains, where applicable.

4.2.3.1 Pricing of GHG emissions

Preventing or reducing the emission of greenhouse gases (GHG) into the atmosphere is the key policy and regulatory mechanism to making the impacts of climate change less severe. Overall Transition Risk of the category "Pricing of GHG emissions" is **high**.

Risk	High
Likelihood	Likely
Impact	Major

Five key instruments impacting pricing of GHG emissions (directly or indirectly) have been investigated in this section. Below overview shows those instruments and how these have been assessed in relation to The Project.

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Policy and Legal																		
Pricing of GHG emissions	H	ST-MT	Accept	X	X		X	X	X			X				X	X	
EU Emission Trading System (EU ETS)	*H*	*ST-MT*	*Accept*	*X*	*X*			*X*	*X*									
Energy Taxation Directive (ETD)	*L*	*ST-MT*	*Accept*	*X*	*X*		*X*									*X*		
Plastic tax (virgin products)	*M*	*MT*	*Accept*	*X*	*X*			*X*										
Plastic tax (excise goods)	*L*	*ST-MT*	*Accept*	*X*	*X*			*X*										
Carbon Border Adjustment Mechanism (CBAM)	*L*	*MT*	*Accept*	*X*	*X*			*X*									*X*	

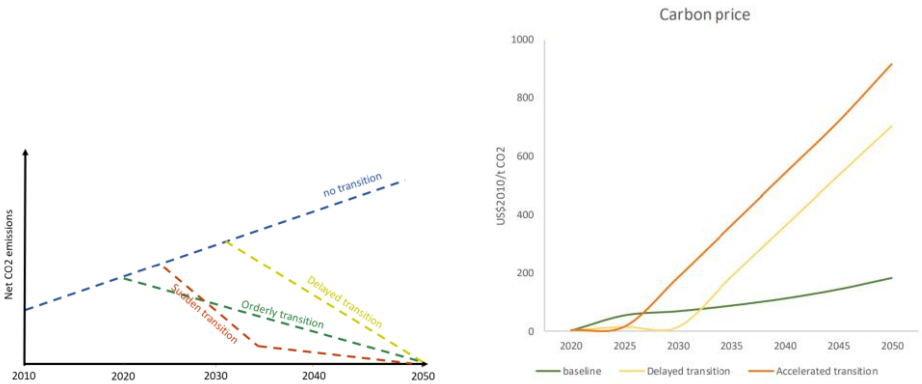
EU Emission Trading System (EU ETS)

Risk	High
Likelihood	Likely
Impact	Major

Carbon pricing is a key element for stress testing. Increased carbon price levels can lead to high impact on OpEx and revenues. In case of prolonged high pricing also impacting capital (asset valuation).

Below the historic prices of Carbon (EU ETS) are shown for the years 2021-2022. Before 2021, prices have been between roughly 10-30 Euro per metric ton. As can be seen, the price level as of 13 December 22 is 88.99 Euro per metric ton. Generally accepted levels of carbon pricing in 2030 range between 50 and 200 Euro per metric ton.

Figure 4-1 ICE endex (source Intercontinental Exchange)



Source: Climate risk analysis and supervision. Scenarios and main assumptions of the ACPR (Banque de France) pilot climate exercise 2020. https://acpr.banque-france.fr/en/scenarios-and-main-assumptions-acpr-pilot-climate-exercise

As can be seen from the Banque de France stress test (to take a financial industry benchmark example), for SSP4.5 (sudden and accelerated transition) stress scenarios should even be much higher (for 2030 +150% and for 2050 +1000%). PKN Orlen have stress tested The Project accordingly resulting in the following outcomes (see table below).

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Energy Taxation Directive (ETD)

Risk	Medium
Likelihood	Likely
Impact	Moderate

Impacting excise goods, the Energy Taxation Directive (ETD) is becoming more strict with new regulation effective 2023. This new regulation will be implemented gradually domestically in the EU. It can be expected to be updated over time and becoming even more strict.

Theoretically ETD could lower feedstock cost of, among others, gas and crude oil potentially as a result of dropping customer demand. This could be an opportunity for The Project, however is unlikely to happen as it would be an adverse effect of the ETD. The risk from the ETD for The Project in the short term is viewed as limited as it's being implemented gradually by each country and Poland has not been a first mover historically. For the long run this can have a significant impact on The Project though. The risk is partially mitigated by internal sourcing of energy sources and feedstock within PKN Orlen.

Theoretically ETD could lower feedstock cost of amongst other gas and crude oil potentially as a result of dropping customer demand. This could be an opportunity for The Project, however is unlikely to happen as it would be an unintended adverse effect of the ETD, which will probably trigger policy intervention.

Plastic tax (virgin products)

Risk	Medium
Likelihood	Unlikely
Impact	Moderate

As part of the Green Deal, countries in the EU are taking different measures per country on plastic taxation. One scenario is a taxation on new plastics (virgin products), which will be charged to the manufacturer. As an example, The Netherlands has published a report about the possibilities to introduce a national tax on virgin plastic, probably taxed when plastic granules and powder are sold to producers of plastic products.

Plastic tax (excise goods)

Risk	Low
Likelihood	Likely
Impact	Insignificant

Next to the previous section, it is expected the Green Deal will trigger further interventions on plastic tax of excise goods (like plastic bags and single use packaging). This can have an impact on demand, however this is deemed limited of impact for The Project as only a small part is used for products which are expected to be taxed. For the majority of products, alternatives are limited and growth of demand is expected regardless.

Carbon Border Adjustment Mechanism

Risk	Low
Likelihood	Unlikely
Impact	Insignificant

The Carbon Border Adjustment Mechanism (CBAM) is protecting the international level playing field on carbon. A less strict regime from the mid 2030 or international more strict regulation may have downside effects on The Project, this however is only expected when international standards are ore aligned. The CBAM becoming stricter might bring possible opportunities, as The Project market is predominantly Europe.

4.2.3.2 Enhanced emissions-reporting obligations

Enhanced emission-reporting obligations are becoming increasingly strict for companies, triggered by regulatory, sector, investors and other stakeholders. Increased pressure will only have limited indirect impact on revenue. The main risk could be related to non-compliance of The Project which could lead to reputational and licence risks. These risks however are strongly mitigated by the overall focus of PKN Orlen on this category and the fact that The Project in isolation will likely not be impacted. Overall Transition Risk of the category “Enhanced emissions-reporting obligations” is **Low**.

Risk	Low
Likelihood	Unlikely
Impact	Minor

Four areas have been investigated which could impact enhanced emission-reporting obligations. Below overview shows those areas and how these have been assessed in relation to The Project.

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Policy and Legal																		
Enhanced emissions-reporting obligations	L	ST	Accept	X	X					X				X				
Additional reporting requirement for companies in the petrochemical sector	*L*	*ST*	*Accept*	*X*	*X*									*X*				
Increased reporting requirement for regulators	*L*	*ST*	*Accept*	*X*	*X*					*X*				*X*				
Increased reporting for listed companies	*L*	*ST*	*Accept*	*X*	*X*					*X*				*X*				
Increased reporting for investors, lenders and insurers due to increased regulatory requirements for the financial services sector	*L*	*ST*	*Accept*	*X*	*X*					*X*				*X*				

Additional reporting requirement for companies in the petrochemical sector

Risk	Low
Likelihood	Likely
Impact	Insignificant

With the sector being disallowed to the SBTi reporting framework, possible more strict requirements for the sector will emerge, including preventive measures against green washing. The risk for The Project is expected to be low.

Increased reporting requirement for regulators

Risk	Low
Likelihood	Moderate
Impact	Minor

With Poland currently not being the most strict in Europe, the reporting requirements could increase over time following EU alignment and further requirements. The risk for The Project however is expected to be low.

Increased reporting for listed companies

Risk	Low
Likelihood	Moderate
Impact	Insignificant

Listed companies are first to be exposed to increased reporting requirements and have the highest frequency of reporting. Public reporting on a quarterly basis of key emission metrics to be signed off by the accountant can easily become a standard requirement. The risk for The Project is low.

Increased reporting for investors, lenders and insurers due to increased regulatory requirements for the financial services sector

Risk	Low
Likelihood	Moderate
Impact	Minor

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4.2.3.3 Mandates on and regulation of existing products and services

Overall Transition Risk of the category “Mandates on and regulation of existing products and services” is **Medium**.

Risk	Medium
Likelihood	Unlikely
Impact	Major

Seven areas have been investigated which could impact mandates on and regulation of existing products and services. Below overview shows those areas and how these have been assessed in relation to The Project.

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Policy and Legal																		
Mandates on and regulation of existing products and services	M	ST-MT	Accept	X	X	X		X	X	X		X		X			X	X
Greenhouse gas emission permit (construction phase)	*M*	*ST*	*Accept*	*X*	*X*			*X*	*X*	*X*								
Free emission allowances (construction phase)	*M*	*ST*	*Accept*	*X*	*X*			*X*	*X*									
Free emission allowances (operational phase)	*M*	*ST-MT*	*Accept*	*X*	*X*			*X*	*X*									
Local regulation	*L*	*ST-MT*	*Accept*	*X*	*X*					*X*				*X*				
National regulation	*L*	*ST-MT*	*Accept*	*X*	*X*					*X*				*X*				
Chemical sector regulation	*M*	*ST*	*Accept*	*X*	*X*			*X*	*X*	*X*				*X*				
Certification	*L*	*ST-MT*	*Accept*	*X*	*X*			*X*										

Greenhouse gas emission permit (construction phase)

Risk	Medium
Likelihood	Very Unlikely
Impact	Major

PKN Orlen: "In accordance with the „Act on the greenhouse gas emission allowance trading system" (Journal of Laws of 2021, item 1047) for the Olefins III Complex, the application for a greenhouse gas emission permit will be submitted to the competent authority approximately 5 months before the operation of the installation. After obtaining the permit, the emission will be monitored in accordance with the approved methodology contained in the Emission Monitoring Plan."

RHDHV: The risk for The Project is deemed low given the short timeline and no precedents/litigation of similar cases.

Free emission allowances (construction phase)

Risk	Medium
Likelihood	Unlikely
Impact	Moderate

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RHDHV: Given the short period the likelihood is expected to be low, the impact however would be moderate. Resulting in a medium risk score.

Free emission allowances (operational phase)

Risk	Medium
Likelihood	Moderate
Impact	Moderate

The transition to auctioning is taking place progressively. It is not unimaginable the petrochemical sector over time will, like the power generation sector, not have free emission allowances anymore (except maybe for modernising). Likelihood increase compared to the construction phase, but still overall to be Medium.

Local regulation

Risk	Low
Likelihood	Very unlikely
Impact	Moderate

Local regulation is not expected to be impacting The Project significantly from a transition risk perspective, as these are generally less severe compared to national and EU regulation.

National regulation

Risk	Low
Likelihood	Unlikely
Impact	Moderate

PKN Orlen: “National regulation in terms of GHG emission pricing and reporting obligation is limited to minimal implementation of the EU regulation requirements, i.e. EU ETS Directive, rules on non-financial reporting. It is not expected to change. More strict national regulations would lead to increased higher compliance costs.”
“Additional EU regulation in place and applied are: REACH, CPL. The national "Act of 25 February 2011" is in Force to comply with both REACH and CPL.”

RHDHV: based on the feedback from PKN Orlen it is not expected Polish regulation is going to be progressively restrictive. It will likely keep its current stance in relation to complying the minimal requirements of the EU regulations.

Chemical sector regulation

Risk	Medium
Likelihood	Moderate
Impact	Moderate

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Certification

Risk	Low
Likelihood	Moderate
Impact	Minor

Certification related to permits and licences will be impacted over time due to more and changed climate criteria, higher auditing standards and additional disclosures. The risk of not being able to comply however is deemed manageable, though it can come at a cost.

4.2.3.4 Exposure to litigation

The risk of being sued in court for failing to take appropriate climate action and be held accountable for past actions, for failing to comply with existing climate obligations and regulations, and for the lack of climate-related ambition. See link: https://www.ngfs.net/sites/default/files/medias/documents/climate_related_litigation.pdf.

Expectation is this is limited risk in Poland. Overall Transition Risk of the category “Exposure to litigation” is **Low**.

Risk	Low
Likelihood	Unlikely
Impact	Minor

Three areas have been investigated which could impact enhanced emission-reporting obligations. Below overview shows those areas and how these have been assessed in relation to The Project.

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Policy and Legal																		
Exposure to litigation	L	ST-MT	Control	X	X			X	X	X				X				
NGO Climate Litigation	*L*	*ST-MT*	*Control*	*X*	*X*			*X*	*X*	*X*				*X*				
Shareholder Climate Litigation	*L*	*MT*	*Control*	*X*	*X*			*X*	*X*	*X*				*X*				
Local Pollution Climate Litigation	*L*	*ST-MT*	*Control*	*X*	*X*			*X*	*X*	*X*				*X*				

NGO Climate Litigation

Risk	Low
Likelihood	Moderate
Impact	Minor

Risk of court cases from an Non-Governmental Organisation (e.g., WWF, Greenpeace etc) is expected to be increasing over time, but specifically for The Project itself the impact is expected to be low.

Shareholder Climate Litigation

Risk	Low
Likelihood	Very unlikely
Impact	Minor

Risk of court cases from a (group of) shareholder(s). This risk could happen when for instance the 2050 ambition is not translated into a clear pathway and or is not met. And/or The Project does not contribute to

the expectation and is more polluting as expected, thus to be associated with Green Washing and deception, impacting the stock price. Risk for The Project is low.

Local Pollution Climate Litigation

Risk	Low
Likelihood	Very unlikely
Impact	Minor

Could happen if local communities become ill or have higher death rates. This however will be difficult to connect to The Project in isolation.

4.2.4 Technology

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4.2.4.1 Substitution of existing products and services with lower emissions options

This category involves the risk of a lack of competitiveness with competitors who are able to reduce their emissions further than PKN Orlen. Overall Transition Risk of the category “Substitution of existing products and services with lower emissions options” is **Medium**.

Risk	Medium
Likelihood	Likely
Impact	Minor

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Technology																		
Substitution of existing products and services with lower emissions options	M	MT	Accept	X	X	X			X				X		X		X	X
Competitors within the EU upgrade their facilities to use electrified steam crackers	*M*	*MT*	*Accept*	*X*	*X*	*X*			*X*				*X*		*X*		*X*	*X*

Competitors within the EU upgrade their facilities to use electrified steam crackers

Risk	Medium
Likelihood	Likely
Impact	Minor

Competitors in the EU have started piloting electrified steam cracker units to prepare for future low-emissions requirements. Such installations rely on a supply of non-fossil fuel electricity to remain competitive with current gas-fired units. Nevertheless, such units pose a technological risk within the asset life of this project. Technologies selected were deemed by PKN Orlen to be acceptable as proven processes at the time of project planning.

4.2.4.2 Unsuccessful investment in new technologies

This category involves Risk that competitors upgrading their own facilities in the next 10 years will take advantage of newer technologies to reduce their emissions. Overall Transition Risk of the category "4.2.4.2 Unsuccessful investment in new technologies" is **Low**.

Risk	Low
Likelihood	Moderate
Impact	Minor

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Technology																		
Unsuccessful investment in new technologies	L	MT	Accept	X	X	X			X				X		X		X	X
More energy efficient breakthrough technologies (e.g. new catalysts, new process for olefins production) are developed within asset life (25 years)	*L*	*MT*	*Accept*	*X*	*X*	*X*			*X*				*X*		*X*		*X*	*X*

More energy efficient breakthrough technologies

Risk	Low
Likelihood	Moderate
Impact	Minor

Confidential data

4.2.4.3 Costs to transition to lower emissions technology

This category involves risk that costs to upgrade to lower-emissions technologies within project lifetime will affect profitability. Overall Transition Risk of the category “Costs to transition to lower emissions technology” is **High**.

Risk	High
Likelihood	Likely
Impact	Major

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Technology																		
Costs to transition to lower emissions technology	H	ST-MT	Mitigate	X	X	X	X		X				X		X		X	X
Cost to retrofit gas-fired CHP and steam cracker with electrified unit	*M*	*ST-MT*	Mitigate	*X*	*X*	*X*	*X*		*X*				*X*		*X*		*X*	*X*
Cost to retrofit equipment to accept aMTernative (low carbon) feedstocks	*L*	*ST-MT*	Mitigate	*X*	*X*	*X*	*X*		*X*				*X*		*X*		*X*	*X*
Cost to retrofit gas-fired CHP and steam cracker to accept green or blue hydrogen	*M*	*ST-MT*	Mitigate	*X*	*X*	*X*	*X*		*X*				*X*		*X*		*X*	*X*
Cost to retrofit facilities with carbon capture and storage/utilisation	*H*	*ST-MT*	Mitigate	*X*	*X*	*X*	*X*		*X*				*X*		*X*		*X*	*X*

Cost to retrofit gas-fired CHP and steam cracker with electrified unit

Risk	Medium
Likelihood	Moderate
Impact	Moderate

Confidential data

4.2.5 Market

Shifts in supply and demand for certain commodities, products, and services as climate-related risks and opportunities are increasingly taken into account.

4.2.5.1 Changing customer behaviour

Changing demand from consumers and clients resulting in financial risks. Overall Transition Risk of the category “Changing customer behaviour” is **Low**.

Risk	Low
Likelihood	Moderate
Impact	Minor

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Market																		
Changing customer behavior	L	MT	Mitigate	X	X			X	X								X	X
Changing consumer demand (e.g. increased demand for lower carbon products/services or decreased demand of high carbon products/services)	*L*	*MT*	*Accept*	*X*	*X*			*X*	*X*								*X*	*X*
Changing client demand (e.g. Increased customer (B2B) preference for low-carbon footprint olefins)	*L*	*MT*	*Mitigate*	*X*	*X*			*X*	*X*								*X*	*X*

Changing consumer demand

Risk	Low
Likelihood	Moderate
Impact	Minor

PKN Orlen:
“The changes in customer demand were analysed by the external adviser - e.g. Global virgin polymer demand vs. Global virgin+feedstock recycling polymer demand showed small changes in demand 2,7% p.a. vs. 3% p.a. (2021-2050).

The probability is limited. In line with its strategy, PKN ORLEN reduces CO2 emissions. Investments in sustainable development, energy transformation, decarbonisation and recycling support this strategic goal. The state-of-the-art technologies selected for the Project will ensure, inter alia, a 30% reduction of CO2 emissions per tonne of olefin produced at the Płock Complex. The Project will also create the potential for a reduction in scope 3 emissions by converting liquid fuels into petrochemicals with possibility to recycle the final products.
Additionally, PKN ORLEN analyses the preferences of its customers regarding the emissivity of products (continuously).”

RHDHV: Risks of reduced consumer demand are deemed limited. Longer term risks are slightly elevated if for instance lower carbon or recycled plastics would have better supply and be lower in cost. This risk is mitigated due to the recycling capability of The Project.

Changing client demand

Risk	Low
Likelihood	Moderate
Impact	Minor

PKN Orlen:
“We notice the growing awareness of petrochemical customers. Customers are still looking for information about the carbon footprint of their suppliers. The next step will probably be to try to reduce the carbon footprint of our own products by choosing low-carbon products.”

RHDHV: Risks of reduced demand from The Project are deemed limited. Short term (2030) risks are largely hedged with contracts (70%). Longer term risks are slightly elevated if for instance lower carbon plastics would become available. The ability for market players to provide low carbon alternatives in large scale is limited during the lifespan of The Project. This risk is also mitigated due to the recycling capability of The Project. Overall limited risk for The Project

4.2.5.2 Uncertainty in market signals

Overall Transition Risk of the category “Uncertainty in market signals” is **Medium**.

Risk	Medium
Likelihood	Likely
Impact	Moderate

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Market																		
Uncertainty in market signals	M	ST-MT	Mitigate	X	X		X		X				X		X		X	X
Rising energy costs	*M*	*ST-MT*	*Mitigate*	*X*	*X*		*X*											
Energy shortage	*L*	*MT*	*Mitigate*	*X*	*X*		*X*						*X*				*X*	
Feedstock prices	*H*	*ST-MT*	*Control and mitigate*	*X*	*X*		*X*		*X*									
Feedstock availability	*L*	*ST-MT*	*Mitigate*	*X*	*X*		*X*		*X*				*X*		*X*		*X*	*X*
Insurance	*L*	*MT*	*Transfer*	*X*	*X*			*X*	*X*	*X*								

Rising energy costs

Risk	Medium
Likelihood	Likely
Impact	Moderate

Cost of rising energy can impact The Project. This may be mitigated partially by planned solar energy plans. This however will not help for low solar energy periods.

Energy shortage

Risk	Low
Likelihood	Unlikely
Impact	Minor

PKN Orlen has capacity to generate its own electricity. With additional solar energy plan, this risk is further mitigated.

Insurance

Risk	Low
Likelihood	Moderate
Impact	Minor

Rising premiums, reduced coverage due to unwillingness by insurance companies to insure high carbon intensive activities/companies, transition risk cover limitations (e.g. climate litigation, reputation, business interruption)

Impact expected to be limited to The Project. PKN Orlen is advised to investigate transition risk related coverage.

4.2.5.3 Raw materials for construction and maintenance

Increased cost and/or limited availability of raw materials for construction and maintenance can pose risks for The Project. Overall Transition Risk of the category "4.2.5.3 Raw materials for construction and maintenance" is **Medium**.

Risk	Medium
Likelihood	Likely
Impact	Moderate

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Market																		
Raw materials for construction and maintenance	M	MT	Accept	X	X	X			X			X	X					
Raw materials (construction)	*L*	*ST*	*Transfer*	*X*	*X*	*X*												
Raw materials (maintenance)	*M*	*MT*	*Accept*	*X*	*X*	*X*			*X*			*X*	*X*					

Raw materials (construction)

Risk	Low
Likelihood	Moderate
Impact	Minor

PKN Orlen:
"Based on our opinion, carbon pricing may have minor impact on the construction phase for the project. However, as we are observing the current geopolitical and macro-level situation, we can consider below factors which in our opinion may have bigger impact on the construction phase:

- energy crisis in Europe as a result of the Ukraine war, increase in energy prices and uncertainty as to its availability;
- decrease in the availability of certain raw materials also as a result of the war in Ukraine, and consequently an increase in prices;
- uncertain situation in China and its impact on the global economy".

RHDHV: Given the short horizon, transition risk factors will not have a significant impact on the construction phase. Slightly increased pricing as a result from high demand could happen. The majority of price fluctuation is a result of other macroeconomic and geopolitical factors. Additionally most of the risk is transferred to the contractor.

Raw materials (maintenance)

Risk	Medium
Likelihood	Likely
Impact	Moderate

Increase pricing and especially limited availability of key materials could pose a threat. The risk is deemed limited given the scheduled maintenance plan, with sufficient available materials.

This category is exposed to double risk in combination with a physical risk event (e.g. flooding, fire) which could cause immediate maintenance and repair needs. This however should normally be covered under insurance, and thus mitigated.

4.2.6 Reputation

Reputational risk tied to changing customer or community perceptions of an organization's contribution to or detraction from the transition to a lower-carbon economy

4.2.6.1 Stigmatization of sector

Overall Transition Risk of the category "Stigmatization of sector" is **Low**.

Risk	Low
Likelihood	Moderate
Impact	Minor

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/MH/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Reputation																		
Stigmatization of sector	L	MT	Control	X	X			X			X			X			X	X
Media/Activist	*L*	*MT*	*Control*	*X*	*X*			*X*			*X*			*X*			*X*	
Local population	*L*	*MT*	*Control*	*X*	*X*			*X*			*X*			*X*			*X*	
Workforce	*L*	*MT*	*Mitigate*	*X*	*X*			*X*			*X*						*X*	

Media/Activist

Risk	Low
Likelihood	Moderate
Impact	Minor

PKN Orlen: “In SEP, we detailed local media, NGOs and informal groups that may be interested in the project, as well as ways to mitigate the risk and our response.”

RHDHV: low short term risk, likely increased risk longer term looking at other EU countries. However this risk is deemed lower in Poland.

Local population

Risk	Low
Likelihood	Insignificant
Impact	Minor

PKN Orlen: “We have not conducted any research evaluating support for the project in the local community, but according to what we wrote in SEP, after the construction of Olefin III, the budget of the Stara Biała commune will increase by an additional amount of approx. PLN 7 - 12 million annually. This means an increase in the commune's investment opportunities, and thus an increase in the quality of life of the inhabitants. We have no signals that the local community does not accept the Olefins III project in this situation. In the grievance mechanism launched a few months ago for the needs of Olefins III Project, we have so far not seen any request for intervention or even reporting any problem.”

RHDHV: low short term and long term risk. As The Project is bringing economic improvements to the region, it is not expected to become a risk, as long as jobs are secured, no health issues arise and climate change is limited"

Workforce

Risk	Low
Likelihood	Very unlikely
Impact	Minor

PKN Orlen is working with contractors for construction phase, no risks expected. Existing workforce of steam crackers is going to work on The Project. Only potential risk is ageing workforce and young generation not willing to work in the industry. Risk expected to be mitigated with recruiting and salaries. No risk for the short term, limited risk in the medium term.

4.2.6.2 Increased stakeholder concern or negative stakeholder feedback

Risk of reduced sales, resources, limited funding possibilities, share price pressure due to negativism with stakeholders. Overall Transition Risk of this category is **Low**.

Risk	Low
Likelihood	Moderate
Impact	Minor

Climate Related Risks	Risk			Scenarios		Potential Financial Impact				Potential Impact on Business					Potential Opportunities			
	Score (L/M/H/E)	Time Horizon (ST/MT)	Management Action PKN Orlen (mitigate/transfer/accept/control)	Orderly Transition (Paris) SSP 2.6 (1.5°C)	Sudden Transition SSP 4.5 (2.0°C)	Expenditure (CapEx)	Expenditure (OpEx)	Revenue	Capital (asset valuation and depreciation)	License to operate issues	Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased efficiency	Financial benefit	Competitiveness	Business diversification
Reputation																		
Increased stakeholder concern or negative stakeholder feedback	L	MT	Control	X	X			X						X				
Investors	*L*	*MT*	*Control*	*X*	*X*			*X*						*X*				
customers	*L*	*MT*	*Mitigate*	*X*	*X*			*X*						*X*				

Investors

Risk	Low
Likelihood	Unlikely
Impact	Minor

PKN Orlen: PKN ORLEN is not aware of any divestment campaigns for assets similar to the Project and/or technologies involved in the Project. PKN ORLEN cannot comment on hypothetical future changes to the behaviour of Investors over the lifespan of the Project however, you should note that (i) the targeted debt structure is fully amortising i.e., the project will not be exposed to any refinancing risk and (ii) the technology of the steam cracking unit allows for the use of plastic waste as a feedstock.

RHDHV: low risk for The Project given it is embedded in the operations of the Group and given the loan structure or The Project

Customers

Risk	Low
Likelihood	Moderate
Impact	Minor

PKN Orlen: “Changing customer preferences are always a challenge for the seller. As part of the Olefins III project, long-term contracts were signed to reduce the risk of losing customers. Captive use and sales under long-term contracts will account for c. 70% of the Project’s production.”

4.3 Double Shock Scenarios

Transition risks in this CCRA are assessed individually. It is however not unlikely several risks will happen at the same time when they evolve. This has to do with the positive correlation between several of the transition risks. This are called double shocks scenarios.

An example of this could be a strong policy intervention by elimination of free emissions for the industry. Next to the direct impact, this could also have a very significant impact in carbon emission price (well over 200 Euro per tonnes), also leading to increased feedstock prices and demand being under pressure because of higher prices. This all could happen in a relatively short period of time (2-5 years). Consequently, this would also boost technological innovation, which however will have a lagged effect.

It is clear a highly correlated sequence of events related to transition risk is not unlikely and could lead to significant risks for The Project. This particularly could happen in case of late, sudden and uncoordinated

transition interventions from different perspectives (e.g. policy & legal and markets). In a worst case, such events could lead to a green swan risk for The Project, which would imply significant losses and even stranded assets. Given the lifetime of 25 years for The Project this is very unlikely to happen though. However, if it does, it is more likely to happen towards the end of the lifecycle of The Project.

Appendix

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Appendix

2. Risk Register – Physical Risks

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EP4 CCRA Category	Subcategory	Risk description	Risk Impact (H?M?L)						Impact Description	Impact on decision-making?		Risk Management
			Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased operating costs	Early write-off of assets			Impact on license to operate? (Y/N)	
Acute - Wildfires	Increased frequency of wildfires	Impeded access to installations	X	X	X		X	X	process stops partially or completely	Informs evacuation procedures, fire extinguishing equipment management	N	What are the current risk management processes? Fire risk assessments etc? The risk from external fire should be considered low: □ The installation and adjacent areas are concreted over and there is no way to transfer fire from a litter fire, meadow fire, etc. □ No tall forests are maintained around the plant and there are no trees in the area where fire could spread through the crowns. The Project installation has a protection strip so the risks are low
Acute - Wildfires	Increased frequency of wildfires	Risks of transport to and from the installation. Risks associated with disruption of dispatch.	X	X	X		X	X	Risks Associated with disruption or dispatch	Informs logistical routing	N	Fire risk assessments: PKN ORLEN S.A. has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Acute - Wildfires	Increased frequency of wildfires	Risks related to the availability of external utilities (incl. energy, e.g. damage to HV transmission lines, power system blackout)	X	X	X	X	X	X	Risks of disruption of external utilities, liability. Environmental damage as a consequence of systems failure during power interruption.	Informs redundancy measures, UPS	Y	What redundancies are in place to protect against power outage? SOPs for low power/no power situations. PKN ORLEN S.A. has its own electricity and heat generation sources. The construction of a new energy generation source is also planned for the needs of the Project.
Acute - flooding	Increase in frequency and intensity of pluvial flooding	Disruption of process control	X		X	X	X	X	Process stops partially or completely. Risk of run-off of pollutants/ contaminants on site due to bund/pumping/drainage failure.	Informs plant lay-out, informs site design	Y	Place the vulnerable installations higher. SOPs and drainage management plans are in place.
Acute - flooding	Increase in frequency and intensity of pluvial flooding	Impeded access to installations	X	X	X		X		faults more difficult to rectify more difficult to keep the process running	Informs plant lay-out, informs site design	N	Automation and control settings, possibly interlocks
Acute - flooding	Increase in frequency and intensity of pluvial flooding	Risks of transport to and from the installation (including rail, road transport, pipeline).	X	X	X		X		Risks Associated with disruption or dispatch	Informs logistical routing	N	Fire risk assessments: PKN ORLEN S.A. has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Acute - flooding	Increase in frequency and intensity of pluvial flooding	Risks related to the availability of external utilities (including energy, e.g. damage to HV transmission lines, power system blackout);	X	X	X	X	X	X	Risks of disruption of external utilities, liability. Environmental damage as a consequence of systems failure during power interruption.	Informs redundancy measures, UPS	Y	What redundancies are in place to protect against power outage? SOPs for low power/no power situations. PKN ORLEN S.A. has its own electricity and heat generation sources. The construction of a new energy generation source is also planned for the needs of the Project.

EP4 CCRA Category	Subcategory	Risk description	Risk Impact (H?M?L)						Impact Description	Impact on decision-making?		Risk Management
			Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased operating costs	Early write-off of assets			Impact on license to operate? (Y/N)	
Acute - storms	Increase in heavy snowfall/icing	Heavy snowfall increasing the probability of icing and rapid melting of the Vistula leading to an ice threat/jam to nearby transport infrastructure	X	X	X				Damage to railway bridge in Plock interfering with supply chain	Consider supply chain resilience and alternate routes for receiving inputs and sending products in event of bridge failure.	N	PKN ORLEN S.A. has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Acute - storms	Increase in heavy snowfall/icing	Heavy snowfall/icing affecting assetss	X		X		X		Heavy snowfall and icing leads to reduced performance/access to equipment	Consider de-icing equipment/detection systems.	N	Orlen to confirm - are such systems already in place? Heavy snowfall/icing SOP?
Acute - storms	Increase in frequency and intensity of storms	Severe or prolonged weather phenomena	X	X	X				Restrictions in road and rail transport for both raw materials and finished products	Consider supply chain resilience and alternate routes for receiving inputs and sending products in event of bridge failure.	N	PKN ORLEN S.A. has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Acute - storms	Increase in frequency and intensity of storms	Severe or prolonged weather phenomena and interaction of flooding and high wind	X	X	X		X		Damage to assets and limited access to site. Impact on ability to operate facilities	Informs plant lay-out, informs site design	N	Automation and control settings, interlocks. Extreme storm weather SOPs.
Acute - storms	Increase in frequency of high wind speeds (>30m/s)	Intensifying phenomena of strong wind plus soil erosion may increase the average level of PM 2.5 and silica particles in the air					X	X	High winds and fine particulate matter increase wear and damage of all outdoor, physical assets	Consider additional reinforcement or incorporation of air filters where relevant.	N	Management plans for wind/dust?
Acute - storms	Increase in frequency of high wind speeds (>30m/s)	Changes wind dynamics (speed and direction) in the region				X			Air emissions (odour or particulate) may impact a larger area of the environment/community).	Design of air quality mitigation measure - may require overdesign relative to current standards or requirements.	Y	Review of air quality management plans for new site
Acute - storms	Increase in frequency of high wind speeds (>30m/s)	Changes wind dynamics (speed) in the region			X		X	X	High wind speeds and gusts causing damage to assets	Consider additional reinforcement of tall assets (e.g. steam cracker, stacks) and building roofs in design parameters	N	Wind SOP: Maximum wind speed to close site/cease operations.

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EP4 CCRA Category	Subcategory	Risk description	Risk Impact (H?M?L)						Impact Description	Impact on decision-making?		Risk Management
			Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased operating costs	Early write-off of assets			Impact on license to operate? (Y/N)	
Chronic - extreme heat	Increases in number of hot days	Reduction in the productivity of personnel operating the installation due to excessive heat in the workplace,			X		X		Increasing the number of errors made and accidents;	Informs HVAC of control rooms, should inform HSE management how to improve working conditions	N	SOP for Hot Weather? Increase cooling degree days.
Chronic - extreme heat	Increases in number of hot days	May indirectly increase fugitive emissions from similar production installations (so-called "breathing" from tanks);	X		X	X	X	X	Risk of ignition of substances released into the air	Informs plant management of possible non-compliance regarding permitted emissions	Y	Emission detection, Inspection
Chronic - extreme heat	Increases in number of hot days	Industrial pollutants emitted remain close to the ground and cause increased impact on human health, may intensify;	X		X		X		Absent personnel (sick leave) process stops partially or completely	Informs HVAC and HSE to increase ventilation or expand PPE measures	N	PPE design, SOP for hot days
Chronic - extreme heat	Increases in number of hot days	Disruption of process control	X	X	X		X		Equipment doesn't operate or malfunctions in higher temperatures. Inputs and products become more volatile at higher temperatures.	Informs HSE to increase heat protection and redundancy	N	
Chronic - extreme heat	Increases in number of hot days	Inefficiency of peripheral equipment including pumps and compressors	X	X	X				Equipment doesn't operate or malfunctions in higher temperatures. Inputs and products become more volatile at higher temperatures.	Consider equipment that is designed for operation at higher temperatures	N	
Chronic - extreme heat	Increases in number of hot days	Heightened rate of corrosion of steel structures resulting in the need for more frequent painting and protection					X	X	Hot weather creates a hazard for the operation of combustible gas compressors	Consider additional reinforcement or incorporation of cooling equipment where relevant.	N	Management plans/hot weather SOPs
Chronic - extreme heat	Increases in number of hot days	Risks of transport to and from the installation. Risks associated with disruption of dispatch.	X	X	X		X	X	Risks Associated with disruption or dispatch	Informs logistical routing	N	Hot weather risk assessments: PKN ORLEN S.A. has an extensive set of terminals connected to the rail and road network so that any disruption in the availability/functioning of one terminal can be replaced or partially replaced by other terminals and means of transport.
Chronic - extreme heat	Increases in number of hot days	Risks related to the availability of external utilities (incl. energy, e.g. damage to HV transmission lines, power system blackout)	X	X	X		X	X	Risks of disruption of external utilities, liability. Environmental damage as a consequence of systems failure during power interruption.	Informs redundancy measures, UPS	N	What redundancies are in place to protect against power outage: SOPs for low power/no power situations. PKN ORLEN S.A. has its own electricity and heat generation sources. The construction of a new energy generation source is also planned for the needs of the Project.
Chronic - changing precipitation	Increase in precipitation	Increased pluvial flooding risk		X	X		X		Flooding on site reduces access to equipment and impacts on process control	Refer to acute floods	N	

EP4 CCRA Category	Subcategory	Risk description	Risk Impact (H?M?L)						Impact Description	Impact on decision-making?		Risk Management
			Inability to do business	Supply chain disruption	Production or capacity disruption	Fines and reputational damages	Increased operating costs	Early write-off of assets			Impact on license to operate? (Y/N)	
Chronic - changing precipitation	Increase in precipitation	Alternate discharge of river systems which may lower the water level and the reliability of water intake.		X	X		X		which may lower the water level and the reliability of water intake. Less coolingwater available	Design installation which uses less cooling water	N	
Chronic - changing precipitation	Increase in precipitation	Increased extent and intensity of waterlogging		X	X		X		Soil subsidence and associated risks around the site due to waterlogging	Consider structural effects, undertake studies to invetigate risks to assets of more waterlogged ground on/around the site.	N	How has soil subsidence risk been considered? Have structural assessments considered these risks?
Chronic - changing precipitation	Increase in precipitation	Increased flow of water on the site		X	X		X		Larger quantities of (polluted) run-off and potential overflow of existing bunds/water management systems	Increased capacity of water management on site	N	
Chronic - changing precipitation	Decrease in precipitation (droughts)	Changes in the quality of river water used for cooling. The water may contain much more crushed rock material (erosion), much more organic pollutants and metal pollutants (soil erosion and leaching of components and carrying pollutants from landfills to the Vistula River) and, in addition, the river water may have a higher salinity (up to 50% higher than current levels, which influences the way the water is treated and conditioned for cooling);			X		X	X	influences the way the water is treated and conditioned for cooling	Consider additional water treatment.	N	Extra water treatment step
Chronic - changing precipitation	Decrease in precipitation (droughts)	Wetlands north of Olefins III dry out, increasing fire risk - the Olefins III site does not have a wide fire ditch planned (watercourse isolation) from agricultural and wetland areas located further away. Temperature effects during summer periods can be significant			X				Fire hazard to processes, personnel, and supply chain.	Informs evacuation procedures, fire extinguishing equipment management	N	Cross-checked with fire risks
Chronic - changing precipitation	Decrease in precipitation (droughts)	Restrictions on raw water abstraction			X	X	X		Less water available for key processes. May result in reduced capacity or shut down during drought periods.	Design more water efficient processes, look at opportunities for recycling or other water sources.	N	To what extent are the new WWTP facilities in Olefins III part of this commitment? https://ceenergynews.com/innovation/orlen-invests-in-new-circular-economy-project/
Chronic - changing precipitation	Decrease in precipitation (droughts)	Reduce water availability from increased competition over water use for production, irrigation, and in-stream flow protection.	X	X	X	X	X		Risk of reputational damage and loss of licence to operate due to competition with local and downstream ares for use of water.	Design more water efficient processes, look at opportunities for recycling or other water sources.	Y	To what extent are the new WWTP facilities in Olefins III part of this commitment? https://ceenergynews.com/innovation/orlen-invests-in-new-circular-economy-project/
Chronic - rising mean temperatures	Higher average temperatures (increase of up to 1.5˚C by 2039 and 3˚C by 2059)	May indirectly increase fugitive emissions from similar production installations (so-called "breathing" from tanks);			X	X	X		Risk of ignition of substances released into the air	Increased safety standards or design of pressure vessels to allow for higher average temperatures.	N	
Chronic - rising mean temperatures	Higher average temperatures (increase of up to 1.5˚C by 2039 and 3˚C by 2059)	May indirectly increase fugitive emissions from similar production installations (so-called "breathing" from tanks);					X		Loss of volatile product/feedstock and greater inefficiency in operations of peripheral equiment (e.g. pumps and compressors)	Factor in inefficiencies, consider cooling solutions, or select for equipment designed for operation in warmer environments.	N	
Chronic - sea-level rise and river (fluvial) flooding	More frequent coastal flooding	The Vistula River breaks it's banks with greater frequency, leading to flooding of some waterfront areas of Plock		X	X				Water intake (inundation of pumping station) and road and rail connections may be impacted by rising water levels.	Consider redundancies in water intakes from river. Consider alternatives for transport of inputs (roads and rail outside of flood zones.	N	