Climate scenario analysis 2024

Assessing how potential climate change can impact OX2

2024-10-09

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Picture to the right: Valhalla, Sweden
Picture on the from page: Bredhälla, Sweden

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Risks
- Increased heat losses
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- Reduced production losses due to decreased ice formation
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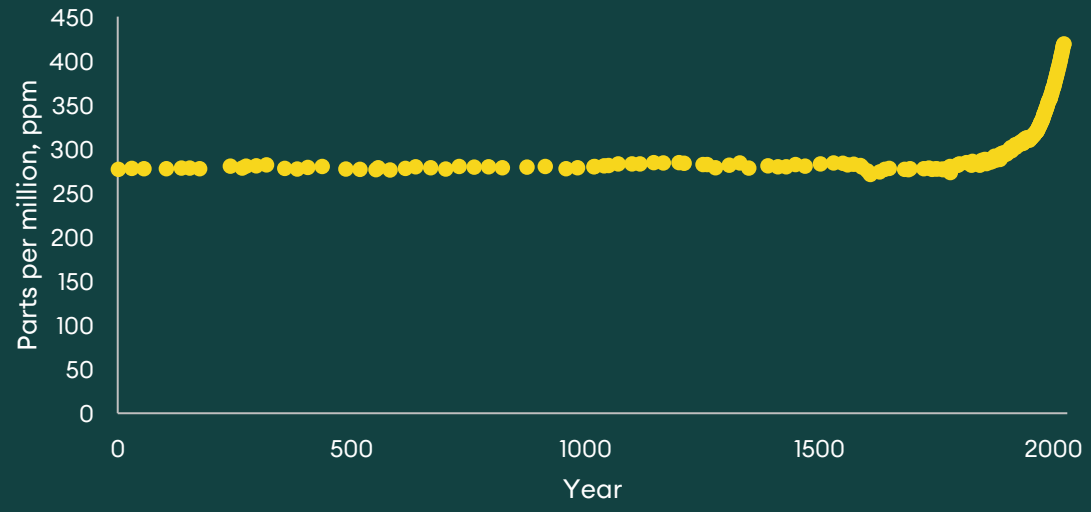
Climate change

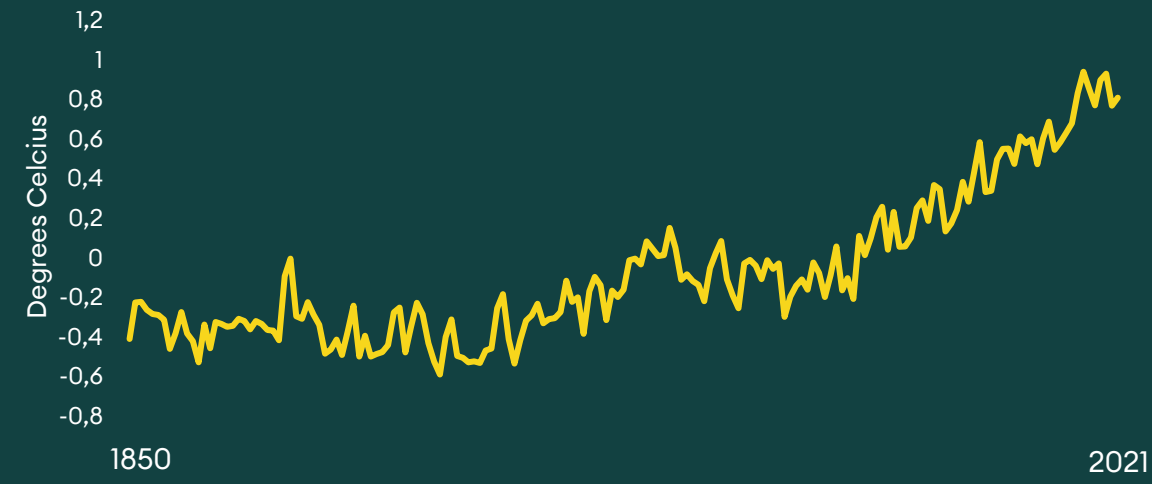
Climate change is the increase in global average surface temperature. This is caused by human activities that emit greenhouse gas emissions and that reduce Earth's ability to absorb and store carbon.

To monitor climate change, the causes and impacts are measured. This includes the concentrations of carbon dioxide in the atmosphere, the greenhouse gas emissions being emitted annually and the global average surface temperature.

Some countries are experiencing more climate change than others. For example the average surface temperature in Sweden has increased 1.7°C and the global average surface temperature has increased with 1.1 ° C[1].

Science agrees that we need to limit climate change to 1.5°C above pre-idustrial times to avoid risk of catastrophic consequences for society and the environment. Nature loss and climate change are intrinsically interlinked and therefore need to be addressed jointly.





1) IPCC AR6

Climate impacts and risks

Climate change causes and intensifies impacts. There are feedback loops[1] and thresholds, resulting in complexity in anticipating and estimating impacts.

Weather and climate

Weather is short-term, and climate refer to a longer time-perspective, commonly measured in a 30 year period. Extreme weather events can occur in any ‘climate’. Climate change, however, intensifies extreme weather events, meaning that they can become more intense, frequent, and longer lasting. Although some regions are more impacted than others, human-induced climate change is already causing many weather and climate extremes in every region across the globe[2].

Impacts becomes risks

The impacts of climate change become risks when we are vulnerable and exposed to them. There are a wide range of consequences, such as economic losses, loss of livelihoods, and displacement.

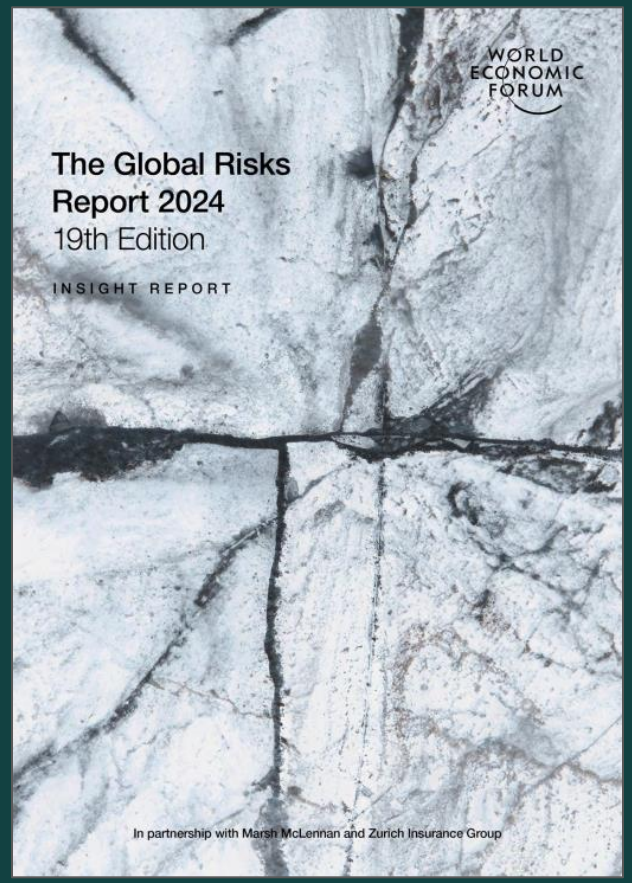
1) Feedback loops entail self-regulating or self-generating characteristics.
2) Climate Change 2021: The Physical Science Basis, IPCC.

Climate risks

According to the Global Risk Report developed by the World Economic Forum (WEF) climate and environmental risks are the core focus of global risks perceptions over the next decade – and are the risks for which we are seen to be the least prepared.

Failure to mitigate climate change and to adapt to climate change are the two top long-term risk (10 years)[1]. Majority (70%) of the responders of the global risk report survey, which the report is build upon rate existing measures to prevent and prepare for climate change as “ineffective” of “highly ineffective”.

Research shows that about 10% of the global economy is at risk to be wiped off by mid-century if climate change stays on the currently anticipated trajectory[2].



Managing climate risks

To manage climate risks, actors are investing in climate change mitigation and adaptation. To anticipate change in risks exposure and vulnerability, climate scenarios are analyzed.

1) Global Risk Report – World Economic Forum 2023
2) The economics of climate change: no action not an option – Swiss Re Institute (April 2021)

Climate opportunities

The actions that are taken to mitigate climate change, and adapt to the impacts of climate change, can imply opportunities for businesses.

Renewable energy: Shift from fossil energy generation to non-fossil sources implies expansion in wind, solar, and other renewable energy sources, which results in ability to avoid emitting greenhouse gas emissions and creating jobs.

Energy efficiency: Innovations in technology to improve energy use in buildings, transportation, and industry, saving money and reducing emissions.

Resource efficiency: Applying circularity principles that limit waste generation.

Resilience measures: Providing services that enhance a city's/business' ability to withstand the impacts of climate change. This is a risk mitigation measure to avoid damage and disruption.

Picture: Finley, Australia

Regulatory demands for climate risk assessments

The regulatory landscape has internalized the climate risks perspective. Below is a description of the two main EU directives demanding a climate scenario analysis for OX2 which refers to OX2's entire geographical footprint, within and outside of the EU.

The EU Taxonomy for sustainable activities

For economic activities to be aligned with the EU taxonomy for sustainable activities's environmental objective climate change mitigation it needs to prove that is does no significant harm to the other environmental objectives. The so-called Do No Significant Harm (DNSH) criteria includes conducting a climate risk and vulnerability assessment[1] for the physical risks using a climate scenario such as the Radiative Concentration Pathway (RCP) 8.5.

The European Sustainability Reporting Standard (ESRS)

The Corporate Sustainability Reporting Directive's (CSRD) mandatory sustainability reporting standard the European Sustainability Reporting Standard (ESRS) includes disclosure requirements regarding strategy and business model's resilience to the impacts of climate change and the impacts, risks and opportunities associated with the impacts of and on climate change. Additional disclosure requirements are within scope if there are any identified material climate risks.

1) At OX2 we call this a 'climate scenario analysis' since we look at both risks and opportunities.

Framework for working with climate-related risks

The Financial Stability Board created the Task Force on Climate-related Financial Disclosures (TCFD) to improve and increase reporting of climate-related financial information. The TCFD recommendations and supporting recommended disclosures are widely adoptable and applicable, and today integrated into sustainability regulation.

Dual perspectives

The TCFD recommendations follow the double materiality principle:

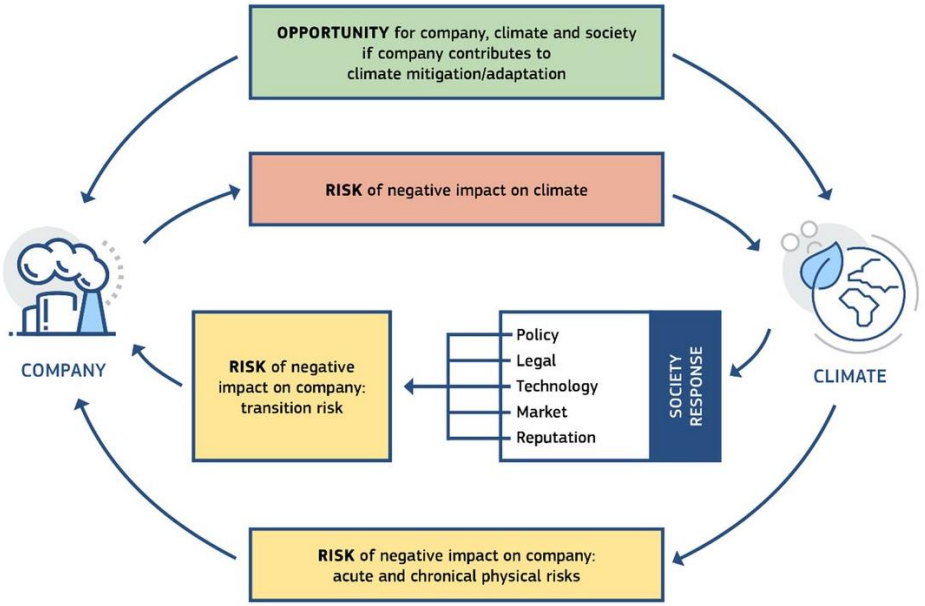
- A company's impact on climate change
- Climate change's impact on a company

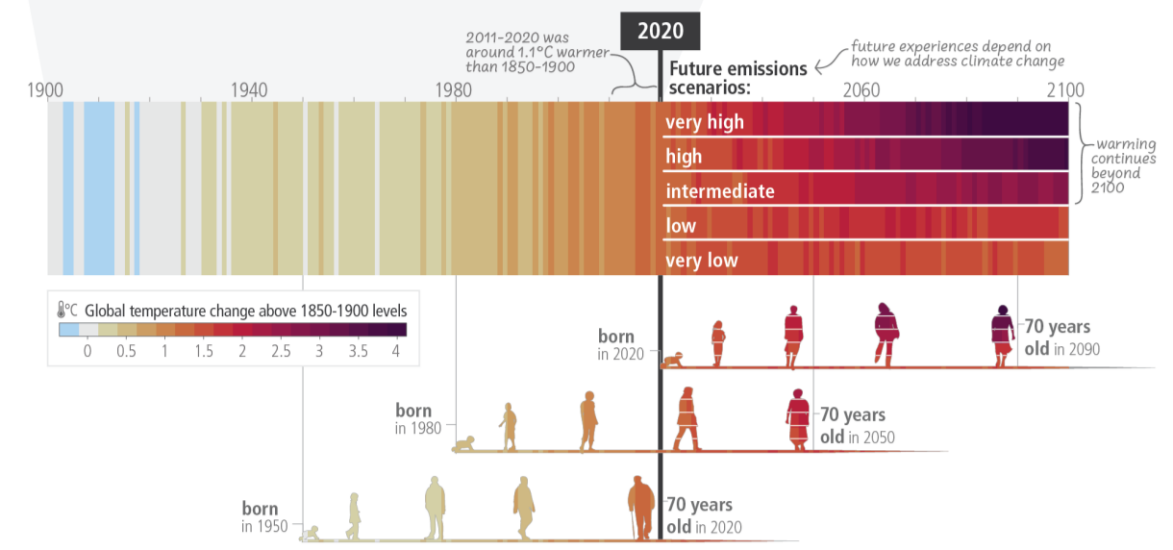
Reporting

The ESRS E1 formalized the disclosure and application requirements for company's work with climate-related risks and opportunities.

Recommendations and Supporting Recommended Disclosures

Governance	Strategy	Risk Management	Metrics and Targets
Disclose the organization's governance around climate-related risks and opportunities.	Disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material.	Disclose how the organization identifies, assesses, and manages climate-related risks.	Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.
Recommended Disclosures	**Recommended Disclosures**	**Recommended Disclosures**	**Recommended Disclosures**
a) Describe the board's oversight of climate-related risks and opportunities.	a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	a) Describe the organization's processes for identifying and assessing climate-related risks.	a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.
b) Describe management's role in assessing and managing climate-related risks and opportunities.	b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	b) Describe the organization's processes for managing climate-related risks.	b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.
	c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.





Anticipating future climate change and its impacts

Climate scenarios are used to anticipate future emissions, climate change and related impacts. Companies use climate scenarios to strengthen resilience of strategy, reduce exposure and vulnerability to climate-related risks, and to act on climate-related opportunities. Scenarios can be based on quantitative and/or qualitative information.

The Intergovernmental Panel on Climate Change (IPCC) have developed climate scenarios based on:

- The extent in which we mitigate climate change (greenhouse gas emission)
- The extent in which we adapt to climate change (resilience)
- Radiative forcing (W/m^2)
- Socioeconomic developments (demographics, urbanization, GDP, etc.)

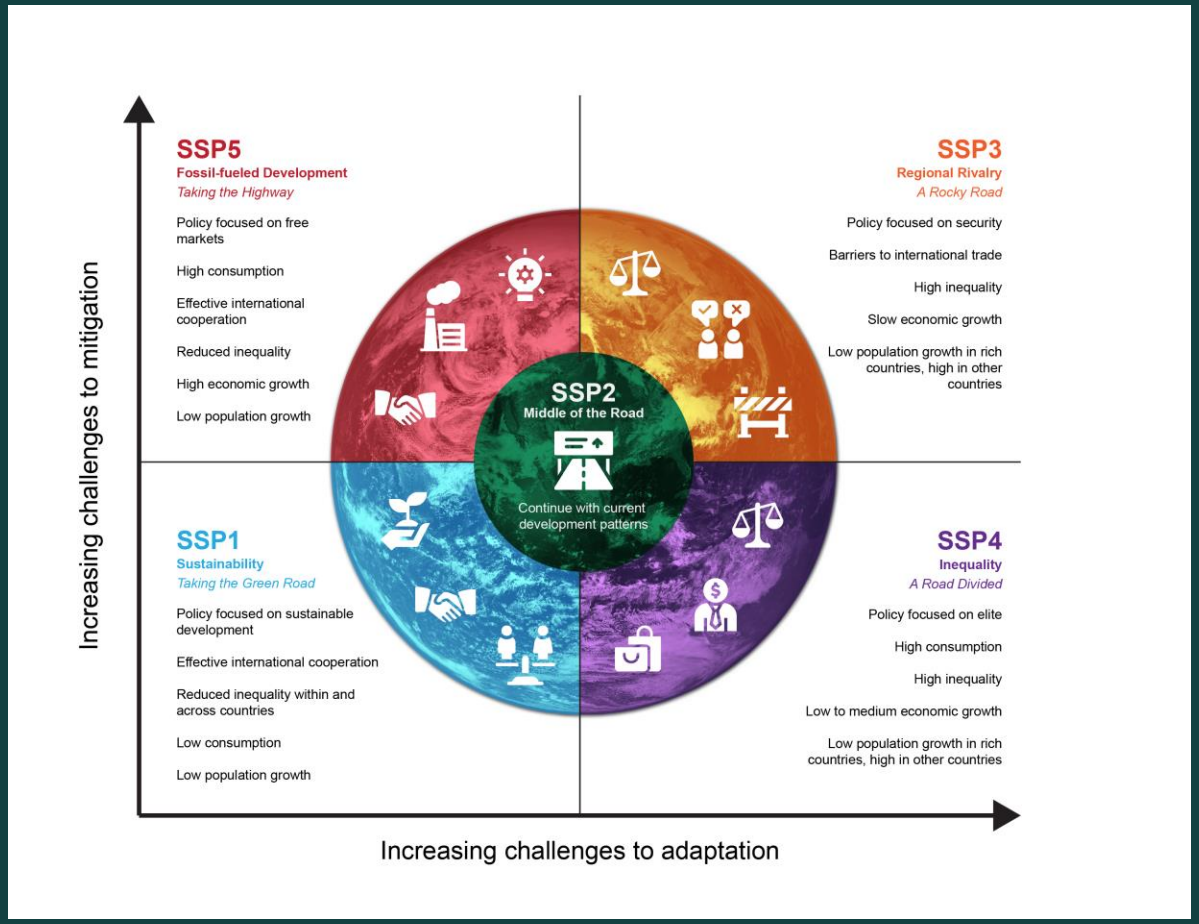
Climate scenarios

IPCC's climate scenarios are called shared socioeconomic pathways (SSPs) and they come with a narrative.

- SSP1: Sustainability ("Taking the Green Road") - this would be desirable
- SSP2: "Middle of the Road"
- SSP3: Regional Rivalry ("A Rocky Road")
- SSP4: Inequality ("A Road divided")
- SSP5: Fossil-fueled Development ("Taking the Highway")

Other scenarios include:

- IEA's Net Zero by 2050 Scenario



Shared socioeconomic pathways (SSPs) narratives

SSP1: Sustainability (Taking the Green Road)

"The world shifts gradually, but pervasively, toward a more sustainable path, emphasizing more inclusive development that respects predicted environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.“

SSP2: Middle of the road

"The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.“

SSP3: Regional rivalry (A Rocky Road)

"A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.“

SSP4: Inequality (A Road Divided)

"Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally-connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labor intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high income areas.“

SSP5: Fossil-Fueled Development (Taking the Highway)

"This world places increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary."

Example of research that is used in assessments.

Sources and climate models

We use open source data and models to consider climate scenarios in our work. See example of data sources and climate models below:

International and regional

- IPCC WG1 Interactive Atlas
- The World Bank Climate Change Knowledge Portal
- Our World in Data
- IEA Climate Resilience Policy Indicator
- Climate-ADAPT

National

- SMHI Advanced Climate Change Scenario Service
- Climate Change in Australia
- Climateguide.fi
- Klimada 2.0
- Meteo Romania

Approach

Description of approach with reference to the TCFD recommendations and dirsclosure requirements in ESRS E1

Approach

Focal question

In order to identify and assess the physical and transitional climate-related risks that we are exposed to as a company, a scenario analysis is conducted based on both qualitative information and quantitative data. The focal question, to be answered through scenario analysis, is: *How could climate-related physical and transition risks plausibly affect OX2 including logistical and supply chain?*

Time horizon

The short-term perspective (0-2 years) encompasses the financing and development of our projects.

The medium-term perspective (2-5) encompasses the construction of our projects.

The long-term (5-40) perspective encompassed the lifetime of our projects.

Note that this is general, it varies between projects, but the predefined time horizons will be applied group wide.

Addressing climate change

How society addresses climate change will have an impact on OX2. We therefore monitor the driving forces behind societal climate action.

Political

Current and emerging legislation are increasing the demand for transparency in corporate climate action (e.g., CSRD), increasing the scope of carbon pricing (e.g., CBAM), and promoting low-carbon activities and products (e.g., the EU Taxonomy). Legislation and regulation is increasingly becoming connected and complimentary, for example the Net Zero Industry Act and the green bond standard.

Geopolitical uncertainty leads to greater focus on energy security, which renewable energy can contribute to.

Technological

The renewable energy sector have experienced a rapid technological development. According to IPCC, the drop in price of renewable energy relates to technological advances.

Technological change relating to the electrification and decarbonization of the industry, transport and shipping sectors contribute to an increasing demand for renewable energy sources and ancillary services.

Economical

The impacts of climate change is increasingly causing economic losses. Adaptation measures along side climate change mitigation is therefore increasingly expected.

High prices for fossil fuel and electricity as a result of the global energy crisis have made renewable energy technologies a much more financially attractive option.

Environmental

As coal power plants reach their end of life and are commissioned, the land can be converted into renewable energy projects.

Although renewable energy generation can experience heat losses and impacts associated with climate change, they can deliver when hydro and nuclear energy generation is impacted by other impacts. For example, hydropower is impacted by drought and nuclear is impacted when the cooling water is too warm.

Social

The health effects and premature deaths attributeable to climate change are increasingly experienced and acknowledged.

Demand to address climate change is larger that what is commonly believed.

Electrification is increasing demand for electricity generation and ancillary services from industries and households.

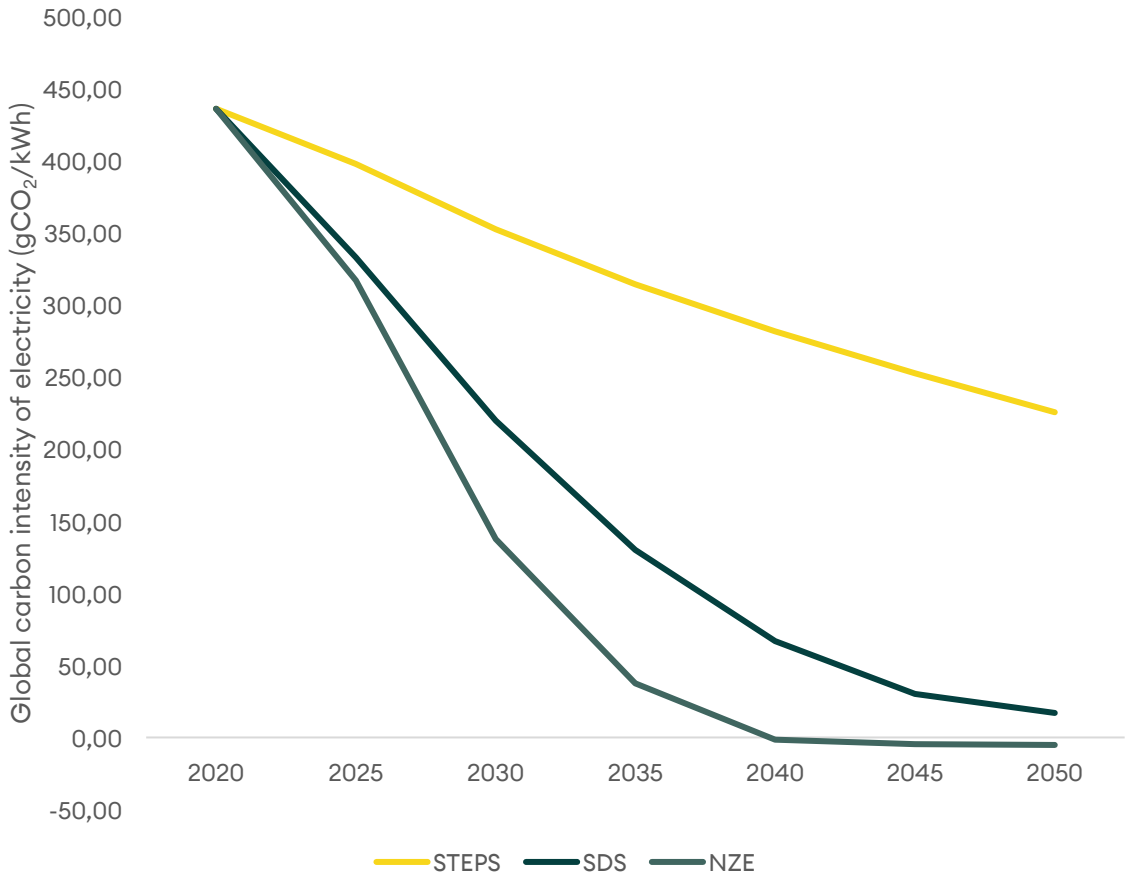
As temperature rises and temperature extremes become more frequent, intense and longer lasting, energy demand goes up in society for heating and cooling.

Climate scenario analysis

Analysing the anticipated development of indicators relevant to the renewable energy industry and the markets where we operate (based on climate scenarios).

Decarbonization of electricity

IEA's scenarios



The Stated Policies Scenario (STEPS) is designed to provide a sense of the prevailing direction of energy system progression, based on a detailed review of the current policy landscape.

The Net Zero Emissions by 2050 Scenario (NZE Scenario) is a normative scenario that shows a pathway for the global energy sector to achieve net zero CO_2 emissions by 2050, with advanced economies reaching net zero emissions in advance of others.

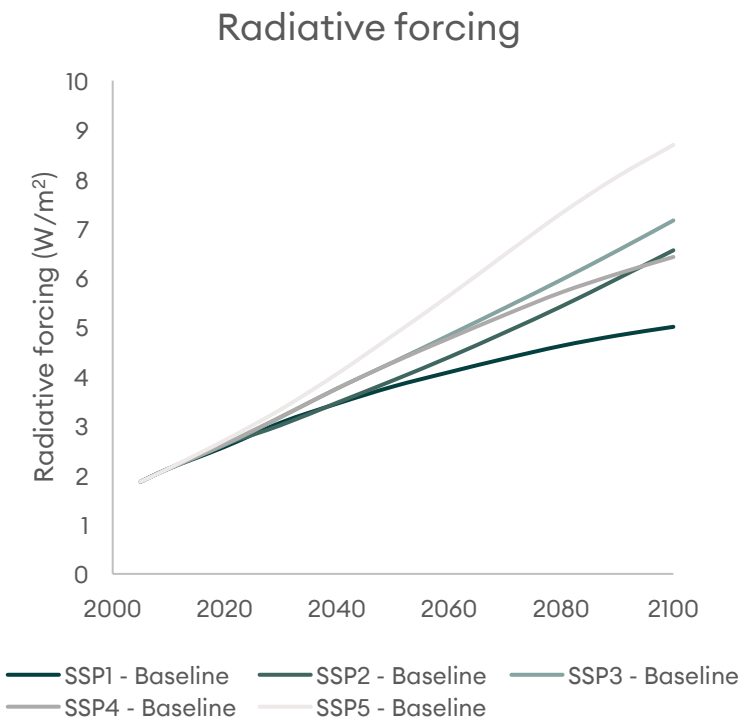
The Sustainable Development Scenario (SDS) describes the broad evolution of the energy sector that would be required to reach the key energy-related goals of the United Nations, including the climate goal of the Paris Agreement (SDG 13), universal access to modern energy by 2030 (SDG 7), and a dramatic reduction in energy-related air pollution and the associated impacts on public health (SDG 3.9).

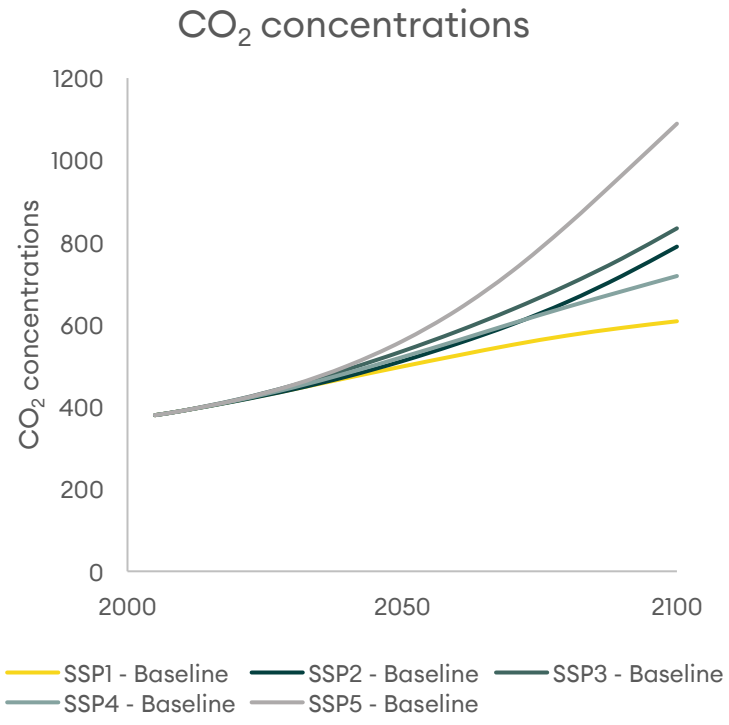
Observed advancements

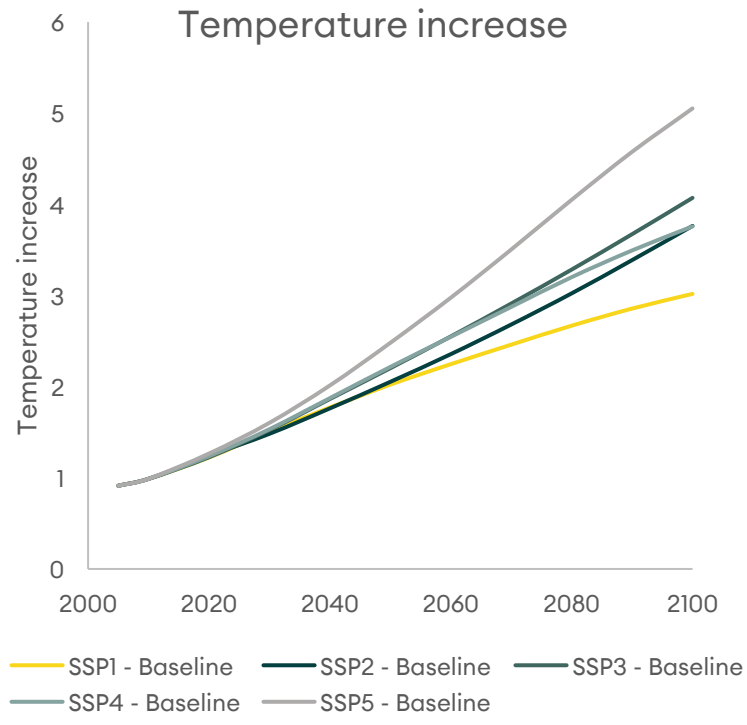
Investments, innovation and technological advancements are needed to decarbonize the energy sector, which is observed in terms of:

- CO_2-reduced material (e.g., CO2-reduced steel and cement, and wooden towers, blades, and PV structures)
- Recycling capabilities (e.g., Vestas recycling methods for epoxy and fibers)
- Reduced land use and accelerated installation (e.g., climbing cranes)

Increasing challenges to adapt to climate change







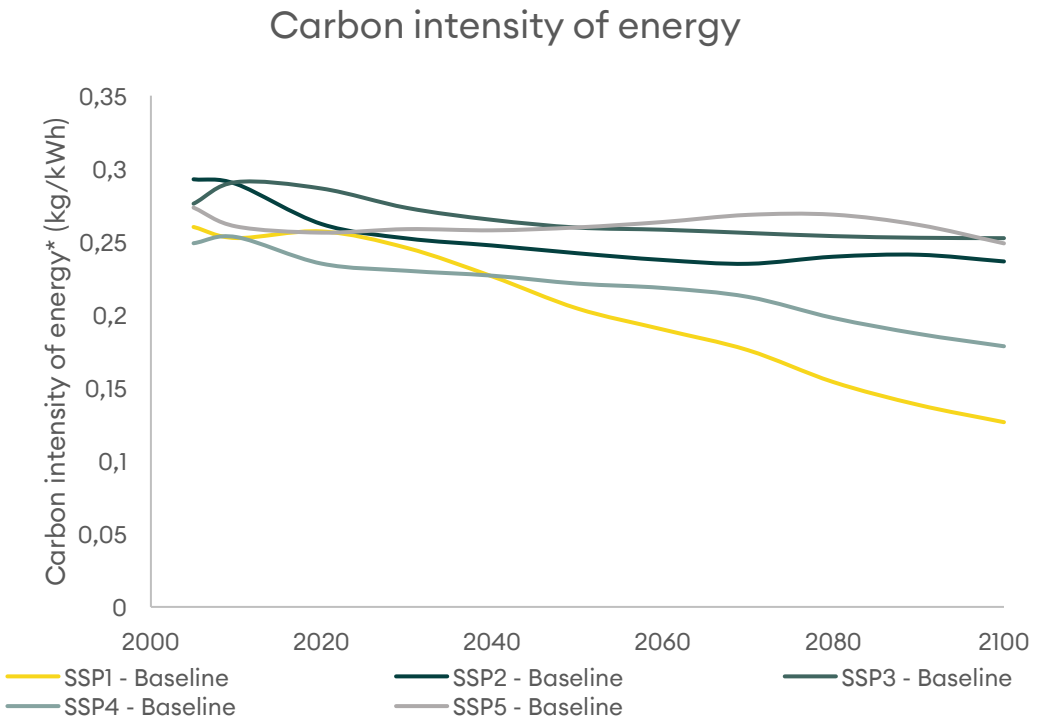
Adapting to the impacts of climate change will be more difficult over time. The differences between the scenarios take off towards the end of the century.

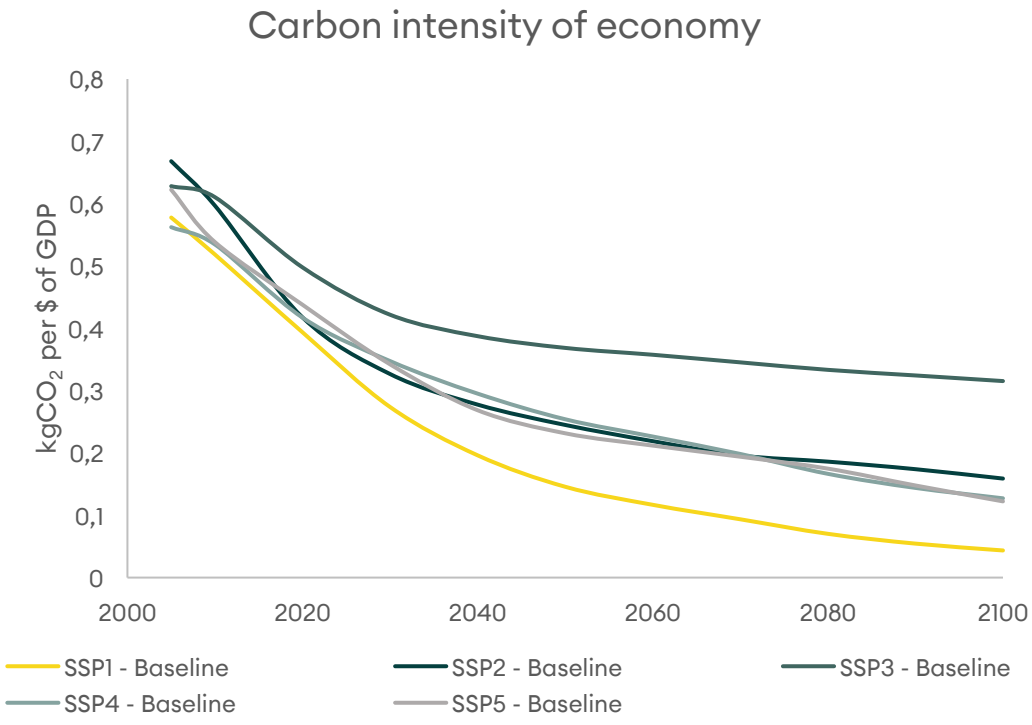
Implications for OX2

- Monitor developments in technological and nature-based solutions to increase resilience in our projects, as well as developments in data and system support to improve our capabilities in anticipating and understanding potential climate-related impacts.
- Continue to conduct climate scenario analyses for all projects to understand project-specific risks and what we can do to manage them.

Mitigating climate change

Demand for our business



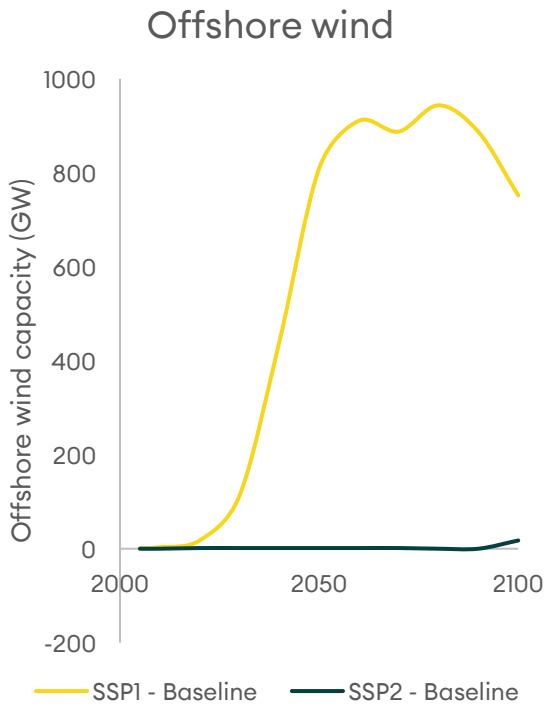


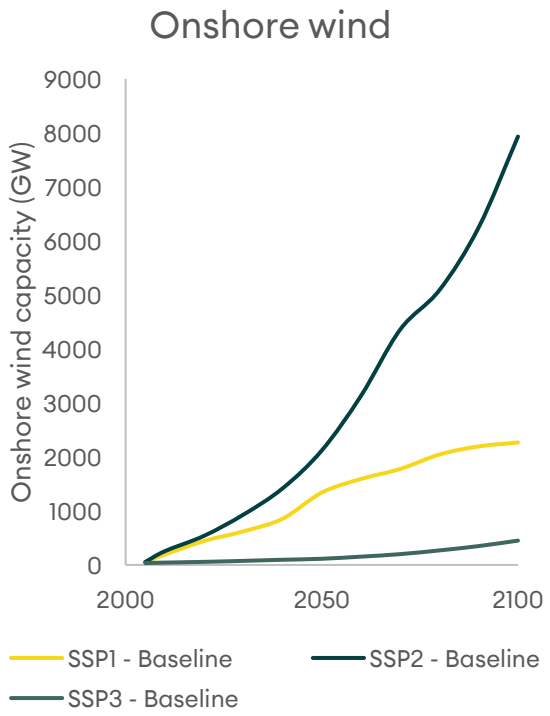
Implications for OX2

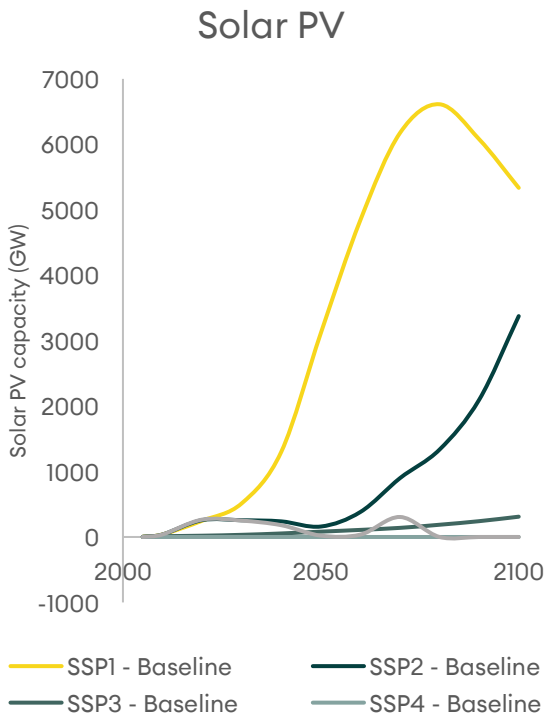
The carbon intensity of energy reflects the share of renewable energy in the energy system, indicating that there is more demand for renewable energy in the SSP1 and SSP4 scenarios. It does not indicate what renewable energy technologies are in focus and how much energy is consumed. Larger share of renewable energy production indicates implemented solutions for balancing energy (ancillary services).

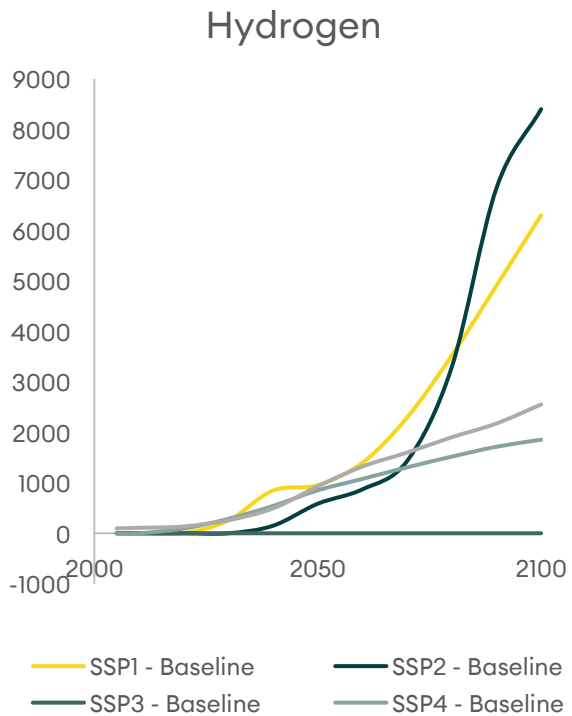
Mitigating climate change

Technologies in focus









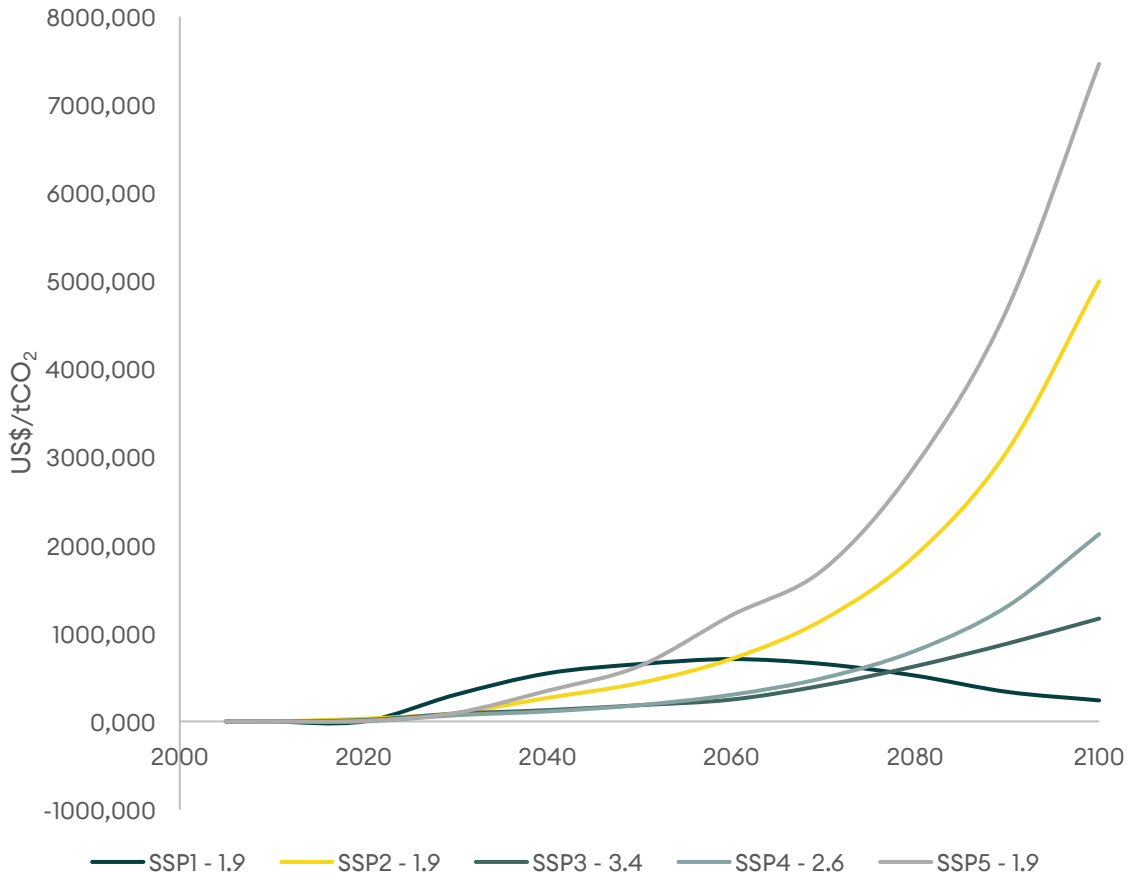
All scenarios indicate that there is a demand for OX2's business in the short, medium and long-term. Which technologies are in focus and the anticipated take-off for respective technology differs between scenarios.

Implications for OX2

- Continue to have a diversified portfolio in terms of technologies used.

Global carbon price

IPCC SSP scenarios



The global price on carbon goes up in every scenario. In one of the scenario, the SSP1 scenario, the trend changes direction by mid century and return to pre 2030 levels by 2100.

Driving demand for our business

A rising price on carbon drives the demand for projects that can deliver low-carbon energy, for example renewables.

Emphasing on the decarbonization of energy

Renewable energy's upstream activities that give rise to greenhouse gas emissions will also have to adapt to an increasing price on carbon. Material and fuel with lower CO_2 are likely to become more price competitive, if not standard practice. Circular business models, where resource outflow can be directed to being resource inflow, are likely to increase in scale, efficiency and capacity.

Implications for OX2

- Continue to monitor the developments of recycling and repurposing technologies and capacity within the renewable industry, to increase preparedness for when projects are expected to reach end of life.
- Continue to calculate greenhouse gas emissions associated with our business and monitor the price on carbon (the actual cost and the development of new carbon pricing mechanisms) to understand how the price on carbon will affect our business.

Supply chain risks

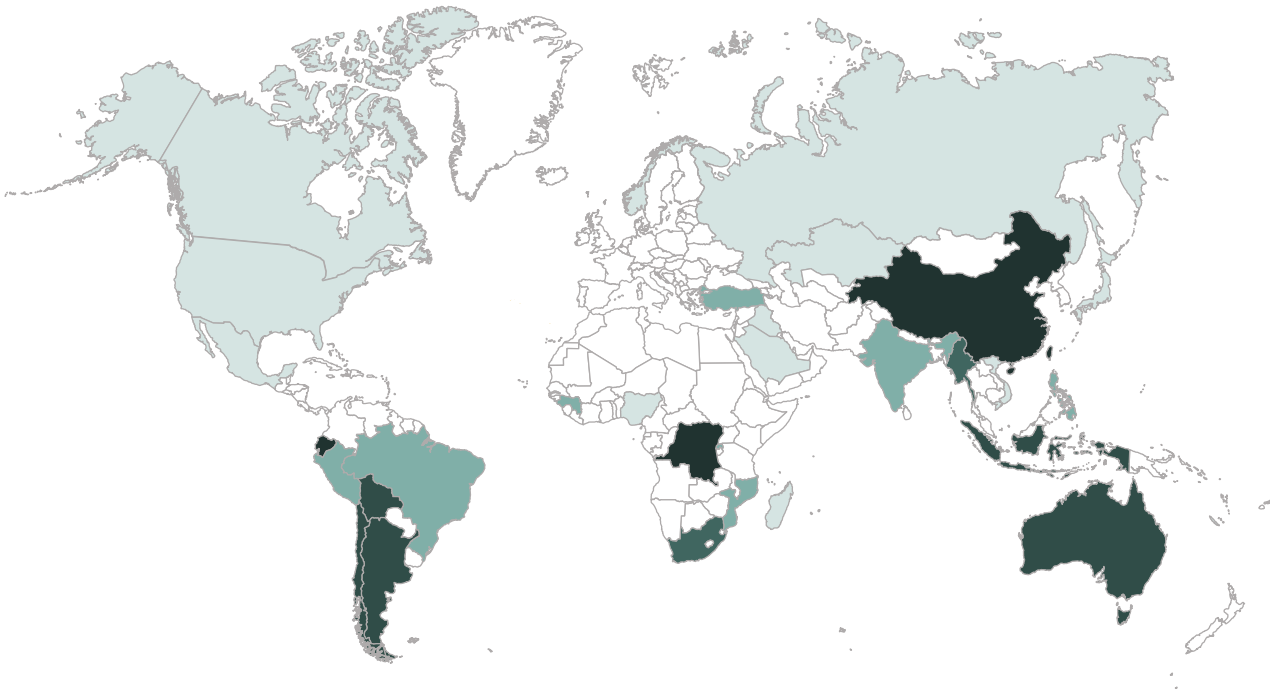
Metals and mining

The geographical footprint of our supply chain is much larger than the markets where we operate. Due to lacking overview of the supply chain, the risks are assessed based on where the material could be from, what risks exists there, and how that can impact us as a company. For example, steel makes up around 85-90% of wind power and in 2022 34% of the World's iron ore was mined in Australia and 52% was refined in China.

The metals and mining sector is vulnerable to physical and transitional climate risks. Key physical risks are intensifying storms and flooding, sea level rise, water-related issues (droughts and water scarcity), shifting permafrost, and rising temperatures and heat stress[1]. Key transitional risks are increasing price on carbon, public policy restrictions, shifts in market preferences, technology and the rise of low-carbon alternatives, rising reputational risk, emerging legal risk, and growing investor action[1]. These risks can for an actor who relies on mining for material imply increased costs of materials, and manufacturing delay as a result of disrupted mining.

The visualization to the rights includes steel (iron ore), aluminum, copper, zinc, wood, gold, crude oil, lithium, and nickel. Excluded from the visualization but also included in renewable energy supply chain are bauxite, cement (limestone and sand), LNG, and petrol.

1) United Nations Environmental Programme Financial Initiative (UNEPFI), Climate Risks in the Metals and Mining Sector (2024)



Percentage by mass of world production or refinery (2022) for materials used in our technologies (2024).

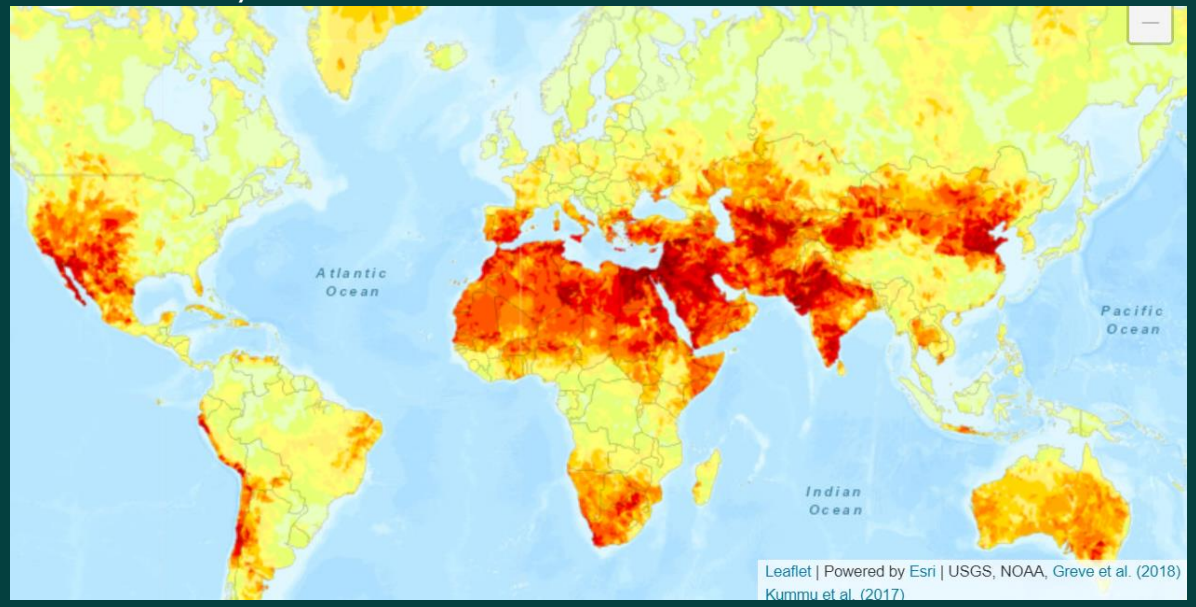
- >50%
- 25-50%
- 10-25%
- <10%

Supply chain risks

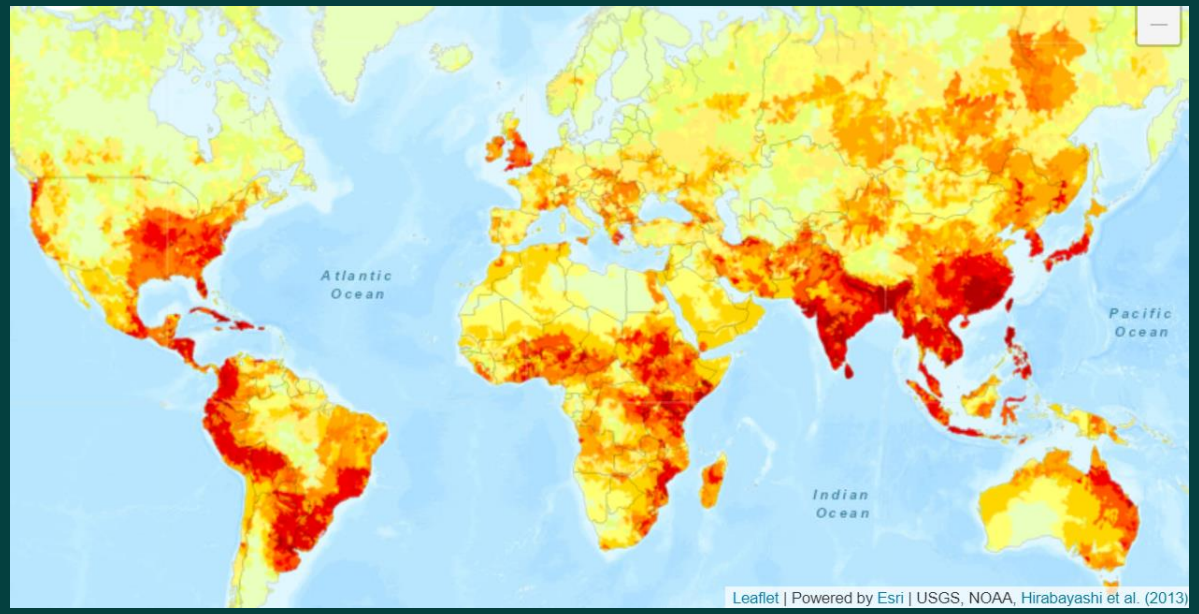
Flooding and other water-related risks

Extreme weather events, such as water-related risks, can disrupt mining activities. Many countries where material used in renewable technologies derives from, such as Australia, China, Indonesia, Chile, and Brazil are experiencing the impacts of climate change such as flooding and water scarcity. Visualizations to the right derives from the WWF Risk Filter which is a tool that project risk levels in different scenarios. The scenarios used here refers to the current trend which follows SSP2 and intermediate GHG emission levels (RCP4.5 /RCP6.0).

Water scarcity risk 2050

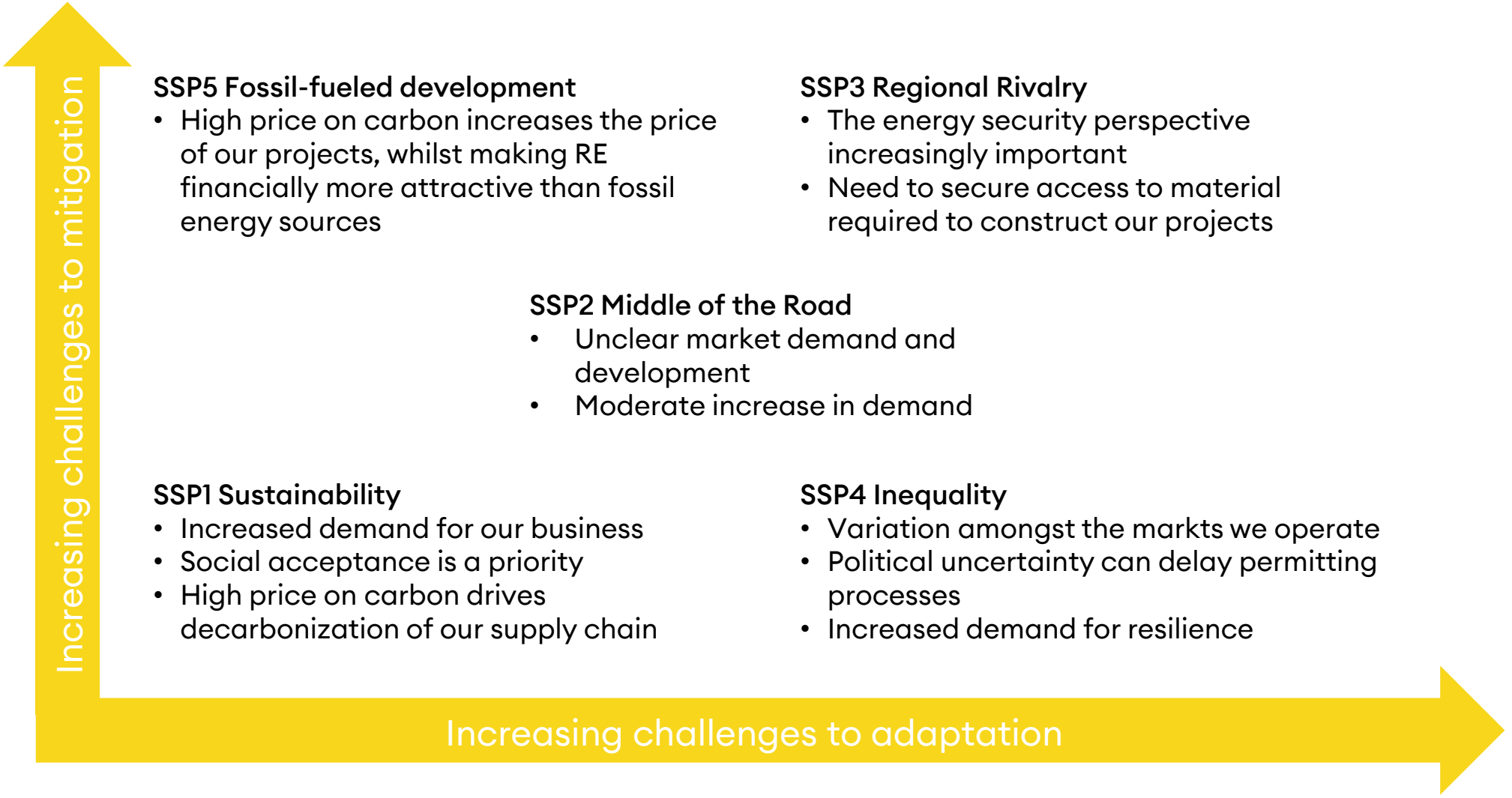


Flooding risk 2050



Climate scenarios

Implications for OX2



SSP5 Fossil-fueled development

- High price on carbon increases the price of our projects, whilst making RE financially more attractive than fossil energy sources

SSP3 Regional Rivalry

- The energy security perspective increasingly important
- Need to secure access to material required to construct our projects

SSP2 Middle of the Road

- Unclear market demand and development
- Moderate increase in demand

SSP1 Sustainability

- Increased demand for our business
- Social acceptance is a priority
- High price on carbon drives decarbonization of our supply chain

SSP4 Inequality

- Variation amongst the markts we operate
- Political uncertainty can delay permitting processes
- Increased demand for resilience

List of identified transitional climate-related risks

	Policy and legal	Technology	Market	Reputation
Description	*Threats from increases policy and legislation aiming to address climate change*	*Threats to our project portfolio and technological expertise as a result of newer low-carbon technologies.*	*Threats toward OX2's business due to changing market expectations on corporate climate action.*	*Threats towards OX2's business due to reputational damage.*
Identified risks	• Failing to be compliant with enhanced climate reporting e.g., CSRD • Increased price on carbon favoring competitors who have decarbonized their business more successfully e.g., NZIA • Policy favoring other technologies e.g., nuclear	• Reduced demand for the renewable energy solutions that we provide, because of not keeping up with innovation and technical advancements required to decarbonize our business in line with stakeholders' expectations • Unsuccessful investment in new technologies, initiatives, systems, tools and procedures	• Not meeting the market's expectations • Increased competition • Changing market behavior • Uncertainty in market signals • Increased cost of raw materials e.g., CBAM	• Stigmatization of sector • Shift in customer preferences • Negative stakeholder concern and negative feedback
Potential financial impacts	• Increased operating costs due to more resources allocated to meet climate-related requirements from regulation, investors and customers • Increased cost for renewable energy solutions e.g., subsidizing fossil fuels and nuclear energy	• R&D expenditures (direct or indirect) • Investments in training and education to adopt/deploy new technology, innovation and/or methods	• Increased production costs due to increased input prices (e.g., BOP and material) and output requirements (e.g., waste management)	• Decreased production capacity (e.g., delayed permit approvals, supply chain interruptions) • Increasingly difficult to attract and retain employees

List of identified physical climate-related risks

	Acute	Chronic
Description	*Threats to OX2's short-term targets and strategy*	*Threats toward OX2's long-term targets and strategy*
Potential hazards	• Extreme temperatures; heat wave and cold wave/frost • Extreme wind; cyclone, hurricane, typhoon, storm and tornado • Drought, wildfires and water stress • Heavy precipitation and flooding • Landslides	• Changing temperature and temperature variability • Melting permafrost • Changing wind patterns • Changing precipitation patterns and types • Ocean acidification and sea level rise • Soil erosion and solifluction
Identified risks	• Damage to service roads delaying construction and/or causing technology to be inaccessible during operation • Construction activities need to be delayed to avoid risk of starting a wildfire • Delay in WTG installation due to high wind speeds	• Increased ice formation and ice throw • Increased maintenance required for service roads and/or technology • AEP not meeting expectations • Increased erosion of technological equipment, reducing lifetime of components
Potential financial impact	• Limited productivity capacity (transport difficulties and supply chain disruption) • Higher costs to ensure safety for our employees and people who work on behalf of OX2	• Reduced sales e.g., decreased demand for our projects due to productivity being reduced and/or unpredictable • Higher operating costs e.g., higher cost of climate change adaption measures for the projects • Early retirement of projects due to unforeseen wear

List of identified climate-related opportunities

	Policy and legal	Technology	Market	Reputation
Description	*Potential benefits from increases policy and legislation aiming to address climate change.*	*Potential benefits to our project portfolio and technological expertise because of technological advancements and adoption.*	*Potential benefits toward OX2's business due to changing market expectations on corporate climate action.*	*Potential reputational benefits for OX2's business as a result of climate action.*
Identified opportunity	• Favorable policy environment for renewable energy technologies and ancillary services	• Technological development and innovation benefit our business, such as efficiency recycling methods • Localized and low-impact innovation e.g., climbing cranes	• Increased access to capital • Lower cost of capital • Access to new markets	• Improved brand reputation • Increased ability to attract and retain employees