INVESTING THROUGH THE ENERGY TRANSITION AND A CHANGING CLIMATE

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TABLE OF CONTENTS

INTRODUCTION

The Washington State Investment Board (WSIB) has been assessing the potential impacts of climate change and the evolving energy landscape for many years. Climate change and energy investments are key concerns for many of the WSIB's stakeholders, including the Board, beneficiaries, and members of the public. This research paper builds upon the research described in *Risks and Opportunities from a Changing Energy Complex and Climate Change* (Martinell & Tucker, 2019), which was presented to the Board in February 2019, as well as the WSIB's Climate Blueprint, which was adopted in 2022.

EXECUTIVE SUMMARY

KEY TAKEAWAYS

- Global temperatures are expected to increase at a rate that will have profound and highly uncertain impacts on both humans and the global economy over the next century. Some impacts are already being felt. We see little evidence that energy sources are shifting from traditional fossil fuels toward renewable sources at a rate that is sufficient to prevent many of the potential impacts of climate change.
- There is a high level of uncertainty around the pace of the energy transition and the impact climate change will have on the global economy, asset prices, and investment returns. Because of this uncertainty, we believe it is prudent for investors to maintain broadly diversified exposures across asset classes, sectors, and geographies, rather than create policies designed to divest the portfolio from certain energy-related industries. This aligns with the WSIB's investment beliefs and fiduciary duties and is consistent with academic research on the subject (Berk & van Binsbergen, 2024).
- Investment decisions at the WSIB incorporate financially material climate-related risks and opportunities. These risks and opportunities vary across asset classes and are impacted by time horizon, industry focus, investment strategy, and the type of investment vehicle. Through continuing education and collaboration across teams, the WSIB will continue to thoughtfully consider climate-related risks with the upmost prudence, care, and due diligence.

Energy resources are a key driver of economic growth. Energy powers our homes, allows for efficient transportation, and enables social and technological progress. Although harnessing energy for economic development has improved the quality of life for most humans, the use of fossil fuels as a primary source of energy has had negative impacts on Earth's climate. Increasing global temperatures and other changes to Earth's atmosphere have made its climate less predictable, with extreme weather events and other natural disasters increasing in magnitude and frequency.

Over the past few decades, leaders around the globe have called for actions to reduce the world's reliance on fossil fuels, most notably a transition to renewable sources of energy. While the speed of this transition toward renewable sources of energy is uncertain, the systems that provide safe, reliable energy are undergoing the most profound transformation in over a century. This shift is occurring against a backdrop of geopolitical uncertainty unlike anything the global economy has faced in several decades, which at times has led countries to delay their transition efforts.

The transition from fossil fuels to renewable sources of energy has been slowed recently by an increase in the global demand for energy. Increased demand from developing economies as they grow richer and an explosion in the use of energy-intensive artificial intelligence (AI) are dramatically impacting global energy consumption. These factors have supported the continued use of fossil fuels in many countries, at times in parallel with an increased use of renewable energy. For instance, natural gas and oil production are expected to increase through 2050 even if the current climate-related policies outlined by nations in the Paris Agreement are implemented.

The world is making progress in its transition away from fossil fuels, even if that progress is at times uneven. Developed economies have begun to reduce their coal consumption in favor of gas, wind, and solar. Renewables are currently cost-competitive in many places and are expected to continue to increase as a proportion of the overall energy mix. From a technological perspective, global passenger electric vehicle (EV) use has increased at rates higher than initially projected in the WSIB's 2018 research. We have also seen an increase in the commercialization and economic viability of technologies that were nascent in 2018, including utility-scale battery storage, small modular nuclear reactors, and carbon capture.

For long-term investors like the WSIB, the energy transition presents both risks and opportunities across our investment portfolios. In line with our Climate Blueprint, the WSIB seeks to continuously enhance its approach to climate risk management, particularly as data improves and industry best practices emerge. Greenhouse gas emissions, exposure to high-risk industries and sectors, and exposure to companies and funds that are investing in the energy transition are now reported annually in the WSIB's Sustainability Report. Staff have engaged with external data providers and partners to discuss further enhancements to the WSIB's climate risk management process at a total portfolio level, including climate scenario analysis and physical risk analysis. We also continue to explore additional ways to understand material climate-related risks and opportunities through continued education and information sharing across asset classes. The impacts of AI and an increasingly uncertain geopolitical environment are among the key trends that staff will continue to explore within the context of sustainability.

The WSIB's asset class teams are highly attuned to the impacts of climate change and the energy transition on their investment portfolios. Each new investment opportunity at the WSIB includes a review of material climate-related risks and opportunities. Below are key takeaways from each asset class.

- **Public Equity**: Public equity staff utilize a dual structure approach to investing, with passive strategies providing broad market exposure and active management strategies adding resilience to the portfolio. With its detailed and nuanced research focused on each individual company's circumstances and strategies, active management is best positioned to assess and respond to the risks and opportunities associated with climate change and the energy transition. The global energy transition may create multi-decade tailwinds for companies capable of addressing structural energy and resource gaps, including but not limited to AI and data centers, grid and utility modernization, and critical minerals. Within passive equities, staff continually researches potential new indices. Thus far, staff has found no compelling evidence that low-carbon and fossil fuel-free indices would outperform traditional passive strategies over the long term, net of fees and costs. Further, a rules-based approach would likely be ineffective at capturing the risks, opportunities, and impacts of the climate transition with any consistency. Staff will continue researching climate-aware indices and active strategies as the industry evolves.
- **Fixed Income**: Unlike other asset classes at the WSIB, which generally invest through external investment managers and other fund structures, fixed income investments are managed in-house by WSIB staff. The fixed income team is highly attuned to climate-related risks and opportunities and how they might impact their investments over time. The fixed income portfolios' primary exposure to climate-related risks is tied to bonds issued by fossil fuel companies. The fixed income portfolios do not have investments in coal-focused businesses. Portfolio investments in electric utilities provide stable, predictable cash flows and include transition leaders that have significantly reduced carbon intensity with credible renewable integration plans. The team will remain highly selective when investing in companies with fossil fuel exposure.
- **Private Equity**: Investing in private equity during the ongoing energy transition requires both the consideration of opportunities for growth and returns and the avoidance or mitigation of value destruction caused by climate change. The convergence of these two concepts may be found in the sizeable opportunity offered through a combination of investments that support renewable energy and decarbonization. As part of the WSIB's governance and oversight of private equity investments, staff serve on the Limited Partner Advisory Committees of all funds in which we invest. This allows staff the opportunity to voice concerns and provide advice to investment managers on matters related to energy transition risks and mitigation efforts.
- **Real Estate**: To varying extents, many, if not all, real estate geographies and property types will be impacted by climate change, regulation, and the energy transition. Several climate change-related factors that can impact the real estate portfolio are addressed naturally through both the investment style and philosophy of the WSIB's real estate program, which is focused on investments that provide a long-term, high-quality, and stable income stream. Markets and assets in the existing portfolio, as well as each new investment, are evaluated with a

consideration of both opportunities and risks related to the energy transition and climate impacts. For example, our investment partners have invested in solar panel installations on building rooftops, Passivhaus construction in Europe that greatly enhances heating and cooling efficiency, and construction of properties designed for resilience in extreme weather events. Considering opportunities that support long-term value creation while taking into account climate risks helps maintain the team's thoughtful approach toward portfolio construction.

- **Tangible Assets**: Climate-related risks are more pronounced in the tangible assets portfolio's power and energy investments along with agriculture exposures, where performance and value are sensitive to weather volatility, water constraints, policy market shifts, and market changes. These risks are managed through disciplined underwriting and ongoing monitoring, supported by diversification, contractual protections, and operational mitigants aligned with income-producing and inflation-protected return objectives. Meanwhile, the transition is broadening the opportunity set beyond investments in renewable energy generation, which the tangible assets team has many years of experience investing in. The expanded opportunity set includes technologies and services that improve energy reliability and efficiency, carbon capture, utilization, and storage (CCUS), and generating carbon credits in timber and agriculture.
- **Private Credit**: The WSIB is focused on ensuring that its private credit managers consider the implications of evolving energy systems, regulatory changes, and operational efficiencies in their investment decisions, with an emphasis on building resilient portfolios that are well-positioned to capture emerging opportunities linked to the energy transition. Private credit's shorter contractual horizon helps mitigate structural exposure to long-duration climate risk; however, borrower-level sensitivities may emerge as operating conditions evolve. Companies that proactively adjust cost structures and capital expenditure plans are better positioned to sustain performance, while others may encounter incremental pressures driven by changing energy dynamics. As the transition progresses, credit performance is expected to diverge across industries, reflecting differences in energy intensity, asset durability, and the ability to adapt to shifting conditions.
- **Innovation Portfolio**: The innovation portfolio is intentionally flexible and can evaluate a wide range of themes, strategies, sectors, and instruments as opportunities emerge and market conditions evolve, including certain climate- and transition-related strategies that may not fit neatly within WSIB's existing asset class frameworks. Because of this flexibility, it is not practical to define a fixed set of transition-risk categories, opportunity themes, or process considerations that would apply uniformly across future investments. Instead, these considerations are assessed at the investment level, with the depth and focus tailored to the strategy and primary exposure drivers and informed by the diligence, underwriting, and monitoring practices of the most comparable asset class. For example, the innovation portfolio invested in TPG's impact and climate transition funds at a time when the ability of such strategies to achieve private equity-like returns was less established. As the market has evolved, some of these strategies have become more clearly aligned with existing asset class mandates and return objectives and may, where appropriate, be pursued outside the innovation portfolio.

PROJECT OVERVIEW

The Energy Transition project, and this paper, are meant to further the WSIB's understanding of the energy transition and potential investment impacts of climate change. This work was led by the Head of Sustainability, with input from the Risk Management and Asset Allocation (RMAA) and asset class teams. Staff also sought additional insights from the WSIB's investment partners and other external experts to complete this work. This research aligns with the WSIB's Climate Blueprint as well as the 2025 and 2026 Strategic Plans.

This paper attempts to address:

- Climate science and potential impacts of a destabilizing climate on the global economy
- Trends in supply, demand, and costs associated with different types of energy
- Geopolitical trends and the prospective impacts of global climate-related regulations
- Total portfolio approaches to managing the investment risks and opportunities associated with the energy transition and climate change
- Asset class-specific risks, opportunities, strategies, and key takeaways

This project ties directly to several of the WSIB's defined benefit retirement fund investment beliefs. These beliefs pertain specifically to the defined benefit assets of the Commingled Trust Fund (CTF or Fund). However, the project and associated white paper were completed with all funds entrusted to the WSIB in mind.

- The mission of the Fund is to maximize returns at a prudent level of risk. The time horizon for this mission is long term (i.e., 15+ years).
- The WSIB has a long investment horizon and is subject to complex and systemic global dynamics that unfold over time. These create risks and opportunities, including, but not limited to, environmental, social, and governance (ESG) considerations such as financial impacts resulting from climate change; improved economic outcomes from a more diverse, equitable, and inclusive work force; and governance practices that provide effective transparency and long-term sustainability.
- Risk:
  - The CTF should be compensated for the investment risks it takes.
  - Risk must be considered at the investment, asset class, and portfolio level.
  - Only some investment risks can be clearly defined and measured.

The work that follows incorporates the findings of numerous reports and papers authored by academics, government agencies, think tanks, sell side research, energy companies, and money managers. This includes relevant papers submitted to the WSIB by members of the public through both the formal public comment submissions process and interactions with staff. Additionally, team members held several meetings with recognized experts in the field to further gather insights and perspectives.

This paper is divided into two sections. The first section offers an introduction to climate science and the long-term outlook for energy markets. The second section focuses on investment risks and opportunities associated with climate change and the energy transition.

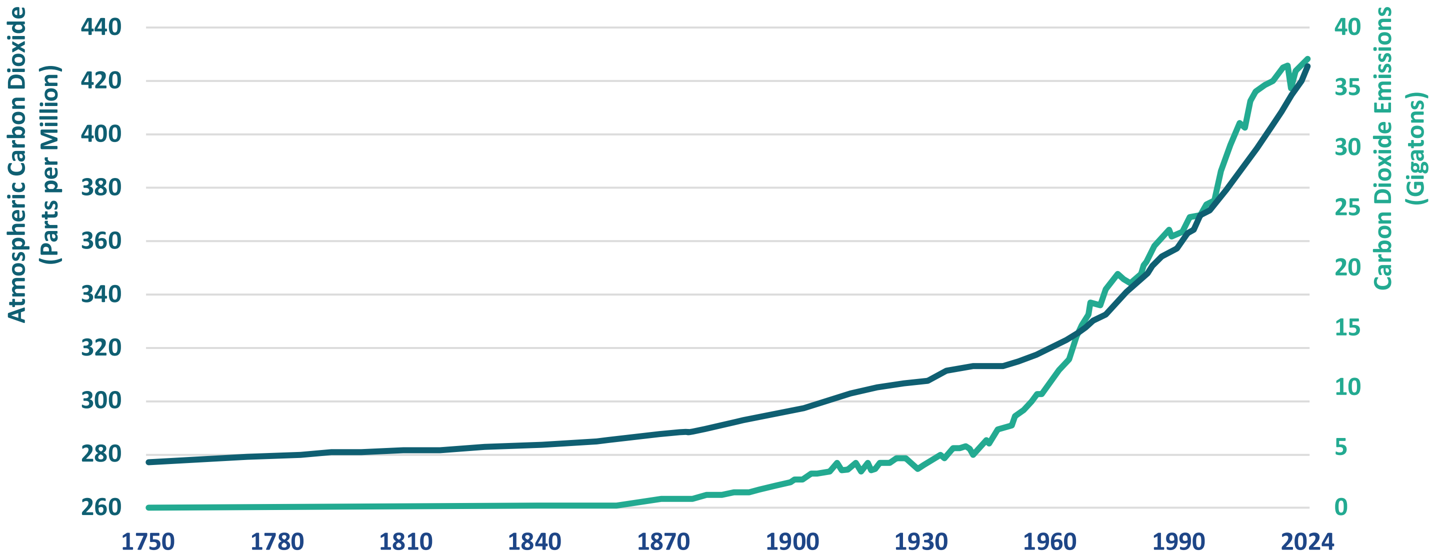
INTRODUCTION TO CLIMATE SCIENCE AND ENERGY BASICS

CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS

Climate change refers to significant and lasting changes in weather patterns and distribution, spanning from decades to millions of years. It can be caused by natural phenomena like variations in solar radiation, plate tectonics, or volcanic activity. Earth's climate has undergone significant changes over the last 800,000 years, with eight cycles of ice ages and warmer periods. The end of the most recent ice age about 11,700 years ago marked the beginning of human civilization (NASA, 2024).

Earth's climate is currently warming at a rate not seen in the past 10,000 years and the scientific community almost universally agrees that human activities since the industrial revolution have been the cause of this warming trend. Human activities have led to increasing concentrations of greenhouse gases in the atmosphere, trapping more heat and causing global warming (Lee & Romero, 2023). Greenhouse gas (GHG) emissions that contribute to warming include carbon dioxide (CO2) as well as other gases such as methane (CH4), nitrous oxide (N2O), and fluorinated gases such as hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride. Throughout this paper, there are references to both CO2 emissions and GHG emissions. GHG emissions are also sometimes expressed as carbon dioxide equivalents (CO2e).

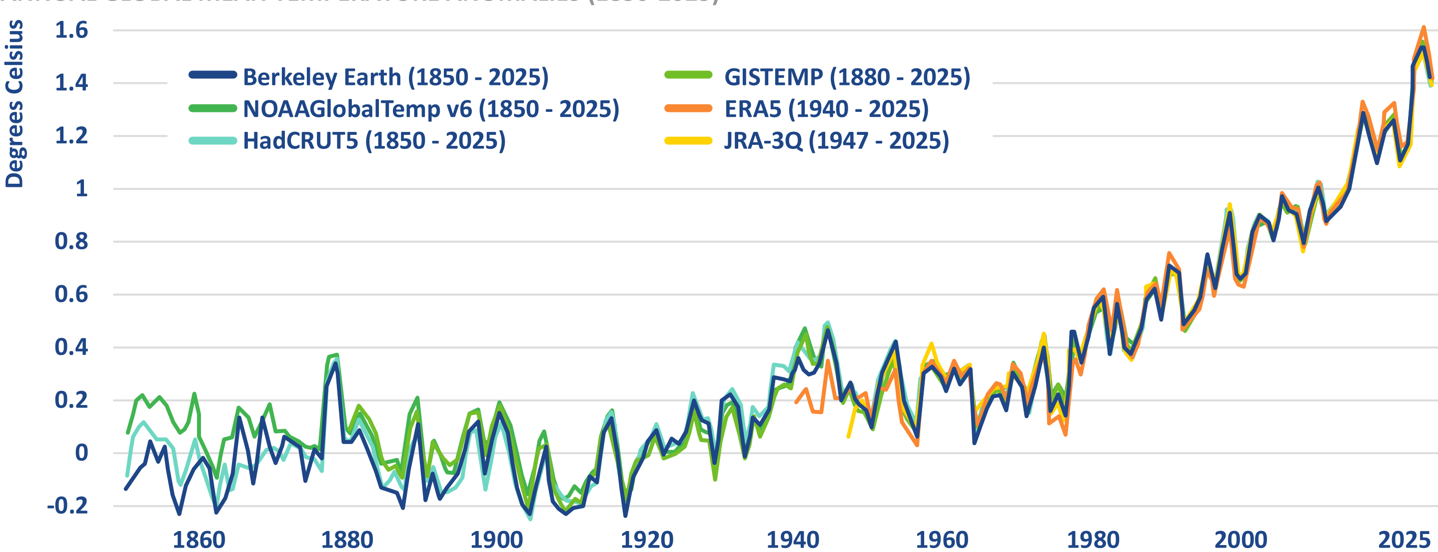
GLOBAL CARBON DIOXIDE EMISSIONS AND ATMOSPHERIC CARBON DIOXIDE (1750-2024)



Source: Climate.gov, 2025.

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) found that from 2011-2020, the Earth's global surface temperature averaged 1.09°C above the average temperature of the "pre-industrial period" of 1850 to 1900. Further, the average global surface temperature increased faster between 1970 and 2020 than it has over any other 50-year period over the last two millennia (IPCC, 2023). According to data collated by the Met Office, National Centre for Atmospheric Science, and University of East Anglia, 2024 was the warmest year on record, likely exceeding 1.5°C above the 1850-1900 global average for the first time since the industrial revolution. The previous warmest year on record was 2023.

ANNUAL GLOBAL MEAN TEMPERATURE ANOMALIES (1850-2025)



Source: State of Climate: Update for COP30, World Meteorological Organization, 2025. Annual global mean temperature anomalies relative to 1850 to 1900. The 2025 average is based on data from January to August.

Rising and volatile temperatures are having measurable impacts on the Earth's climate. For example, most land areas have experienced more frequent and longer heatwaves compared to the 1950s (Perkins-Kirkpatrick & Lewis, 2020). Marine heatwaves now occur approximately twice as often as they did in the 1980s. Heat that is trapped in the atmosphere warms the oceans, which store the excess heat like a battery. This contributes to further warming as well as stronger and more frequent tropical cyclones and precipitation. Research published in early 2025 found that the heat content of the upper 2000 meters of most of the world's oceans was the highest in recorded history (Cheng, et al., 2025). Water expands as it warms, leading to higher sea levels and higher risks of coastal flooding, erosion, and saltwater intrusion.

Heatwaves can lead to an increased likelihood and magnitude of wildfires and water scarcity, changes in agricultural production, reduced biodiversity, increased air pollution, and negative impacts on critical infrastructure. The UCLA Anderson School of Management estimates that the property and capital losses due to the Los Angeles wildfires in January 2025 fell somewhere between $76 billion and $131 billion, translating to a 0.48 percent decline in county-level gross domestic product for 2025 and wage losses of $297 million for local businesses and employees in affected areas (Li & Yu, 2025). These climate-related crises, which are occurring with increasing frequency and magnitude, are also dangerous to human health and could necessitate mass migration, which might lead to multiple concurrent humanitarian crises around the world.

THE SIGNIFICANCE OF 1.5°C

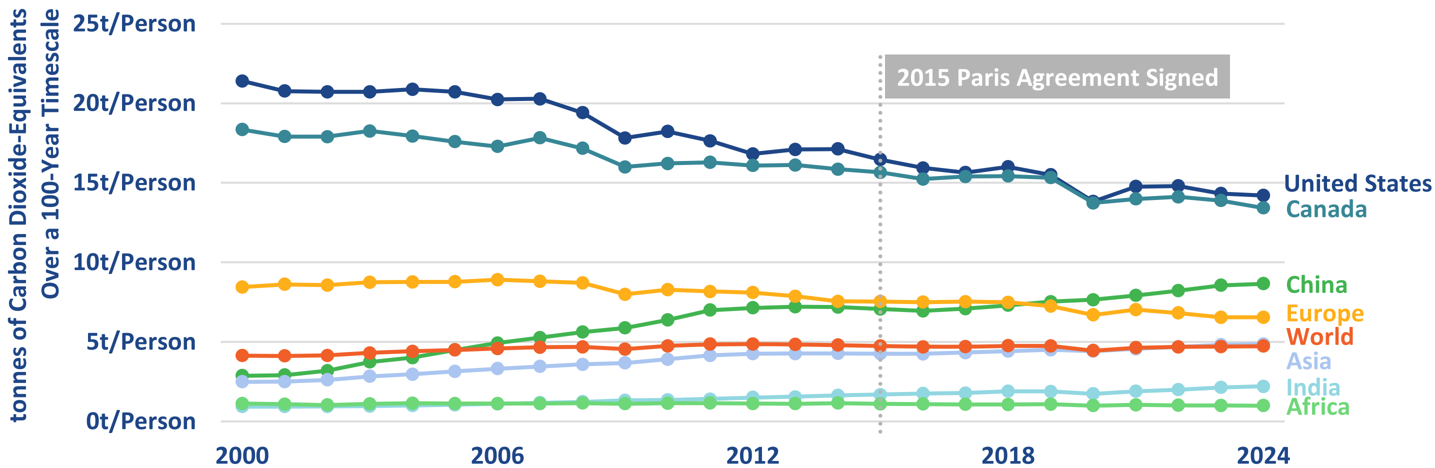
Given the consequences associated with a warming climate, global leaders have worked to develop strategies for slowing the progress of climate change, mitigating its negative impacts where possible, and supporting adaptation efforts in areas where change is impractical. In 2015, the Conference of Parties to the UN Framework Convention on Climate Change (COP21) held its annual session in Paris, France. Delegates from 196 countries signed the Paris Agreement at the conference, agreeing to limit global warming to well below 2°C above pre-industrial levels, with a goal of limiting the increase to 1.5°C (NOAA, 2025). While 2°C was a threshold that had been used by the scientific community for decades, research indicated that for some particularly vulnerable ecosystems, the risk of significant damage rapidly increases at levels lower than 2°C of warming. The significance of limiting warming to 1.5°C is discussed in detail in the 2018 IPCC Special Report on Global Warming of 1.5°C (IPCC, 2018). Since then, IPCC research and other scientific publications have continued to provide evidence that limiting global warming to 1.5°C will reduce the impacts on human and other ecosystems.

While the average global surface temperature in 2024 exceeded 1.5°C, it does not necessarily mean that the critical climate threshold has been breached. Temperature anomalies must be measured over periods of multiple years to assess temperature changes resulting from natural causes relative to human impacts. Furthermore, the Paris Agreement does not specify how many years constitute a long-term trend, which dataset should be used, or the exact timeframe for the pre-industrial period. This means different scientists, governments, and groups will likely arrive at different conclusions on when the Earth passes this critical threshold. With that said, as of late 2025, there is increasing consensus that efforts to decarbonize have not been sufficient and that Earth's climate is nearly certain to cross the 1.5°C threshold (Liberto, 2024).

PROGRESS SINCE 2015

Thus far, concerted global efforts to decarbonize and meet the objectives of the Paris Agreement have only had limited impact. Globally, per capita tonnes of CO_2e remain mostly unchanged, at 4.74 tonnes per person in 2015, versus 4.73 tonnes per person in 2024. However, in many developing economies including China and India, per capita emissions continue to increase. In the U.S., per capita emissions have declined from 16.5 tonnes per person in 2015 to 14.2 tonnes per person in 2024. The US still has the highest per capita emissions globally (Our World In Data, 2024).

GLOBAL PER CAPITA GREENHOUSE GAS EMISSIONS (2000-2024)



Source: Our World in Data, 2024. Greenhouse gas emissions include carbon dioxide, methane, and nitrous oxide from all sources, including land-use change.

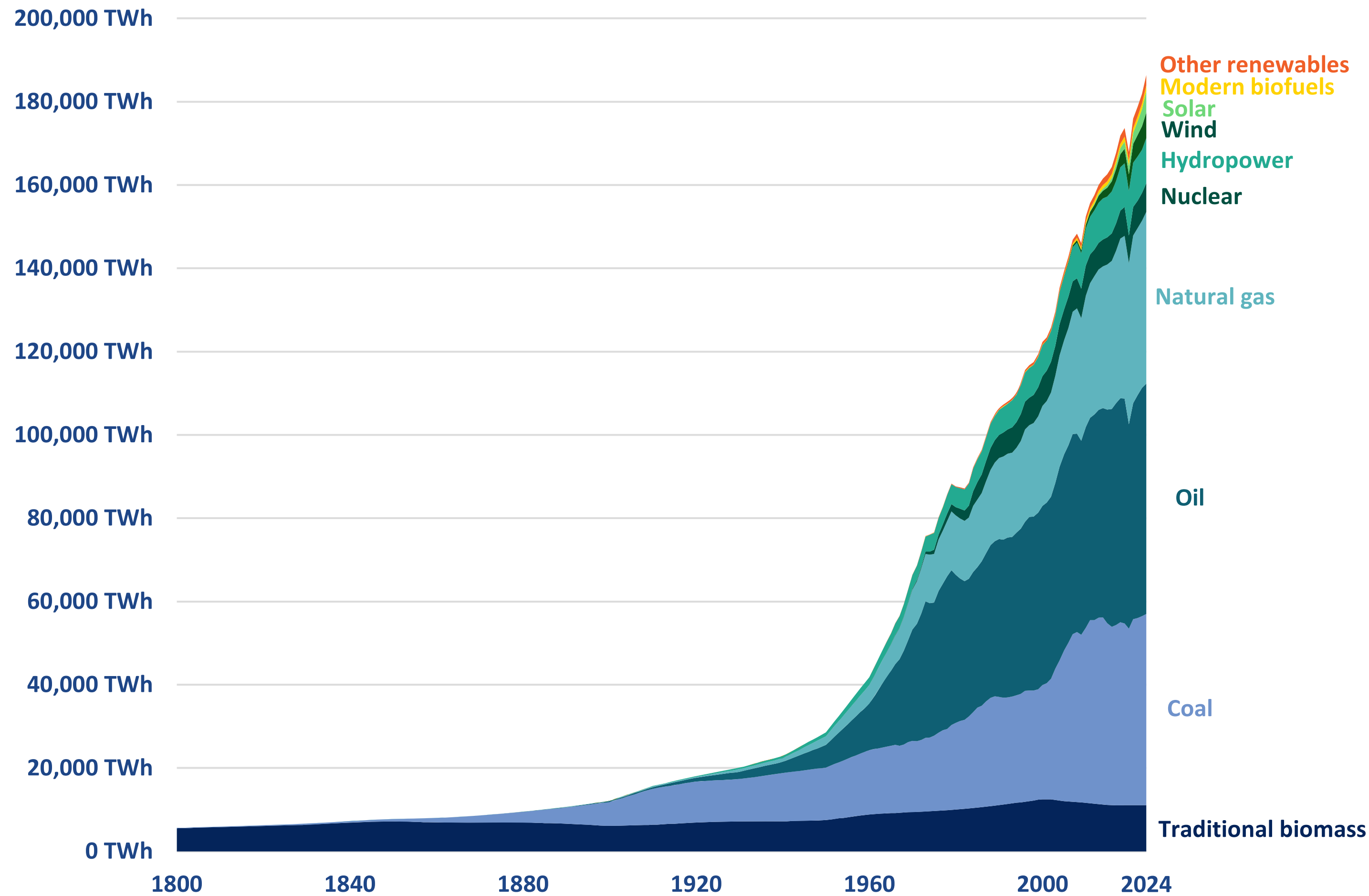
Current policies and regulations aimed at reducing greenhouse gas emissions are insufficient to meet the 1.5°C objective. A continuation of the mitigation efforts implied by current policies is estimated to lead to global warming of a maximum of 3.1°C over the course of the century (United Nations Environmental Programme, 2024). As policymakers and investors recognize the inevitability of a warming climate, attention is shifting towards adaptation and resilience. Climate adaptation aims to reduce damage associated with rising temperatures and increasing natural disasters. This includes building flood defenses, developing drought-resistant crops, and retrofitting buildings to reduce damage from major weather events. These actions can improve the resilience of communities and ecosystems and reduce associated long-term economic impacts.

The next section of this paper will explore historical and projected energy supply and demand, which have a significant impact on the trajectory of greenhouse gas emissions and increasing temperatures.

EVOLUTION OF ENERGY

The availability of energy is inextricably linked to economic growth. Early humans relied on fire for cooking, warmth, and protection, primarily from traditional biomass (wood and other plant sources). Ancient civilizations utilized water and wind for certain industrial practices. During the industrial revolution, coal replaced traditional biomass as the primary source of energy, and eventually oil and natural gas became major energy sources. Historically, transitions from one source of energy to another have been very slow, as each type of energy is unique with respect to its cost, availability, use, and efficiency transmission. It can take decades to build the infrastructure to support new energy sources.

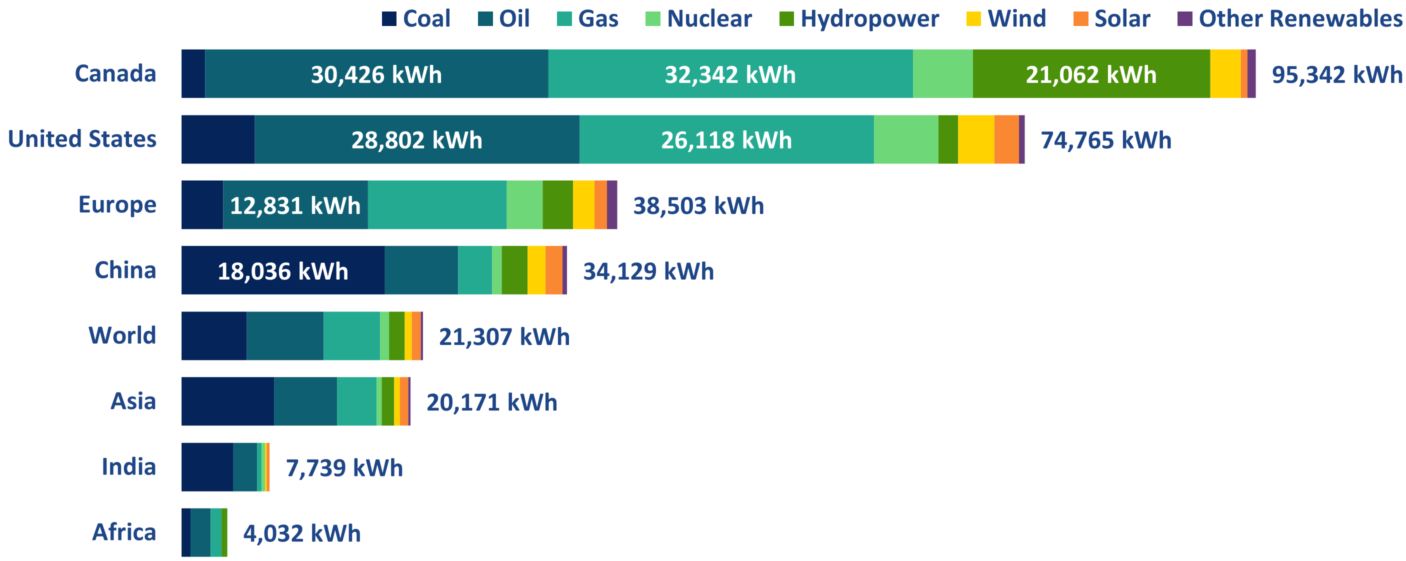
GLOBAL PRIMARY ENERGY CONSUMPTION BY SOURCE (1800-2024)



Source: Our World in Data, 2025. Primary energy is the energy available as resources – such as the fuels burned in power plants – before it has been transformed. This data is based on the substitution method, which adjusts primary energy consumption for efficiency losses experienced by fossil fuels. 'Other renewables' refers to renewable sources including geothermal, biomass, waste, wave and tidal.

The production of energy is responsible for 91 percent of greenhouse gas emissions (Roser, 2020). Because of this, most efforts to reduce greenhouse gas emissions to date have been focused on transitioning the overall energy supply toward renewable energy sources. In recent decades, renewable and carbon-free energy sources have become more significant components of primary energy consumption, but coal, oil, and natural gas remain dominant globally at the time of this writing. This is expected to continue for several decades.

PER CAPITA PRIMARY ENERGY CONSUMPTION BY SOURCE (2024)

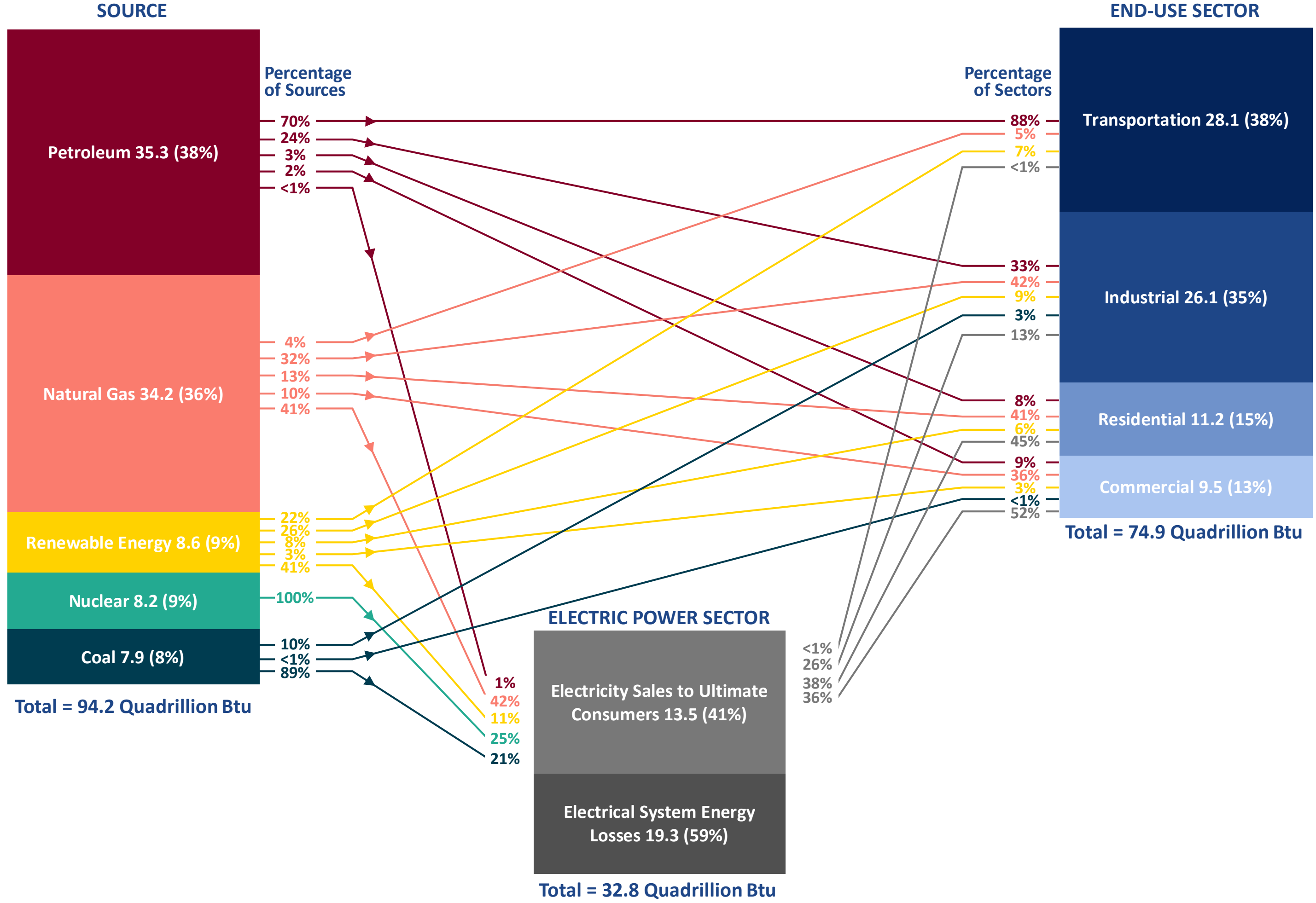


Source: Our World in Data, 2024. Primary energy is the energy available as resources – such as the fuels burned in power plants – before it has been transformed. This data is based on the substitution method, which adjusts primary energy consumption for efficiency losses experienced by fossil fuels. 'Other renewables' refers to renewable sources including geothermal, biomass, waste, wave and tidal.

Globally, energy demand has averaged annual growth of around 1 percent between 2019 and 2024 and is expected to continue to increase. This trend is being driven primarily by increasing prosperity and growth in developing economies (BP, 2025). Around 2 billion people lack access to clean cooking and 730 million are without electricity (International Energy Agency, 2025). Additional investments in both renewable and fossil fuel-based energy will be required to help impoverished people gain access to these essentials. Furthermore, an increase in use of AI is beginning to have a large impact on electricity demand, which is explored later in the paper.

Energy demand can be grouped into four main end-use sectors: transportation, industrial, residential, and commercial. In the U.S. in 2024, the transportation sector consumed the most energy, at 38 percent, followed by the industrial sector at 35 percent. Residential and commercial uses combined comprised 28 percent (U.S. Energy Information Administration, 2025). The chart on the following page is a graphical depiction of the flow of energy consumption in the U.S., from initial source to end-use sector.

U.S. ENERGY CONSUMPTION BY SOURCE AND SECTOR (2024)

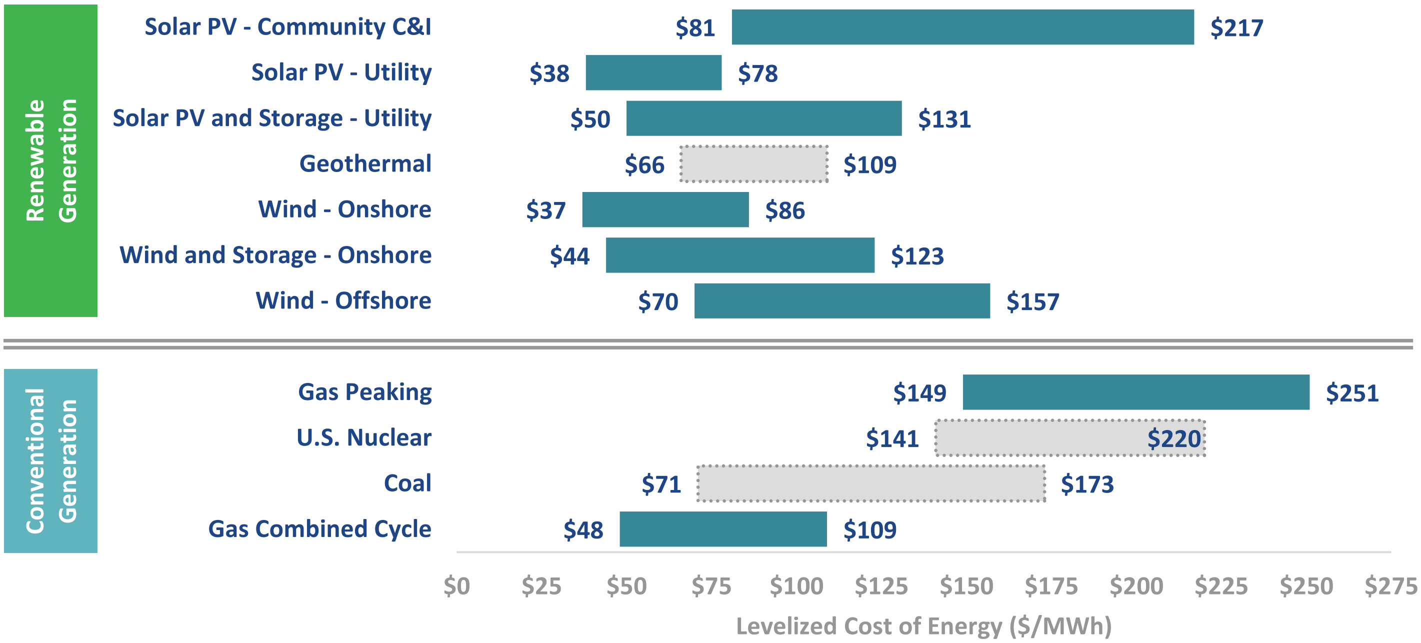


Source: EIA.gov, 2025. Stated amounts are in Quadrillion British Thermal Units (Btu). Electrical system energy losses are calculated as primary energy consumed by the electric power sector minus the heat content of electricity sales to ultimate consumers. All uses of primary energy have efficiency losses. This includes the electrical system energy losses noted in the chart above, as well as losses due to energy production, distribution, and consumption, which are not shown separately in this chart.

COST OF ENERGY

Under certain circumstances, renewable energy generation technologies are cost-competitive with conventional generation technologies (Lazard, 2025). Renewable energy generation can be quickly installed, contrasting with longer deployment times for conventional generation. While intermittency remains a key challenge associated with wind and solar energy, utility-scale batteries and energy storage systems have become dramatically cheaper. Renewable energy can therefore be both a source of backup power generation and increase grid resilience.

LEVELIZED COST OF ENERGY (LCOE) COMPARISON (2025)[1]



Source: Lazard estimates and publicly available information, 2025. Calculations generally reflect 60% debt at an 8% interest rate and 40% equity at a 12% cost. LCOE for renewables reflects standalone generation plus standalone storage less the combined system-level synergies. Given the limited public and/or observable data available for new-build geothermal, coal and nuclear projects, this data reflects Lazard's LCOE v14.0 results adjusted for inflation and, for nuclear, are based on estimated costs of the Vogtle Plant. Coal LCOE does not include cost of transportation and storage. See (Lazard, 2025) for further details on assumptions and methodology.

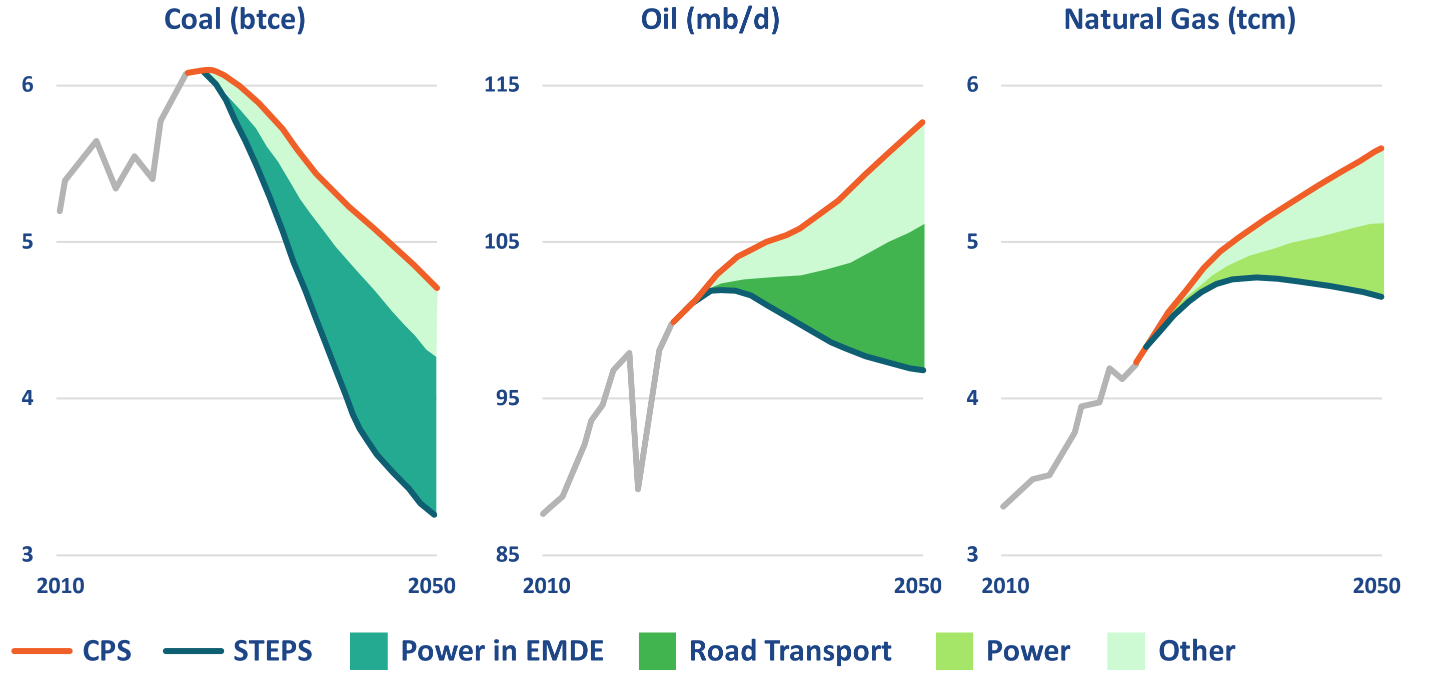
POTENTIAL SCENARIOS FOR FOSSIL FUELS

In its 2025 World Energy Outlook, the International Energy Association (IEA) explored potential scenarios on how the global energy system may evolve (International Energy Agency, 2025). The two scenarios, Stated Policies Scenario (STEPS) and Current Policies Scenario (CPS), use different assumptions regarding the pace of today's policy and technology adoption. CPS only considers policies and regulations that are already in place, while STEPS also considers policies that are currently tabled or not yet adopted, as well as documents that indicate potential future policy actions. STEPS projects lower levels of emissions that keep warming to around 2.5°C by 2100, whereas CPS is consistent with warming of around 3°C. Both scenarios indicate increasing energy demand between now and 2050, albeit at different rates. Much of this increase in demand is expected to be met by fossil fuels.

The IEA report also includes a Net Zero Emissions by 2050 Scenario (NZE) where warming peaks around 2050 at about 1.65°C and declines slowly thereafter. For the purposes of this paper, we have focused our analysis on the STEPS and CPS scenarios, as we consider the NZE scenario highly unlikely given the current global geopolitical environment and the lack of appetite for concerted, coordinated change. While this report only focuses on two scenarios that have a basis in current and proposed policies, the actual range of outcomes is highly uncertain and significantly larger than these simplistic scenarios can capture.

[1] LCOE is used throughout this report because it allows for consistent comparisons of cost trends across a diverse set of energy technologies. However, it does not include the costs of grid integration or climate impacts. Further, LCOE does not consider other environmental and social externalities that may modify the overall (monetary and non-monetary) costs of technologies and alter their deployment.

DEMAND FOR FOSSIL FUELS BY MAJOR DRIVER AND SCENARIO (2010-2050)

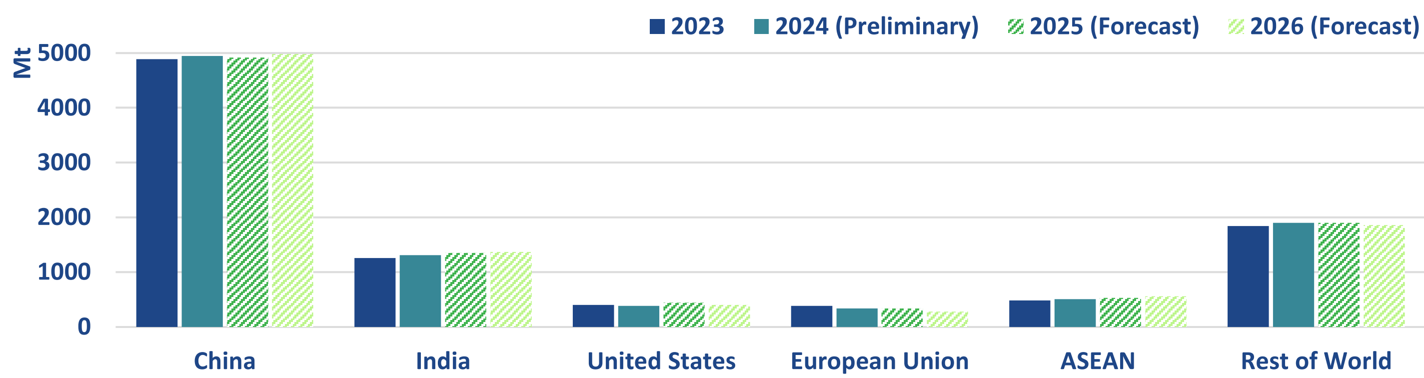


Source: World Energy Outlook 2025. Btce = billion tonnes of coal equivalent; mb/d = million barrels per day; tcm = trillion cubic meters; EMDE = emerging markets developing economies.

COAL

While coal's share of the overall energy complex peaked in 1900, overall usage has increased nearly eightfold since then, even as the proportional mix has shifted to favor other energy sources (Martinell & Tucker, 2019). In 2024, coal demand reached all-time highs, at 8.79 billion tonnes, a 1.5 percent increase from 2023 (International Energy Agency, 2025). Most of the consumption came from China, India, and other developing economies, where demand is expected to increase marginally for several more years. Despite continued use in developing economies, global coal demand is expected to decline over the next decade.

GLOBAL COAL CONSUMPTION (2023-2026)

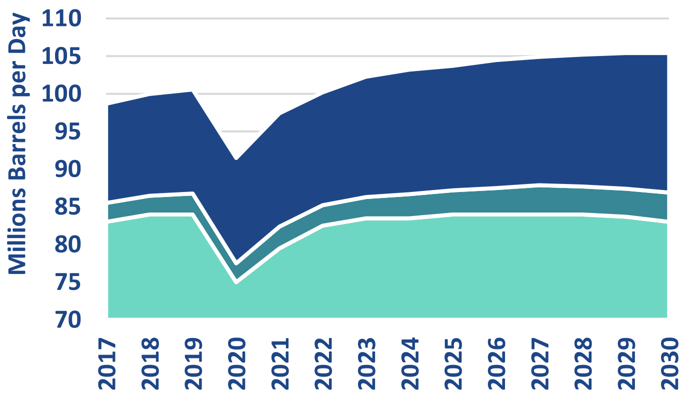


Source: Coal Mid-Year Update 2025. Metric tonnes (Mt). ASEAN = Association of Southeast Asian Nations.

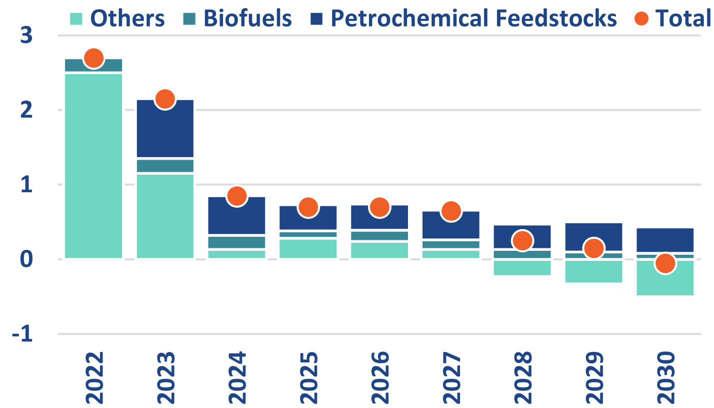
OIL

While peak oil is not expected for several years, oil markets are going through a fundamental transformation as the drivers of global oil supply and demand patterns shift. From 2015 to 2024, the U.S. accounted for 90 percent of the increase in global supply, with the shale boom lifting US oil production by more than 8 mb/d to over 20 mb/d. At the same time, Chinese oil demand rose by nearly 6 mb/d, accounting for 60 percent of the global increase in oil use (International Energy Agency, 2025). Going forward, slower growth in oil demand is expected, driven by a combination of geopolitical tensions, which is discussed later in this report, and the accelerating transition away from oil toward cleaner sources of energy for transportation and electricity uses.

OIL DEMAND (2017-2030)



GROWTH IN OIL DEMAND (2022-2030)



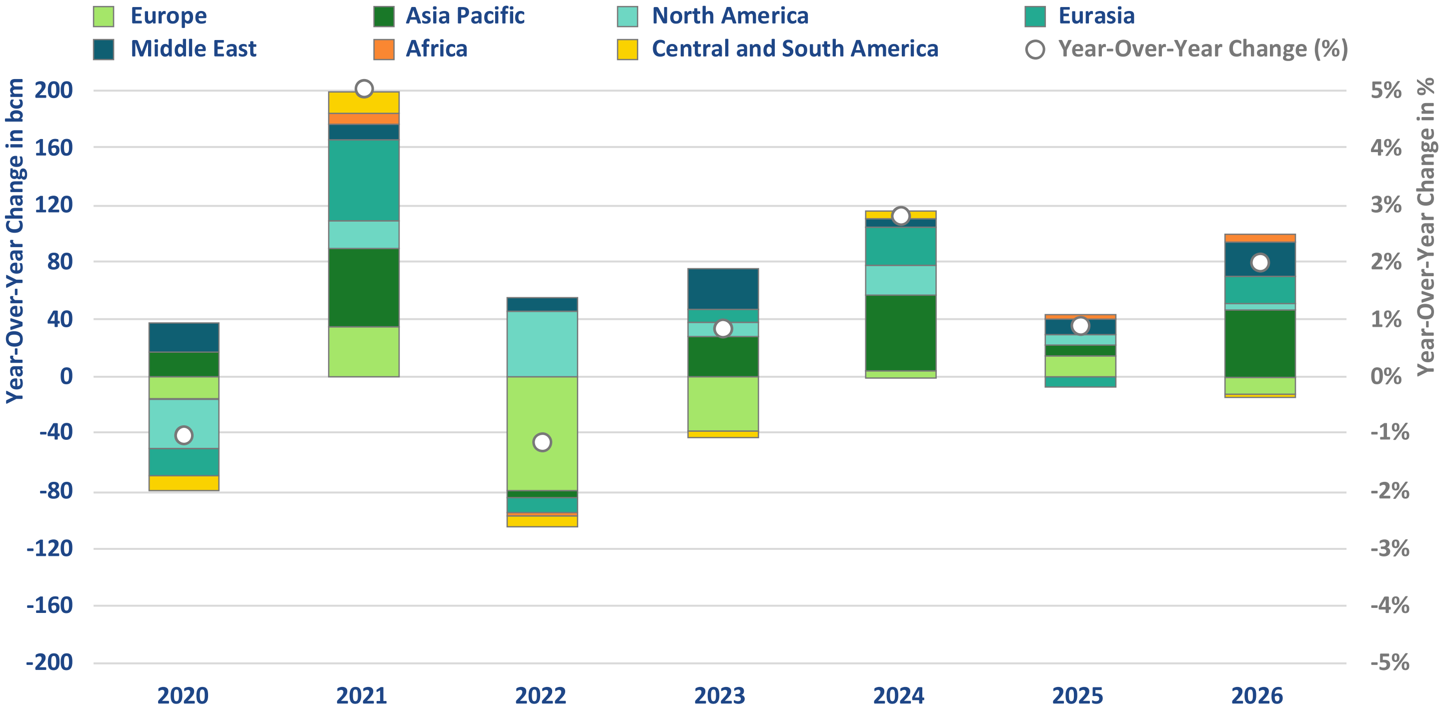
Source: Oil 2025 Analysis and Forecast to 2030, 2025. Millions of barrels per day.

NATURAL GAS

Much of the decline in demand for coal in developed markets in recent years has been replaced by natural gas. Natural gas emits almost 50 percent less CO2 than coal when combusted, (U.S. Energy Information Administration, 2024) and some argue that it has a significant role to play in reaching net zero emissions. Natural gas is efficient, transportable, and does not suffer from the intermittency issues associated with renewable energy. It can also play a role in energy security and affordability in countries that have ample supply. With that said, liquified natural gas (LNG) operations have a sizable greenhouse gas footprint, which is due in part to methane leaks. However, carbon capture utilization and storage (CCUS) is becoming more economically feasible, and several LNG project developers have announced plans to integrate CCUS solutions into planned LNG projects (International Energy Agency, 2025). Lower emissions gases such as biomethane and low-emissions hydrogen are also expected to increase, albeit with no meaningful impact on the overall energy mix over the next decade.

Demand for natural gas is extremely price sensitive in certain geographies, particularly Asia. The Ukraine war led to a supply shock for natural gas in 2022-2023 and prices globally have remained somewhat elevated through 2025. A wave of new LNG export capacity is expected to add around 300 billion cubic meters per year worldwide by 2030. This increase in supply should reduce prices and lead to accelerated demand growth (International Energy Agency, 2025).

CHANGE IN NATURAL GAS DEMAND IN KEY REGIONS (2020-2026)



Source: Gas, 2025. 2026 figures are based on projections.

STRANDED ASSET RISK

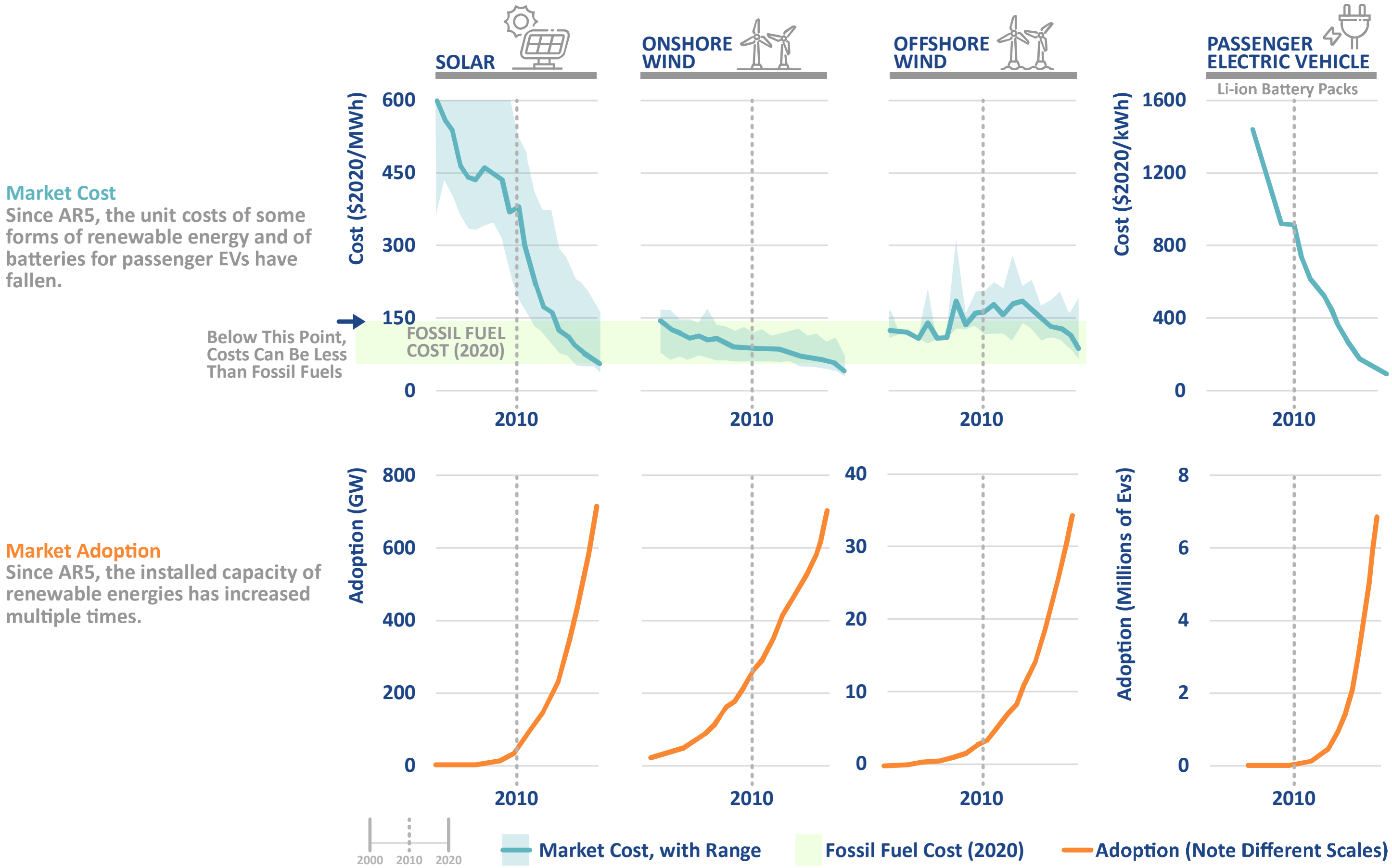
Despite the expectation that the world will remain reliant on fossil fuels for several decades, long term investors should be attentive to stranded asset risk, particularly in their longer-duration investments. Stranded asset risk refers to the potential financial losses associated with assets that suffer unanticipated devaluations, write-downs, or conversions to liabilities because of policy, regulatory, or technology change. According to energy expert Vaclav Smil, "in mass terms, we will never run out of fossil fuels: enormous quantities of coal and hydrocarbons will remain in the ground after we end their use because it would be too expensive to extract them. Although the world of the early 2020s is in no imminent danger of running out of fossil fuels, in the long run they would have to be replaced even in the absence of any connections to global warming" (Smil, 2024).

While it is difficult to forecast exactly how quickly and to what extent the transition to renewable energy from the various fossil fuels will play out, it is important for investors to understand both near- and long-term trends in energy markets given the potential impacts this will have on their investments. The WSIB's exposure to fossil fuels is explored further in later sections of this report.

POTENTIAL SCENARIOS FOR RENEWABLES

As seen in the chart on the next page, market adoption of renewables and related technologies has increased in recent years. These have been supported by regulatory and policy frameworks that have either encouraged or mandated actions to reduce greenhouse gas emissions. The IPCC's Sixth Assessment Report noted that "mitigation actions, supported by policies, have contributed to a decrease in global energy and carbon intensity between 2010 and 2019, with a growing number of countries achieving absolute GHG emissions reductions for more than a decade" (IPCC, 2023). The cost of cleaner power sources like solar and wind has fallen considerably and consistently, which has facilitated their adoption. Technological improvements and climate-aware designs have improved the efficiency of structures, transportation, and industrial processes. Passenger EVs have become more commonplace.

RENEWABLE ELECTRICITY COST AND ADOPTION (2000-2020)



Source: Climate Change 2023: Synthesis Report, 2023. The top panel shows global costs per unit of energy (USD per MWh) for some transition technologies. Solid blue lines indicate average unit cost in each year. Gray shaded areas show the range between the 5th and 95th percentiles in each year. Yellow shading indicates the range of unit costs for new fossil fuel (coal and gas) power in 2020 (corresponding to USD 55 to 148 per MWh). For passenger EV batteries, costs shown are for 1 kWh of battery storage capacity; for the others, costs are LCOE, which includes installation, capital, operations, and maintenance costs per MWh of electricity produced. The bottom panel shows cumulative global adoption for each technology, in GW of installed capacity for renewable energy and in millions of vehicles for EVs. A vertical dashed line is placed in 2010 to indicate the change over the past decade.

Renewables are expected to continue to grow as a percentage of the electricity generation mix within the U.S. and globally. Significant challenges remain, including intermittency, insufficient grid infrastructure, and an unfavorable regulatory environment in the U.S. To date, moving the electricity mix towards cleaner sources has been the largest contributor to global emissions reduction.

GLOBAL REGULATIONS AND GEOPOLITICAL IMPACTS

The level of uncertainty and instability related to global climate regulations and the geopolitical environment in 2026 is significantly different than when the Paris Agreement was signed in 2015. This uncertainty makes it extremely difficult to use global energy and climate-related forecasts as a basis for long-term investment decision making. However, it is critical to understand the geopolitical environment in the context of longer-term trends and incorporate current regulations into any investment due diligence process.

The Russian invasion of Ukraine in 2022 had several downstream impacts on the supply of oil and natural gas to Europe. While Europe has been shifting toward renewable sources of energy for over a decade, European countries are still heavily reliant on fossil fuels for heating their homes, industrial uses, and managing the intermittency challenges associated with renewables. However, most European countries do not have their own supply of oil and natural gas and rely on imports from other countries, like Russia. Following its invasion of Ukraine, Russia is no longer supplying Europe with as much oil and natural gas, which has dramatically increased electricity and energy costs for end consumers. This marked a dramatic shift, as countries, including many outside of Europe, shifted focus from decarbonization to securing and controlling their own supply of energy. In the near term, this focus on energy security has led some countries to delay planned closures of coal plants (Weili, 2025), which emit far more CO2 than natural gas. In Germany, the largest coal consumer in the European Union, the IEA estimates that coal power generation increased by 11 percent in the first half of 2025 (International Energy Agency, 2025). In response to evolving geopolitics and shifting energy priorities, many countries, including the U.S. have expanded LNG export capacity (as described above). Over the long term, the need for energy security will likely to be supportive of increased investments in renewables, which can be built nearly anywhere with varying levels of efficiency and are not dependent on the availability of underground natural resources.

Over the past decade, the U.S. has withdrawn, rejoined, and then withdrawn again from the Paris Agreement. In 2025, the U.S. government took several steps to weaken climate and environmental regulations and reporting across federal agencies, including the Environmental Protection Agency (EPA) and the National Oceanic Atmospheric Administration (NOAA). It also removed many of the 2022 Inflation Reduction Act's support mechanisms for the expansion of renewable infrastructure across the U.S. In January 2026, the President issued a memorandum announcing the U.S.'s intention to withdraw from several international organizations focused on reducing the impacts of climate change (The White House, 2026). In the near-term, these developments will likely have a negative impact on the pace of renewables adoption and electrification within the U.S. With that said, in most regions globally, renewables are already a cost-effective energy source. So, while policy and regulatory regime shifts may slow the pace of the transition, they are not expected to reverse the longer-term global trend of increasing renewables as a portion of the overall energy mix.

DATA CENTERS AND AI: DRIVERS OF ELECTRICITY DEMAND

The widespread and growing adoption of generative AI and subsequent rise in demand for datacenters are driving increased electricity demand, creating both grid constraints and opportunities for investment across the electricity value chain. In 2023, data centers consumed 176 terawatt-hours (TWh), or 4.4 percent of total U.S. electricity consumption. By 2028, the U.S. Department of Energy estimates that this could grow to between 325 and 580 TWh, or 6.7 percent to 12.0 percent of total U.S. electricity consumption (Shehabi, et al., 2024).

Much of the increased electricity demand is tied to hyperscalers, large-scale cloud-based service providers that offer vast computing, storage, and networking capabilities. These include Amazon, Alphabet (formerly Google), and Microsoft. Many of these companies remain committed to their corporate decarbonization targets despite a current lack of policy and regulatory support within the U.S. Their decarbonization strategies include a mixed approach of onsite generation, renewable power purchase agreements (PPA), carbon and/or renewable energy credits, and investments in new clean energy technologies. Over time, these hyperscalers will require a significant buildout of renewable energy sources, long-duration storage, and transmission to achieve decarbonization objectives. In the nearer term, they will primarily rely on baseload electricity generation from local utilities, which places significant constraints on the electricity grid.

Data center demand is part of a broader trend toward increasing demand for electricity. End consumers and manufacturers have also been transitioning from goods and services that rely on oil and natural gas toward electricity. For example, electric heat pumps are replacing natural gas furnaces in both residential and commercial properties, and EVs are replacing traditional internal combustion engine (ICE) vehicles. This increased electricity demand is placing constraints on already-outdated electricity grids, which leads to higher electricity prices and potential power shortages for end consumers as demand for electricity outpaces supply.

Thus far, the buildout of energy infrastructure and services to support AI has been funded primarily by the private sector. Over $1 trillion of private capital spending has been earmarked for AI infrastructure (Mills, 2025), including significant capital investments from the aforementioned hyperscalers. The potential impacts of this increased infrastructure investment span across multiple asset classes, sectors, and geographies.

CARBON MARKETS

While carbon markets are not the primary focus of this white paper, it is important to understand their basic purpose, mechanisms, and potential impacts. Carbon markets can be a useful tool for global decarbonization efforts. The idea behind carbon markets is that emissions generated by countries or companies will impact the entire globe, not just the entity that is responsible for their generation. In the same way, efforts to reduce emissions benefit the entire globe. Companies or countries that face a comparatively high cost associated with reducing their emissions can instead pay another company or country to reduce them more efficiently, which, in turn, decreases the overall cost of decarbonization.

There are two primary types of carbon markets: compliance and voluntary. Compliance markets are driven by regulation and voluntary markets are based on the purchase of carbon credits to support a climate commitment made by an entity. The overall economic and behavioral impact of these markets is largely based on the implied price of carbon: the higher the price associated with one tonne of CO_2 emitted, the higher the likelihood that the entity will begin to make changes to decarbonize.

As of early 2026, 95 jurisdictions globally had implemented compliance-based instruments, either in the form of an emissions trading scheme (ETS) or a carbon tax. This covers around 28 percent of global GHG emissions, or 14.7 gigatonnes of CO_2e. The price associated with 1 tonne of emissions varies widely, from $0.01 to $158.80 (World Bank, 2025). Emissions are generally not tradeable across compliance markets unless there is an agreement mechanism in place.

The carbon credit market is considered a voluntary market and is used by companies that have made climate commitments to expand their ability to decarbonize outside of their own operations by paying another company to decarbonize for them. They do this by purchasing carbon credits, which represent a reduction in emissions relative to what would have happened without the project. These credits must be additional, in that the reductions in emissions would not have occurred without the incentive created by the credit revenues. Credits must be quantified as accurately as possible, the reduction or removal must be permanent, and they must be independently validated. Historically, there has been skepticism about the actual impact that carbon credits have on decarbonization, and companies that utilize them are often criticized for continuing to operate in a carbon-intensive manner. However, as these markets have matured, standards and certifications have been established, reducing some concerns.

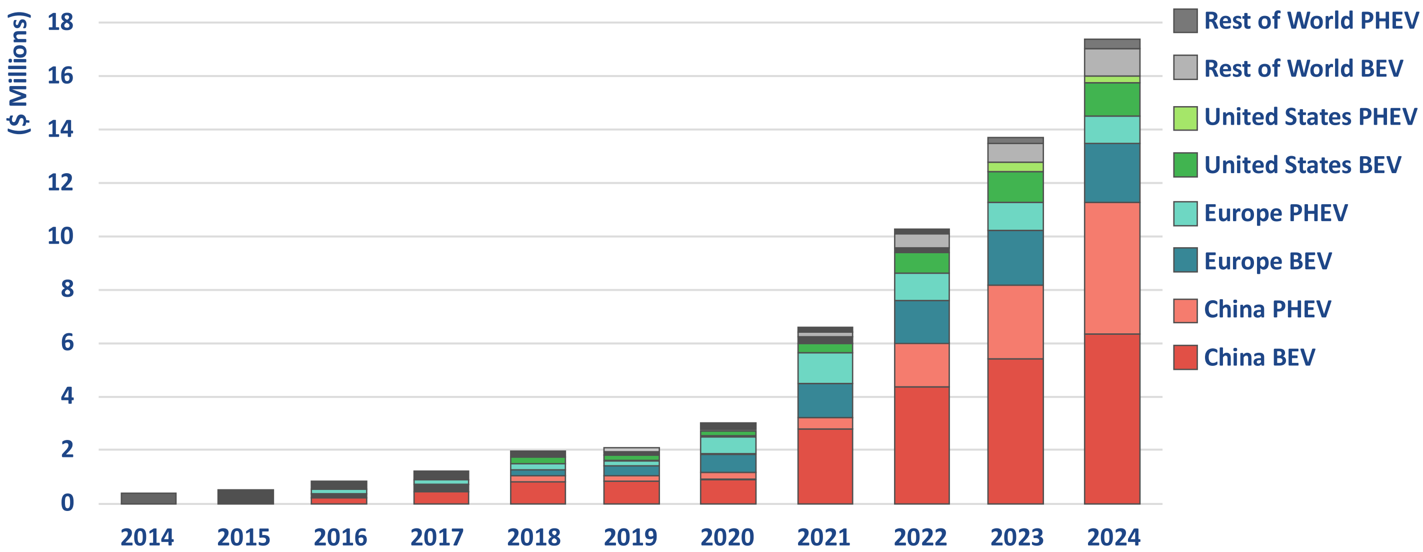
SUPPORTING TRANSITION TECHNOLOGIES

Global decarbonization efforts have fostered several new technologies, which have reached varying levels of maturity. These are listed below based on the magnitude and impact we believe they will have on the overall energy transition over the next five to ten years.

ELECTRIC VEHICLES

EVs will continue to play an important role in the energy transition as the transportation sector is a large source of emissions globally. The growth in global adoption of EVs can lead to reduced oil demand, alongside an increased demand for electricity. As renewables become larger components of the overall electricity grid, EVs can provide a much cleaner source of transportation than traditional internal combustion engine (ICE) vehicles. EV sales exceeded 20 percent of the overall share of passenger vehicles sold in 2024 (International Energy Agency, 2025), and demand is expected to continue to increase globally, despite recent policy headwinds in certain countries. This is a remarkable shift, given that EVs represented less than five percent of new vehicle sales just a few years ago.

GLOBAL ELECTRIC CAR SALES (2014-2024)



Source: IEA, 2025. BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Includes new passenger cars only.

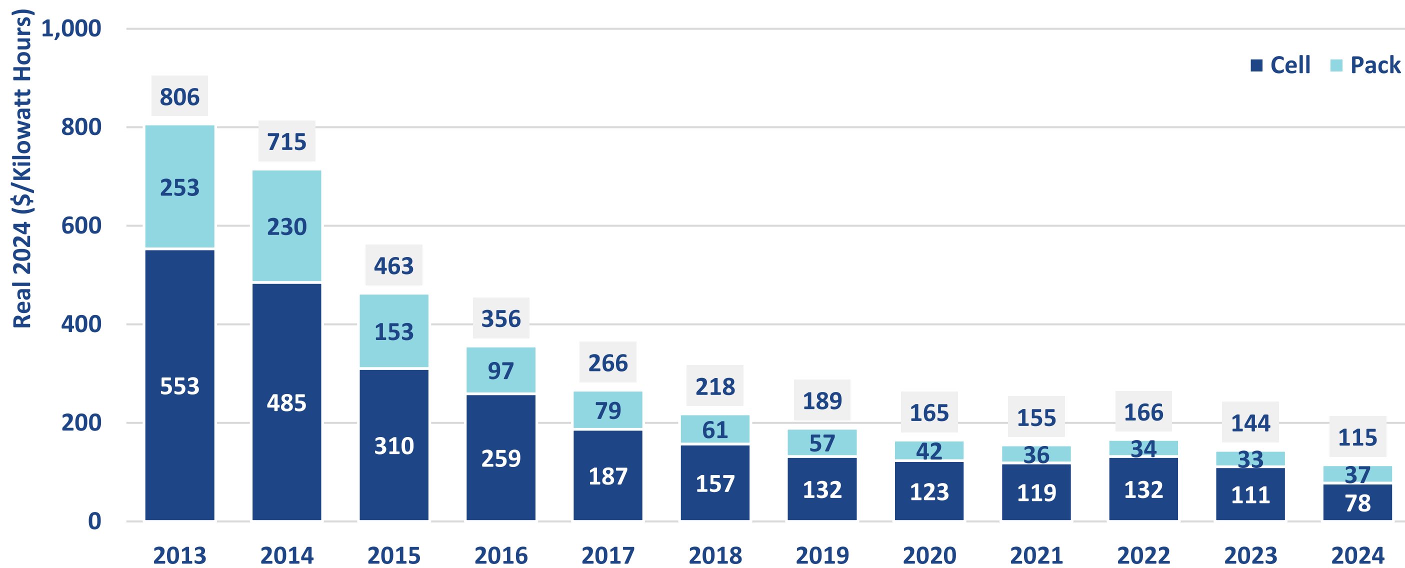
Most of the increased demand for EVs is coming from China, where they are now cheaper than traditional ICE vehicles on average. For most of the rest of the world, EVs command a 20-70 percent premium over ICE vehicles. The demand for EVs globally also depends, at least somewhat, on governmental policies, such as the availability of tax credits, battery charging infrastructure, and the cost of charging relative to the equivalent cost of fueling an ICE vehicle.

GRID-SCALE STORAGE AND BATTERIES

Grid-scale storage must grow significantly to support intermittent sources of energy like wind and solar as they take on a larger share of the overall energy mix. These technologies connect directly to the power grid to store energy for a period and then supply it back to the grid later, such as at night when solar power is not available. The most common technology is pumped-storage hydropower, where water is pumped into a reservoir and then released to generate electricity at a different time, but this is geographically limited (International Energy Agency, 2025). Batteries are also playing a larger role in grid-scale storage. Grid-scale storage is receiving increasing policy support from governments globally, particularly those with higher overall exposure to renewable energy within their grids.

Battery costs have fallen dramatically in recent years, due in part to the increase in EV production (Moscovitch, 2025). However, increased demand for battery parts from vehicle makers is leading to higher costs for key minerals used in battery production, particularly lithium. The IEA estimates that by 2040 EV production could require over 40 times more lithium than is currently mined (Smil, 2024).

COST TO MANUFACTURE AND INSTALL NEW BATTERY STORAGE (2013-2024)



Source: Batteries included: How storage systems enable the global energy transition, 2025. A battery cell is a single unit, while a battery pack is a larger assembly that can contain multiple cells or modules. Cells are responsible for energy storage and release, whereas packs are designed to deliver power and manage the overall performance of the battery system.

Historically, technology limitations have slowed the adoption of grid-level battery storage. As of a few years ago, most batteries were only able to store and discharge power for periods of around an hour, which limited their ability to support intra-day (and longer) supply and demand fluctuations. Four- to eight-hour battery systems are now becoming more economical and commonplace, and the operational life of a single battery has also increased. These improvements in battery technology, alongside policy support, may be catalysts for further investment in this space.

SMALL MODULAR REACTORS

In recent years, there has been renewed interest in nuclear fission as a source of relatively clean energy. Nuclear is technically a zero-emissions source of energy, however it has historically been challenged by reputational issues associated with accidents, the time and cost associated with building and maintaining plants, security concerns, and nuclear waste management. Several companies, particularly in the technology sector, are investing in Small Modular Reactor (SMR) technologies to address some of these concerns. In 2026, Meta announced a deal with TerraPower to build 8 SMR plants in the U.S., with initial units completed by 2032 (TerraPower, 2026). Somewhat similar designs were built in the 1950s to power military submarines and ships with nuclear propulsion and have maintained an excellent safety record (German Federal Office for the Safety of Nuclear Waste Management, 2025). However, the newer SMRs in development are considered a nascent technology with unknown risks. There is still a lot of uncertainty on the impact that SMRs might have in global efforts to decarbonize.

NUCLEAR FUSION

Whereas nuclear fission produces energy by splitting large elements into smaller ones, nuclear fusion produces energy by forcing small elements like hydrogen to merge into larger elements. Fusion is the process that powers stars like the Sun. Nuclear fusion's potential to provide a steady supply of energy with fewer harmful byproducts compared to nuclear fission and fossil fuels has long captured the interest of scientists, engineers, and science fiction writers. However, fusion reactions can only occur under extreme conditions, which poses significant engineering challenges, and as of this writing, fusion power remains quite far from commercial viability. Nevertheless, there have been some encouraging developments in fusion research in recent years that are worth mentioning. Interest in fusion spurred a boom in investment, with $2.6 billion invested in the sector in 2021, and nearly $2 billion invested in 2025 (BloombergNEF, 2026). Near the end of 2022, the U.S. Department of Energy's National Ignition Facility managed to generate more energy via a fusion reaction than the energy needed to power the reaction, the first time that "break-even" fusion had been achieved (U.S. Department of Energy, 2022). Researchers have also made significant progress in their ability to maintain the extreme conditions needed for fusion for longer periods of time, with both Chinese and French teams managing to maintain stable conditions for over 1000 seconds in 2025, a key milestone for demonstrating the viability of the fusion reaction. (CEA, 2025) (Pester, 2025) (Xinhua, 2025) (Song, et al., 2023) While fusion is unlikely to be part of the world's energy mix this century, these achievements have given the world some hope that the dream of fusion-powered energy will be achieved some day.

WSIB APPROACH

The WSIB continues to enhance its approach to investing in the energy transition and assessing climate-related risks and opportunities. This section of the paper describes our approach to total portfolio climate risk management and asset class-specific considerations and insights.

TOTAL PORTFOLIO CLIMATE RISK MANAGEMENT

EXPOSURE TO FOSSIL FUELS

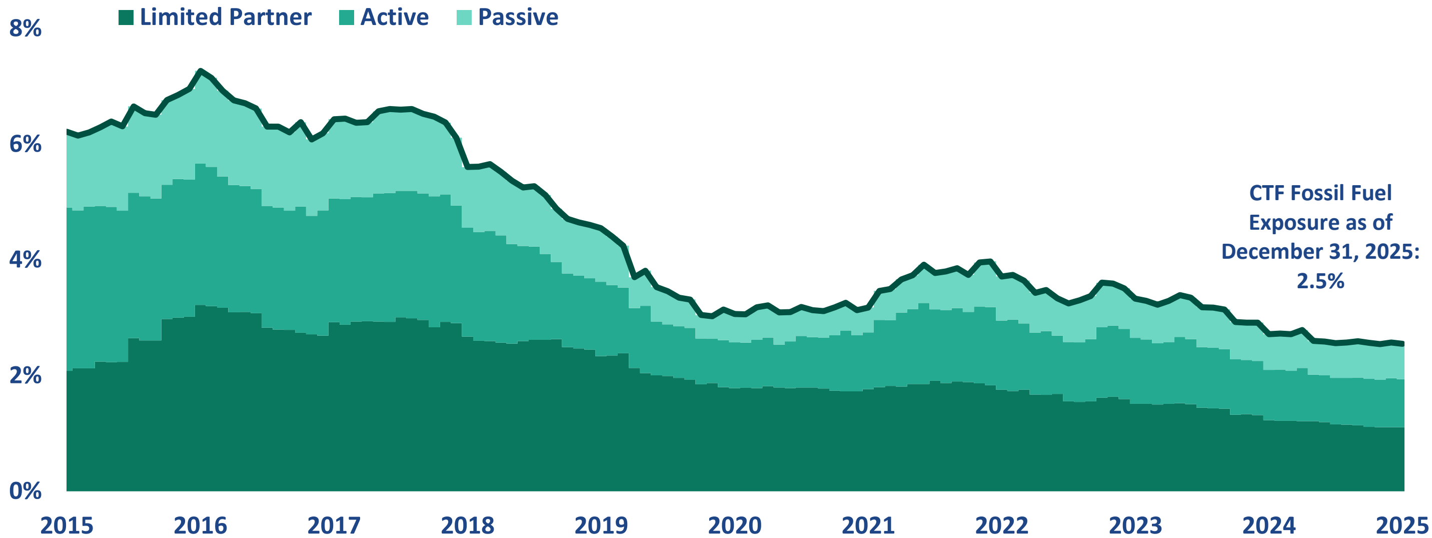
The WSIB's earliest efforts to measure climate-related risk date back to 2016, when the agency first formalized its definition of "fossil fuel exposure" for reporting purposes. At that time, there was concern that the value of fossil fuel-related assets could decline significantly as the world transitioned away from fossil fuels and the WSIB was interested in understanding how its portfolios might fare under that scenario. Since there was not an industry-accepted definition of a "fossil fuel company" at the time, WSIB staff reviewed possible approaches and settled upon a definition based on Global Industry Standard Classification Standard (GICS), a standard and objective way of assigning industries to securities in public equities. The WSIB uses GICS for more general industry exposure analysis of its portfolios, and has developed internal methodologies for classifying corporate debt, private assets, and other securities that are not classified by MSCI to ensure full coverage of all assets.

Staff defined a "fossil fuel company" as any security classified under GICS in the Energy sector where the company's principal business activity involves the extraction, transportation, and/or refinement of oil, gas, and thermal coal. This definition captures many of the companies that are commonly thought of as "fossil fuel companies"; those for which a transition away from fossil fuels would pose an existential risk to their business models. This definition avoids counting the same energy assets at multiple points during their lifecycle, i.e., exposure is counted only during the extraction and production of the asset. The WSIB's definition also excludes companies that have some connection to fossil fuels but lie outside of the GICS Energy sector. While such companies might experience short-term losses during the transition away from fossil fuels, they have diversified lines of business and would be expected to survive the transition.

In addition to fossil fuel companies, the GICS Energy sector includes some companies that do not meet the WSIB's definition of a "fossil fuel company", such as uranium miners and biofuel producers. Staff maintain a list of these exceptions.

Fossil fuel exposure within the CTF has declined over time on a relative basis, in large part due to active managers choosing to invest in other sectors. The substantial increase in the value of information technology stocks has decreased the relative weight of energy as well as other sectors within the indices tracked by the WSIB's passive equity managers. The WSIB's exposure to fossil fuels declined at the beginning of the COVID-19 pandemic, as energy prices collapsed, but rebounded as prices recovered and then rose in response to the Russian invasion of Ukraine. The CTF's holdings in fossil fuel companies have again trended downward recently, and as of December 31, 2025, 2.5 percent of the CTF was invested in fossil fuel companies.

CTF EXPOSURE TO FOSSIL FUELS (2015-2025)



Source: WSIB calculations. December 2015–December 2025.

Novel frameworks and approaches to evaluating climate-related risks are regularly developed and considered as governments, investors, and the public seek to better understand how climate change will impact them. The Task Force on Climate-Related Financial Disclosures (TCFD) was created in 2015 to help companies and investors better evaluate climate-related risks, make better informed capital allocation decisions, and assist with long-term strategic planning. The TCFD framework has emerged as the standard framework for disclosing financially material climate-related risks and opportunities and is now owned by the IFRS foundation, which sets international accounting standards.

The TCFD framework expands upon the WSIB's "fossil fuel company" definition discussed above by including all industries that the TCFD believes will be impacted by climate change. This includes the energy companies captured in the WSIB's historical definition and adds companies in sectors such as agriculture, forest products, materials, and real estate. This broader definition captures potential climate-related risks in the WSIB's portfolio that extend beyond oil, gas, and coal companies.

The WSIB adopted the TCFD framework in 2023 and has included its exposure under this framework in its annual Sustainability Report. As of December 31, 2025, about 38 percent of the CTF was exposed to sectors the TCFD believes have a "high likelihood of climate-related financial impacts." The WSIB continues to report fossil fuel (and more specifically, thermal coal) exposure under the historical definition, allowing staff to track changes in exposure over time.

CTF EXPOSURE TO HIGH-RISK INDUSTRIES IDENTIFIED BY TCFD (DECEMBER 31, 2025)

Sector and Industry	Total Value ($ Millions)	Percent of CTF
Agriculture, Food, and Forest Products	**$7,683**	**4.1%**
Agriculture	$2,905	1.5%
Beverages	$1,105	0.6%
Packaged Foods and Meats	$2,606	1.4%
Paper and Forest Products	$1,067	0.6%
Energy	**$7,871**	**4.1%**
Coal	$38	0.0%
Electric Utilities	$2,874	1.5%
Oil and Gas	$4,959	2.6%
Materials and Buildings	**$50,130**	**26.4%**
Capital Goods	$8,224	4.3%
Chemicals	$1,569	0.8%
Construction Materials	$506	0.3%
Metals and Mining	$3,088	1.6%
Real Estate Management and Development	$36,742	19.4%
Transportation	**$5,834**	**3.1%**
Air Freight	$995	0.5%
Automobiles and Components	$2,390	1.3%
Maritime Transportation	$517	0.3%
Passenger Air Transportation	$768	0.4%
Rail Transportation	$928	0.5%
Trucking Services	$234	0.1%
Total Exposure to at-Risk Industries	**$71,517**	**37.7%**
Total CTF AUM	**$189,690**	

Source: WSIB calculations.

WSIB PORTFOLIO CARBON FOOTPRINT

Carbon footprinting is a way for staff to approximate transition risks associated with climate change across the WSIB's portfolios. Carbon footprinting attempts to measure the GHG emissions caused directly and indirectly by an entity and is typically expressed in metric tonnes of carbon dioxide equivalents (Mt CO2e). Companies with high emissions today may not have a license to operate in their current forms indefinitely and will likely face increasing regulatory and reputational risks over time. However, measuring emissions at either the company or portfolio level can be fraught with difficulty. Estimation methodologies differ by industry, and emissions can be double and triple counted across an investment portfolio. The WSIB has been attempting to measure its portfolio GHG emissions in a way that is useful within the investment decision-making process while providing an additional layer of emissions transparency.

The WSIB's portfolio carbon footprint is discussed annually in the WSIB's Sustainability Report. Historically, the focus has been on public equities, as that asset class has the most reliable data. In 2025, staff expanded disclosure to include the carbon footprint of its corporate fixed income portfolio. Staff are still working to identify ways to estimate the emissions of the WSIB's private markets portfolios. We have made significant progress in this area and will keep stakeholders up to date on progress via the Sustainability Report.

PUBLIC EQUITY CARBON FOOTPRINT (DECEMBER 31, 2024)

CTF Global Public Equity Portfolio	Scope 1+2	Scope 3 Upstream	Scope 3 Downstream
WSIB Total Financed Carbon Emissions (Mt C02e)	2,147,595.3	4,272,589.7	10,878,635.8
Benchmark Total Financed Carbon Emissions (Mt C02e)	2,143,632.0	4,069,995.2	9,989,489.7
WSIB Financed Carbon Emissions (Mt C02e / $million invested)	46.7	92.9	236.4
Benchmark Financed Carbon Emissions (Mt C02e / $million invested)	46.6	88.5	217.1

Source: Sustainability Report, 2025. Public Equity Benchmark is the MSCI ACWI IMI with U.S. Gross. Definitions available in Glossary.

The WSIB's public equity portfolio emissions are slightly higher than the emissions associated with the benchmark, primarily as a result of decisions by the WSIB's active global and emerging markets equity managers to overweight traditional energy companies based on attractive fundamentals.

CORPORATE FIXED INCOME CARBON FOOTPRINT (DECEMBER 31, 2024)

CTF Global Fixed Income Equity Portfolio	Scope 1+2	Scope 3 Upstream	Scope 3 Downstream
WSIB Total Financed Carbon Emissions (Mt C02e)	2,502,111.8	2,025,360.2	4,913,508.0
WSIB Financed Carbon Emissions (Mt C02e / $million invested)	160.5	129.9	315.1

Source: Sustainability Report, 2025. Definitions available in Glossary.

For the corporate fixed income portfolio, absolute rather than benchmark-relative emissions are reported because the differences in emissions between the WSIB fixed income portfolio and the corporate fixed income benchmark are largely due to differences in geography and sector exposure rather than security-specific differences.

Investment staff can use company-specific emissions analysis during the investment due diligence process to determine whether a company or investment manager is paying adequate attention to the risks associated with their emissions. It is also a useful engagement tool, as it can help staff focus their engagement efforts on the highest emitting companies.

The WSIB continues to advocate for disclosure of scope 1 and 2 GHG emissions by companies in both public and private markets. In public markets, this is accomplished primarily through proxy voting activities and collective engagements through organizations like Ceres, Climate Action 100+ (CA100+), and CDP (formerly Carbon Disclosure Project). Within private markets, the WSIB actively participates in the ESG Data Convergence Initiative (EDCI), which advocates for streamlined ESG data in private markets, including emissions. Staff also routinely discuss emissions measurement and disclosure with partners during due diligence meetings.

STRATEGIC ASSET ALLOCATION AND CLIMATE SCENARIO ANALYSIS

Research from large institutions like the European Central Bank (ECB) and International Monetary Fund (IMF) indicates that climate change will likely have an inflationary impact on asset prices for a variety of reasons, including extreme weather events destroying crops and disrupting supply chains, carbon taxes, supply volatility of energy sources, and a surge in demand for metals used in the green transition. Ortec, a frequently referenced provider of climate scenario analysis for pensions, contends that a coordinated and orderly transition to a lower carbon economy will be costly in the short term via inflationary impacts, but delaying this transition will lead to intensifying physical risks and potential for higher economic destruction over the long term (Ortec, 2025). Over the last several years, staff has been researching the potential impacts of the various climate scenarios on the WSIB's capital markets assumptions, which are likely to vary greatly based on which scenario will play out.

In the WSIB's 2019 paper, *Risks and Opportunities from a Changing Energy Complex and Climate Change*, (Martinell & Tucker, 2019) staff recommended developing a framework for introducing climate change into capital markets assumptions (CMAs) as a way to explicitly consider the potential long-term impact of climate change on asset classes going forward. Since then, during each CMA study, staff have researched the feasibility of incorporating the potential impacts of climate change on asset class returns and risk. While climate scenario research and risk modeling has improved, the variability and wide dispersion of outcomes means that it's not yet practical to incorporate climate risk into the WSIB's CMAs. Additional challenges include the difficulty of assessing how much climate risk is already priced into market expectations, a lack of robust and transparent data, and divergent industry views. Incorporating climate scenarios into CMAs would also require establishing probabilities around the various scenarios, which even the most prominent climate experts are unwilling to do.

However, frameworks on climate modeling continue to improve, and while the WSIB has not yet explicitly incorporated climate scenarios into its CMAs, the research has been informative.

Staff have met with multiple providers of climate scenario analysis, some of whom have provided analysis specific to the WSIB's portfolio based on its strategic asset allocation (SAA) framework. The most recent analysis was performed by Goldman Sachs Asset Management in late 2025, based on the SAA that was approved by the Board in November 2025. [2] The analysis provided several insightful takeaways for staff, including:

- Under more aggressive transition scenarios, the model suggests lower overall portfolio returns, driven by higher inflation (primarily through increasing capex and higher energy prices).
- Under the smoother, less aggressive transition scenarios, decarbonization may occur without adding significant costs to the economy, decreasing the negative impact on the portfolio.
- The analysis suggested a positive impact on excess returns for the private credit asset class, followed by tangible assets, as these asset classes tend to be more resilient under higher inflation scenarios.
- The analysis suggested that under the more aggressive transition scenarios, equities (both public equity and private equity) and fixed income (primarily long-duration) would be negatively impacted.

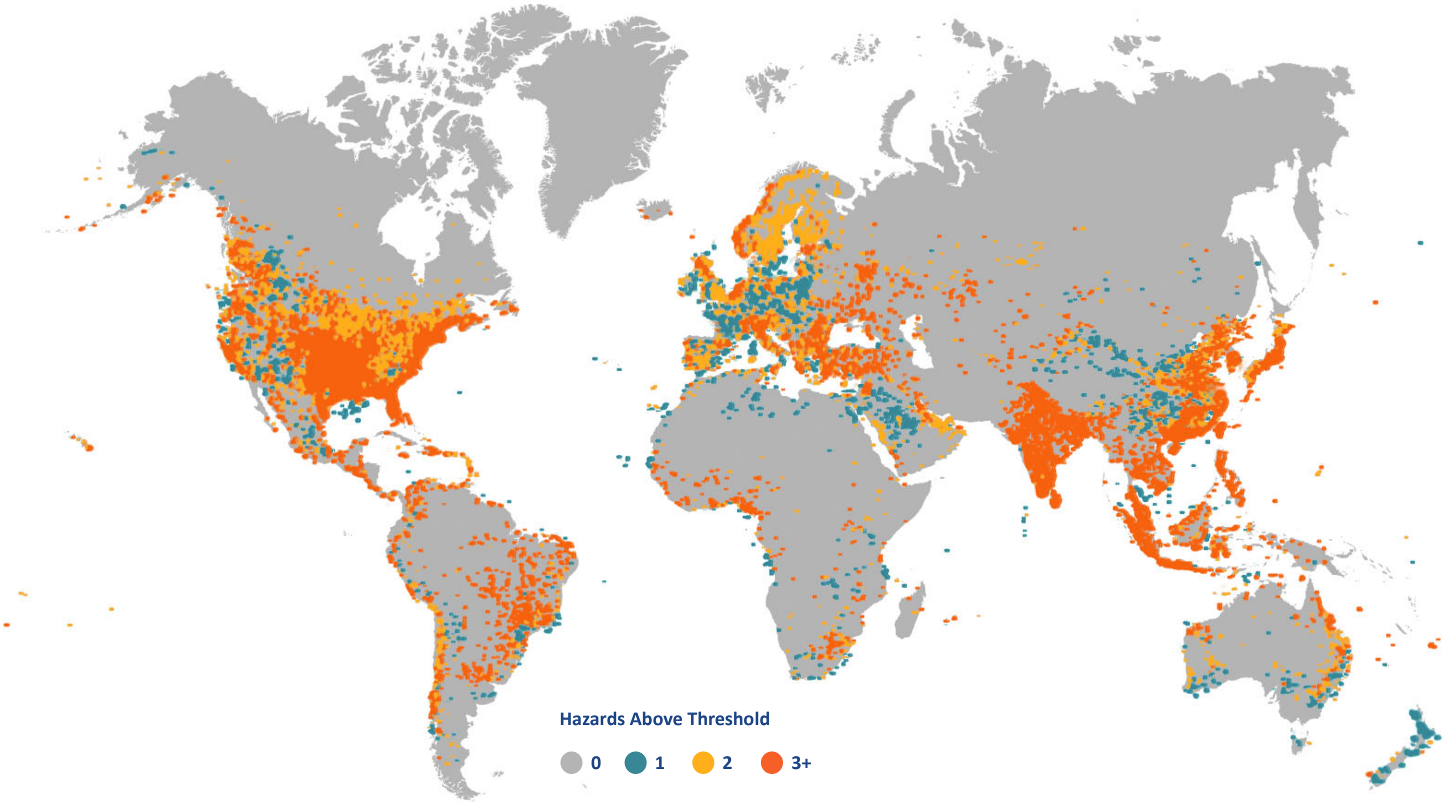
Staff are committed to continuing to meet with experts in climate scenario analysis. While climate-related assumptions have not yet been explicitly incorporated into the formal CMA and SAA process, the discussions and analysis have informed staff considerations of climate-related risks and opportunities and their impacts on the WSIB's portfolios.

OTHER WAYS TO APPROXIMATE CLIMATE RISKS AND OPPORTUNITIES

In 2025, the WSIB participated in a study with MSCI who partnered with Swiss Re Risk Data Solutions to analyze the physical climate risk in the equity portfolios of 18 global asset owners. The study used the physical location of companies' assets and physical hazard data to explore each participant portfolios' overall exposure to various risks and estimate the potential impacts of that exposure. The analysis indicated that nearly two-thirds of the WSIB's public equity holdings face significant exposure to multiple physical hazards. Yet only 16 percent of the most exposed companies disclose the integration of physical risk into their risk management practices (MSCI, 2025). Risks to companies could include decreased output, delayed shipments, and increased insurance costs in addition to the more obvious damage to property from extreme weather events.

[2] The Goldman Sachs Asset Management analysis was performed using proxies for the WSIB's asset classes; it did not use underlying holdings.

ASSET LOCATIONS AND ASSOCIATED HAZARDS OF THE CTF PUBLIC EQUITY PORTFOLIO (SEPTEMBER 29, 2025)



Source: MSCI Sustainability and Climate Research Services. Asset locations are colored by the number of hazards with an intensity value of 8/10 or higher.

While this study was only performed on the WSIB's public equity portfolio, the overall discussion and analysis enhanced staff's understanding of key drivers of physical hazards across all asset classes. The study confirmed that the WSIB is not an outlier relative to the other global asset owners in terms of physical hazard risk. In the future, this type of physical risk analysis might be used by WSIB staff as a tool to focus our efforts on key areas of risk in the portfolio, enhancing our engagement and due diligence efforts.

2025 INVESTMENT PARTNER SURVEY

In 2025, staff sent a survey to the WSIB's investment partners to gather and analyze their perspectives on the impacts of climate change and the energy transition on their investments and received 91 responses. Staff followed up with several partners through individualized meetings where the questions could be discussed in further detail. Key takeaways from the survey research process include:

- The majority of the WSIB's partners who believe climate change factors will have an impact on investment returns or processes believe that the impact will be positive (27), with a minority believing the impact will be negative (8).[3]
- Most partners described both physical (weather, water scarcity, etc.) and transition (policy changes, technology disruptions, etc.) risks to be either highly material or moderately material to their investment process.[4]

[3] The remaining (56) respondents expressed that they either had no opinion, were unsure, or believed that climate change factors are unlikely to impact their investment returns or process.

[4] Not including partners who replied "uncertain/prefer not to respond."

- The survey results suggest that all economic sectors are exposed to climate risk, some more so than others. The highest risk sectors include energy, utilities, materials, industrials, and real estate. Information technology was rated as “moderately exposed” by 29 survey respondents. This is perhaps due to the increase in demand for electricity brought on by AI and datacenter use.
- Geographically, Asia was identified as the continent most exposed to climate-related risks.

ASSET CLASS INSIGHTS

PUBLIC EQUITY

RISKS

The impacts of climate change will affect public equity in multiple and overlapping ways. Climate change poses material long-term risks to public equities, including both physical and transition risks. Climate-related impacts may affect the operations and finances of publicly traded companies, which could, in turn, affect the stock prices of those companies. It’s worth noting that these first and second order effects are not perfectly correlated. Positive growth does not always result in higher stock returns and negative growth does not always result in stock declines, but changes in stock prices will impact the WSIB’s public equity portfolios over time. These three layers of effects – to companies, to stock prices, and to the WSIB’s portfolios - are often conflated but are distinct.

Sectors

The energy transition will impact different sectors in different ways. Industries characterized by heavy use of natural resources, significant carbon emissions, or complex global supply chains will be the most heavily impacted over time. These industries include energy, utilities, insurance, real estate, transportation, and agriculture. It’s worth noting that sector classification cannot fully capture second-level risks as impacts on stock prices may play out in non-obvious ways, including:

- **Green innovation does not guarantee superior financial results:** Although sustainable sectors may see rapid growth in the years ahead, the societal benefits provided by these companies may not be matched by improvements in profitability or financial returns for investors.
- **Capturing value in declining industries:** Conversely, industries in long-term decline can still be good investments provided they are managed well. Stable profits and strong returns may still be possible despite a shrinking market (as we have seen in the tobacco industry).
- **Companies have the capacity to adapt and overcome challenges:** Companies may remain profitable and resilient through efficiency gains, technological breakthroughs, strategic pivots into adjacent markets, and creative problem-solving.

Geographies

Climate-related impacts across geographies will be shaped by a range of factors including:

- **Resource dependence:** Economies reliant on hydrocarbon exports may face more pronounced transition challenges.
- **Regulatory environment:** The ambition of decarbonization targets will vary by jurisdiction.
- **Financial wherewithal:** Economies with limited available capital for mitigation efforts may be more exposed to risks and less able to take advantage of opportunities.

INVESTMENT OPPORTUNITIES

The global energy transition may act as a catalyst for large-scale infrastructure investment, creating multi-decade tailwinds for companies capable of addressing structural energy and resource gaps, including but not limited to AI and data centers, grid and utility modernization, and critical minerals. However, as noted, growth does not necessarily equal strong stock returns. Cash flow, profitability, valuation, and other factors must be considered too.

INVESTMENT PROCESS

The WSIB's public equity program is managed by external asset managers and includes both passive and actively managed strategies.

The WSIB's passive strategies provide low-cost, diversified, broad market exposure, delivering returns that are very hard to beat. In keeping with public equity staff's continual research into indices and consistent with stakeholder feedback and Board requests, staff have researched both ex-fossil fuel and lower carbon indices and found no compelling evidence that they would outperform traditional passive strategies over the long term, net of fees and costs. Indeed, if impacts and opportunities vary as much as suggested by the research referenced throughout this paper, it may be challenging for any simple, broad-based rules to do an effective job capturing the risks, opportunities, and impacts of the climate transition with any consistency.

The WSIB's active managers conduct in-depth qualitative or quantitative analysis on companies and stocks with the goal of outperforming a passive benchmark. These managers incorporate material financial risks into their research, including those related to climate change.

In evaluating climate transition impacts, time horizon and liquidity are key considerations. It's worth noting that public equity investments can be traded whenever markets are open, which means that public equity portfolios are well positioned to respond to evolving assessments of risks and opportunities and the horizon in which they may occur.

Research on how factors related to climate change might affect future stock prices is mixed and evolving. For example, developing research has suggested that the link between GHG emissions and future stock prices is tenuous and varies significantly depending on:

- **Sector:** Each tonne of GHG emissions may have a very different impact on the stock price and risk profile of companies across different sectors. For instance, increases or reductions in GHG emissions will have a much greater impact on a utility company than a bank.
- **Geography:** Impacts may be priced differently in developing economies, the U.S., or Europe.
- **Scope and source of emissions:** Scope 1 and 2 emissions may be most relevant for evaluating the risks to a company in a particular sector, and scope 3 emissions (or some other metric) may be more important for a different company in a different sector.

This may explain why research on the impact of climate change on stock prices yields inconsistent results.

The WSIB's public equity managers are taking a thoughtful approach to considering the risks associated with climate change. Staff continue to engage with WSIB's public equity managers to gain a better understanding of how they are addressing the financial risks associated with climate change in their investment processes, the construction of their portfolios, and in their proxy voting and engagement efforts.

KEY TAKEAWAYS

Public equity staff utilize a dual structure approach to investing, with passive strategies providing broad market exposure and active management strategies adding resilience to the portfolio. With its detailed and nuanced research focused on each individual company's circumstances and strategies, active management is best positioned to assess and respond to the risks and opportunities associated with climate change and the energy transition. The global energy transition may create multi-decade tailwinds for companies capable of addressing structural energy and resource gaps, including but not limited to AI and data centers, grid and utility modernization, and critical minerals. Within passive equities, staff continually researches potential new indices. Thus far, staff has found no compelling evidence that low-carbon and fossil fuel-free indices would outperform traditional passive strategies over the long term, net of fees and costs. Further, a rules-based approach would be likely ineffective at capturing the risks, opportunities, and impacts of the climate transition with any consistency. Staff will continue researching climate-aware indices and active strategies as the industry evolves.

FIXED INCOME

RISKS

Key climate-related risks within the fixed income portfolio include the potential for stranded assets in the oil and gas sector, physical risks to assets and infrastructure, and restrictive regulations. The time horizon tied to various stranded assets scenarios remain uncertain given that global oil consumption is still rising, and the world remains reliant on fossil fuels. Modeling climate-related impacts is extremely difficult, which could lead investors to either over- or under-estimate the timing and consequences associated with these risks. Given the high level of uncertainty surrounding potential climate-related impacts, staff are highly selective when adding fossil fuel investments to the WSIB's fixed income portfolio. For example, several years ago, the WSIB fixed income team made the decision to exit its investments in thermal coal-focused companies—based largely on potential stranded asset risks.

In addition to climate-related risks tied to corporate bonds issued by oil and gas companies, other industries will likely face significant impacts from climate change and the energy transition, including agriculture, cement, chemicals, electric utilities, food, property and casualty insurance, steel, and transportation.

INVESTMENT OPPORTUNITIES

All energy sector investment opportunities are rigorously evaluated, and staff consider each company's strategic importance and climate action plan. The fixed income portfolios maintain a disciplined overweight to electric utilities, prioritizing transition leaders that have significantly reduced carbon intensity and have credible renewable integration plans. Electric utilities provide essential services with stable, predictable cash flows and tend to hold up well in recessions.

Fixed income has invested in green bonds and sustainability-linked bonds issued by companies the team has identified as prudent investments through its long-term, fundamental research. For example, we own a green bond that was issued by a diversified energy company to finance a renewable energy project. We also own sustainability-linked bonds that have performance targets linked to measurable sustainability goals, such as reducing GHG emissions.

INVESTMENT PROCESS

The fixed income team incorporates a long-term fundamental view in the investment process, integrating bottom-up credit research with top-down macroeconomic views. The team focuses their research on economic, industry, company, and market fundamentals. Staff recognize that when industry dynamics or government policies materially change, extrapolating from the past is of limited use. When it comes to assessing a company's ability to repay its debt, future profitability matters most. Therefore, companies that can make strategic shifts, have good financial backing, and a higher degree of certainty, generally provide desirable investment opportunities. Oftentimes, these companies have tighter yields, which is where the fundamental investment process becomes critical. Some risks must be accepted to generate attractive returns. All potential fixed income investments are evaluated under this lens, without preferences for or against certain types of companies or instruments based on non-financial considerations.

Staff evaluate the climate-related risks associated with each company in the fixed income portfolios and remain highly selective when incorporating investments that may be subject to higher potential climate and transition risks over the life of the bonds. Further, credit rating agencies, investment data, and research providers all incorporate climate-related risks and opportunities into their analysis, which staff review regularly as part of their investment process.

KEY TAKEAWAYS

Unlike other asset classes at the WSIB, which generally invest through external investment managers and other fund structures, fixed income investments are managed in-house by WSIB staff. The fixed income team is highly attuned to climate-related risks and opportunities and how they might impact their investments over time. The fixed income portfolios' primary exposure to climate-related risks is tied to bonds issued by fossil fuel companies. The fixed income portfolios do not have investments in coal-focused businesses. Portfolio investments in electric utilities provide stable, predictable cash flows and include transition leaders that have significantly reduced carbon intensity with credible renewable integration plans. The team will remain highly selective when investing in companies with fossil fuel exposure.

PRIVATE EQUITY

RISKS

The WSIB's private equity investments span virtually all sectors and global regions. All businesses risk productivity and financial loss if their operations are impacted by weather-related natural disasters, which are increasing in frequency and magnitude due to climate change. Disruptions to logistics, supply chains and livelihoods present a systemic risk to economic and market conditions across the globe. However, exposure to certain sectors can undeniably pose greater risk than others. The traditional energy sector has been one of the most vulnerable in the current environment, where regulatory shifts and technological advances may render large swaths of the sector uneconomic in the long run. Most developed market countries are shifting away from fossil fuels, investing in cleaner forms of energy such as wind, solar, and geothermal. The increased investments in these sources of energy have made their per-unit cost competitive with traditional oil, gas, and coal powered plants.

Generally, since the global financial crisis, the traditional energy sector has not been value accretive to the WSIB's private equity portfolio, as the volatility in commodity prices and other industry disruptions compounded the negative impact of the crisis just as the benefits of deleveraging and the ensuing economic recovery were beginning to be felt by the broader industry. The WSIB's private equity staff have generally avoided investing in single sector oil and gas exploration and production private equity funds, due to their higher-than-average volatility characteristics and inability to time the market. Private equity staff continue to explore strategies that invest in energy sub-industries that are not fossil fuel or commodity related.

Information technology, and particularly AI, is a major area in which private equity investors have actively sought opportunities, and its climate-related risks are beginning to be better understood. This decade has seen rapid advancement in and adoption of AI models for consumer and commercial uses. However, a major concern around the proliferation of this technology has been the large amount of energy needed to power the data centers that are the lifeblood of the industry.

INVESTMENT OPPORTUNITIES

Challenges often lead to investment opportunities, and climate change has opened up new markets for private equity. Private equity managers have invested in technologies that either combat or mitigate the effects of climate change as companies in the renewable energy sector become commercially viable and profitable. Some of our private equity partners have invested in ancillary opportunities in the power and utility sector, by investing in service providers that upgrade, install, and maintain the electricity grid in various regions across the globe.

As demand grows for cheaper, cleaner, and more efficient sources of energy to power data centers, we may be on the cusp of a virtuous cycle; whereby private investment in these efficient energy sources can help power the development and scaling of AI.

Within the health care sector, investments in pharmaceutical and medical device companies are needed to respond to the increasing incidence of disease due to climate change-related declines in air and water quality. The financial services industry, particularly insurance companies, are becoming more adept at underwriting long-term climate-related risk, particularly those related to physical hazards, which could lead to higher profitability.

INVESTMENT PROCESS

Private equity staff are mindful of climate-related risks and opportunities and discuss the potentially adverse material impacts of climate change on existing portfolio companies. Part of the private equity team's investment process involves scoring and benchmarking a manager's focus on sustainability. Most of the WSIB's private equity partners have a dedicated team that focuses on sustainability, which involves climate change risk management.

Several of the WSIB's private equity investment partners have demonstrated a genuine commitment to ESG in general and climate change in particular as drivers of value creation. An example is TPG, which in 2017 raised The Rise Fund. The Rise Fund is the first impact fund of scale, that pursues an objective to maximize financial return while pursuing positive environmental or social change. Another example is Ara, a general partner that invests in businesses that are focused on decarbonization and sustainable energy, operating largely within the chemicals, energy, agriculture, and manufacturing sectors.

None of the WSIB's private equity managers invest in thermal coal, while some, like Actis and Denham, have built robust renewable energy platforms investing in emerging markets.

KEY TAKEAWAYS

Investing in private equity during the ongoing energy transition requires both the consideration of the opportunities for growth and returns and the avoidance or mitigation of value destruction caused by climate change. The convergence of these two concepts may be found in the sizeable opportunity offered through a combination of investments that support renewable energy and decarbonization. As part of the WSIB's governance and oversight of private equity investments, staff serve on the Limited Partner Advisory Committees of all funds in which we invest. This allows staff the opportunity to voice concerns and provide advice to investment managers on matters including energy transition risks and mitigations.

REAL ESTATE

RISKS

The long horizon of real estate investments naturally exposes the asset class to certain aspects of climate change and energy transition risk over multiple economic cycles. Physical damage to assets arising from severe weather-related events like flooding, storm surges, and wildfires may pose the most immediate and noticeable risks. In addition to physical damage, operating disruptions may negatively impact tenants and their customers. Best efforts are made by the WSIB's partners to identify these risks upfront during both the due diligence phase of an acquisition and throughout the holding period.

Like other asset classes, real estate also faces a shifting regulatory environment in relation to climate change and the energy transition. In some jurisdictions, regulations come with incentives such as the sustainable energy investment subsidy (ISDE) in the Netherlands, (Netherlands Enterprise Agency, RVO, 2025). Other regulations can be punitive. For instance, some jurisdictions prohibit landlords from indexing rents to inflation or even being allowed to rent a property, if energy efficiency requirements are not met. (Paris Property Group, 2024) (Department for Energy Security and Net Zero, 2025)

The WSIB is also monitoring increased insurance premiums and the risk of reduced insurance availability due to increasing physical climate risk. In certain markets, such as Florida and California in the U.S., real estate owners have already begun to experience the impact of insurers leaving the market or increasing premiums. However, the WSIB and its partners have taken a proactive approach to educating insurance carriers about its portfolio, which has allowed some partners to secure attractive coverage and premiums, even in climate sensitive areas.

Lastly, both building operations and construction face exposure to the fossil fuel industry as well as the broader energy market. Heavy machinery and the manufacturing and transportation of building materials is heavily dependent on energy costs. Construction also carries embedded GHG emissions, which could face regulatory obstacles. Building operations can face both short-term disruptions due to utility price spikes as well as long-term price growth. Even if utility cost increases are passed onto tenants, the resulting increases in total occupancy costs and can put downward pressure on rents.

INVESTMENT OPPORTUNITIES

An energy transition creates opportunities for an institutional real estate investor with a long-term horizon such as the WSIB. High regulatory and compliance requirements related to energy efficiency may create barriers for shorter-term or less capitalized investors, positioning established institutional investors like the WSIB to leverage experience, expertise, and resources to gain a competitive advantage. For example, some real estate partners may experience smoother permitting and approval processes, as well as improved financing terms by integrating energy efficient practices in their developments and refurbishments. Additionally, investing in property upgrades that align with sustainability initiatives strengthens tenant retention and positions assets as preferred choices in a competitive market. Thoughtfully considered projects such as this help the WSIB future-proof its real estate assets against climate change and the associated regulatory impact.

INVESTMENT PROCESS

The WSIB and its partners continually monitor regulatory changes, energy availability, and new, more sustainable construction materials. A granular approach is needed, analyzing the unique factors of each asset, such as building type and structural integrity, energy efficiency, or the cost effectiveness of energy upgrades. Steps taken by real estate partners include conducting third party assessments, reviewing flood plain maps and considering surrounding areas, such as nearby mitigating infrastructure projects. Moreover, asset location is key. Staff analyze risks and opportunities not only by region and city but by individual blocks and the physical positioning of assets.

A similar granular approach is used when analyzing dispositions. Staff endeavor to identify assets that could potentially become obsolete or “stranded” and avoids holding these investments over the long term. However, dispositions are uncommon and executed only after careful consideration.

KEY TAKEAWAYS

To varying extents, many, if not all, real estate geographies and property types will be impacted by climate change, regulation, and the energy transition. Several climate change-related factors that can impact the real estate portfolio are addressed naturally through both the investment style and philosophy of the WSIB’s real estate program, which is focused on investments that provide a long-term, high-quality, and stable income stream. Markets and assets in the existing portfolio, as well as each new investment, are evaluated with a consideration of both opportunities and risks related to the energy transition and climate impacts. For example, our investment partners have invested in solar panel installations on building rooftops, Passivhaus construction in Europe that greatly enhances heating and cooling efficiency, and construction of properties designed for resilience in extreme weather events. Considering opportunities that support long-term value creation while taking into account climate risks helps maintain the team’s thoughtful approach toward portfolio construction.

TANGIBLE ASSETS

RISKS

The tangible assets portfolio is subject to both physical and transition risks. Physical risks arise from changing weather patterns and water conditions, leading to asset damage, operational downtime, increased maintenance, capital expenditure, and higher insurance cost. Transition risks stem from shifts in policy and regulation, compliance and disclosure requirements, technology development, and evolving customer and stakeholder expectations. These risks lead to changing project economics, higher operating complexity, permitting friction, and market repricing.

Within tangible assets, climate-related risks are primarily visible in power and energy investments as well as agriculture. Power and energy assets sit at the intersection of long-term infrastructure, policy exposure, changing technology, and market demand, which increase sensitivity to both physical disruption and transition-driven shifts in costs and revenues. Agriculture is directly tied to climate and biological systems, making yield highly dependent on weather volatility and water availability.

Power and Energy

Physical risks such as severe storms, flooding, wildfires, and extreme heat can disrupt the energy value chain. These events drive outages, equipment damage, safety interruptions, and longer repair cycles across generation infrastructure and networks, as well as fuel logistics and processing infrastructure. Heat stress reduces operating efficiency and intensifies peak-demand strain, while water scarcity constrains where assets can be built and how cooling-dependent assets operate.

Transition risks are driven by policy, technological advances, and market changes. Emission standards, permitting timelines, and disclosure requirements raise compliance burdens and narrow operating flexibility. The risk of incentives being reduced or withdrawn pose challenges for project economics, especially where returns depend on timely construction and interconnection. Technology changes and supply chain constraints increase input costs and extend development periods, while changes in carbon pricing and offtake terms can affect the valuation of long-duration assets.

Market dynamics add another layer of risk, as fuel prices and technology costs evolve and reshape overall energy utilization. Even as the long-term energy mix starts to tilt toward renewables, fossil fuels will remain relevant for the foreseeable future. Energy reliability is important; power systems need reliable, dispatchable capacity to cover peak periods, seasonal shortfalls, and extreme weather--and also to provide stability services when intermittent output falls short. Timing and execution are also important considerations. Transmission expansion, network upgrades, and scalable storage solutions take time to permit, finance, and build. Against that backdrop, the expected rapid growth of data centers will increase the near-term need for dependable power, which often extends the life of existing dispatchable generation and supports selective new buildouts. The result is greater policy attention and more valuation sensitivity to assumptions based on utilization, costs, and delivery schedules.

Agriculture

Physical risks in agriculture are more pronounced in operating and financial outcomes. Changing temperatures, precipitation patterns, and water availability affect yields, quality, and harvest timing. These effects are asset specific. For instance, a farm’s water profile, soil quality, crop mix, and local infrastructure often matter as much as broader regional trends. Since outcomes vary from year to year, the key downside is not only a single adverse event, but also the compounding impact of repeated weather stress on productivity, cost structure, and land value.

Transition risks tend to be more gradual but are still material in agriculture, particularly where policy and market requirements influence how land is operated and the cost of producing crops. Moreover, as water rules and allocation frameworks tighten, the relative competitiveness of regions and crop types change over time.

Risk management, therefore, leans on underwriting discipline and operating execution. For instance, one partner emphasizes water availability in underwriting by prioritizing farms with strong water access, tracking local water-district conditions, and investing in practical mitigants such as irrigation upgrades, surface-water delivery infrastructure, and well maintenance where needed.

INVESTMENT OPPORTUNITIES

Climate change is reshaping investment themes across the tangible assets portfolio. Policy shifts, technological advances, and shifting market dynamics are steering capital toward opportunities that increase system reliability, improve efficiency, and secure access to essential resources. Together, these forces are driving demand for assets that can support a more resilient and sustainable operating environment.

Power and Energy

Investments in renewable energy generation within the tangible assets portfolio have grown significantly over the last several years and now comprise a meaningful portion of the portfolio's energy investments. As demand for electricity grows and the supply mix becomes more diverse, investment opportunities are extending beyond wind and solar into technologies and services that improve energy reliability and efficiency, transmission, and storage. Hydrogen, for example, is a technology that sits across production, storage, and end use. On the demand side, hydrogen has become an important feedstock for fertilizers and other chemicals, and is growing in use by industrial processes, transport application, and power generation. It can be produced in one location, stored for extended periods, and then moved to areas of demand, functioning as a flexible energy carrier. Moreover, battery energy storage systems have also become a more mature part of the value chain, supporting grid stability by aligning energy supply with demand and improving system balancing as intermittent generation grows.

Agriculture

As climate volatility and tightening water resources reshape agricultural production, value will increasingly concentrate in producers and regions with more stable growing conditions and stronger resource management. When extreme weather disrupts output in one area, reduced supply often drives prices higher, supporting farmland that remains productive. Over time, shifts in crop viability and growing regions will create opportunities in land enhancement, modern irrigation systems, alternative growing technologies, more efficient resource use, as well as carbon capture and storage. These dynamics extend beyond the field itself, supporting investment themes in storage, processing, logistics infrastructure, and regenerative agricultural practices that enhance efficiency, resilience, and reduce waste.

Other Opportunities

Demand for critical minerals such as lithium, manganese, copper, and aluminum is rising as power infrastructure expands and electrification continues. In transportation, shifts toward EVs increase demand for charging and depot infrastructure, grid-connected logistics facilities, and supporting assets that improve reliability and utilization across networks.

INVESTMENT PROCESS

Within the tangible assets' risk framework, climate change most directly affects its sustainability and ESG risk profile, with implications for regulatory, legal, and reputational risk. These considerations are incorporated into our investment evaluation and ongoing monitoring.

The tangible assets portfolio is constructed to remain diversified across industries and segments, with an emphasis on income-producing and inflation-protected investments. Climate risk on its own does not determine whether an investment is included or excluded. Instead, climate risk is assessed through its impact on operating performance, development, legal terms, and long-term competitiveness. Where climate risk is material, due diligence focuses on mitigants such as contractual protections, operational improvements, resilient supply chains, and credible transition plans that support return expectations.

KEY TAKEAWAYS

Climate-related risks are more pronounced in the tangible assets portfolio's power and energy investments along with agriculture exposures, where performance and value are sensitive to weather volatility, water constraints, policy market shifts, and market changes. These risks are managed through disciplined underwriting and ongoing monitoring, supported by diversification, contractual protection, and operational mitigants aligned with income-producing and inflation-protected return objectives. Meanwhile, the transition is broadening the opportunity set beyond investments in renewable energy generation, which the tangible assets team has many years of experience investing in. The expanded opportunity set includes technologies and services that improve energy reliability and efficiency, carbon capture, utilization, and storage (CCUS), and generating carbon credits in timber and agriculture.

PRIVATE CREDIT

RISKS

Private credit tends to have shorter contractual maturities, which limits the asset class's sensitivity to longer-term climate-related risks. However, borrowers in energy-intensive industries may encounter near- and medium-term pressures as energy input costs evolve, regulatory requirements change, and demand patterns shift. These factors can influence operating margins, refinancing conditions, and recovery outcomes, particularly in companies with elevated energy usage or reliance on physical assets. Cash flow dynamics may vary across subsectors as firms respond to evolving expectations around efficiency, resiliency, and reporting.

Exposure to transition-related challenges may arise where borrowers face increased cost volatility or incremental compliance obligations. As energy systems evolve, companies dependent on older equipment or conventional logistics fleets may incur higher operating or maintenance expenses, and, in some instances, collateral values may be affected by accelerated depreciation or changes in insurance coverage. Borrowers located in regions with greater susceptibility to infrastructure constraints may observe additional cost pressures associated with grid conditions or investments to support resiliency. These effects are likely to be uneven across industries and may require ongoing monitoring to understand how operating environments translate into credit performance.

INVESTMENT OPPORTUNITIES

The changing energy complex may create opportunities for borrowers investing in electrification, efficiency improvements, and resiliency-related upgrades. Companies that modernize equipment, retrofit facilities, or adopt energy management solutions may realize lower long-term operating costs and enhanced competitiveness. In addition, firms providing services connected to industrial retrofits or infrastructure enhancements may benefit from increased demand. These developments may support more stable revenue profiles for select borrowers, although adoption rates and implementation timelines may vary across markets.

INVESTMENT PROCESS

Private Credit is a new asset class within the WSIB, and the portfolio is under development. WSIB investment staff have been proactively engaging with private credit managers for many years on climate related issues, both during initial due diligence and throughout ongoing monitoring of the investment to ensure energy-transition factors are meaningfully integrated into underwriting and portfolio management. This engagement focuses on confirming how managers identify and quantify transition-related risks and opportunities, how those findings are incorporated into credit analysis, and how portfolio exposures are tracked and reported over time.

Private credit strategies often incorporate transition-related considerations into underwriting and monitoring. Financings supported by assets with durable collateral characteristics, diversified customer bases that reduce concentration in energy-intensive sectors or demonstrated efficiency improvements may offer greater stability as energy conditions evolve. While climate-related reporting obligations remain modest in the private lending context, enhanced visibility into operating performance may assist in identifying trends over time.

KEY TAKEAWAYS

The WSIB seeks to confirm that managers consider the implications of evolving energy systems, regulatory changes, and operational efficiencies in their investment decisions, with an emphasis on ensuring that portfolios remain resilient and are positioned to capture emerging opportunities linked to the energy transition. Private credit's shorter contractual horizon helps mitigate structural exposure to long-duration climate risk; however, borrower-level sensitivities may emerge as operating conditions evolve. Companies that proactively adjust cost structures and capital expenditure plans are better positioned to sustain performance, while others may encounter incremental pressures driven by changing energy dynamics. As the transition progresses, credit performance is expected to diverge across industries, reflecting differences in energy intensity, asset durability, and the ability to adapt to shifting conditions.

INNOVATION PORTFOLIO

The innovation portfolio is intentionally flexible and can evaluate a wide range of themes, strategies, sectors, and instruments as opportunities emerge and market conditions evolve, including certain climate- and transition-related strategies that may not fit neatly within WSIB's existing asset class frameworks. Because of this flexibility, it is not practical to define a fixed set of transition-risk categories, opportunity themes, or process considerations that would apply uniformly across future investments. Instead, these considerations are assessed at the investment level, with the depth and focus tailored to the strategy and primary exposure drivers and informed by the diligence, underwriting, and monitoring practices of the most comparable asset class. For example, the innovation portfolio invested in TPG's impact and climate transition funds at a time when the ability of such strategies to achieve private equity-like returns was less established. As the market has evolved, some of these strategies have become more clearly aligned with existing asset class mandates and return objectives and may, where appropriate, be pursued outside the innovation portfolio.

CONCLUSION AND TAKEAWAYS

The Earth's climate is changing due to an increase in human-caused GHG emissions. A global energy transition is underway that, over the long run, should decrease the production and consumption of fossil fuels, one of the primary sources of GHG emissions. However, energy demand continues to increase, which extends the need for fossil fuels as a source of energy for the foreseeable future, as renewable energy is insufficient to meet current and projected demand.

- The WSIB's investments are intentionally broadly diversified across asset classes, sectors, and geographies, and this is a key component of our overall risk mitigation strategy. Given the current level of climate- and energy transition-related uncertainty, we believe it will be prudent for the WSIB to continue to maintain these broadly diversified exposures in line with our investment beliefs and strategic asset allocations, rather than create policies designed to divest the portfolio from certain energy-related industries, which will likely continue to go in and out of favor based on geopolitical and policy trends.
- Staff continue to enhance and evolve the WSIB's approach to climate-related risk measurement and monitoring at the total portfolio level. GHG emissions measurement will continue to improve as the available data improves – though the link between emissions and asset prices remains tenuous. Additionally, the WSIB will continue to increase its focus on physical risk measurements at the total portfolio level, such as analysis of the physical location of certain assets and associated hazards in that area. We will also continue to explore ways to incorporate climate scenarios into the investment decision-making process.
- Each of the WSIB's asset classes is unique with regards to its expected return and risk characteristics, time horizon, structure, and overall investment strategy. Further, climate- and energy-transition related risks and opportunities vary by asset class, as discussed in this paper. One constant across all asset classes is the incorporation of material climate-related risks and opportunities as part of our investment due diligence process. Investment staff receive regular support and continuing education on emerging climate- and transition-related topics to help maintain awareness of emerging themes that could impact their investments.
- Across all asset classes, investment staff continue to seek out investment strategies and companies with attractive risk and return characteristics that support the transition to a low carbon economy and decarbonization.
- Staff will continue to opportunistically engage with companies, partners, advocacy groups, and regulatory bodies on material climate-related issues.

Long-term investors like the WSIB currently face a high level of uncertainty around the financial impacts associated with climate change and the energy transition. What is certain is that there will be impacts, even if they are extremely difficult to predict. The WSIB will remain steadfast in its mission, investing the funds entrusted to us with integrity, care, and skill to maximize return over the long term at a prudent level of risk for the exclusive benefit of beneficiaries. We believe this mission, along with the WSIB's investment beliefs, will continue to serve beneficiaries well as we navigate climate change and the energy transition over the next several decades.

GLOSSARY

MEASUREMENT UNITS COMMONLY ENCOUNTERED IN CLIMATE RISK DISCUSSIONS

In reviewing news articles and research papers on climate risk, the energy transition, and related topics, we encounter many units of measurement. This glossary explains the more commonly encountered units of energy production and consumption, greenhouse gas emissions, and other climate topics. Both measurement and measurement units are complex topics, and this glossary provides an overview rather than an exhaustive review. We encourage interested readers to engage with the materials referenced throughout this paper for a deeper understanding.

SYSTEMS OF UNITS OF MEASUREMENT

The International System of Units, abbreviated SI, is commonly referred to as "the metric system" and is the standard for scientific work. SI defines units such as the second (s) for time, the meter (m) for distance, and the kilogram (kg) for mass. SI also defines a set of prefixes to simplify the reporting of very large or very small quantities of a unit. For this paper we need only concern ourselves with subset of prefixes.

Prefix	Symbol (case sensitive)	Size Multiplier
kilo	k	1 thousand (1 followed by 3 zeroes)
mega	M	1 million (1 followed by 6 zeroes)
giga	G	1 billion (1 followed by 9 zeroes)
tera	T	1 trillion (1 followed by 12 zeroes)
peta	P	1 quadrillion (1 followed by 15 zeros)
exa	E	1 quintillion (1 followed by 18 zeros)

While most of the world uses SI, the U.S., the U.K., and some other countries use other systems for non-scientific purposes. For this paper we only need concern ourselves with the pound (lb) for mass and the Fahrenheit scale for temperature, which will allow us to define the British thermal unit (Btu).

COMMON MEASURES OF ENERGY AND CONVERSIONS

1 kilowatt-hour (kWh)	= 1,000 watts used in 1 hour of time = 3,600 kilojoules (kJ) = 3.6 megajoules (MJ)
1 British thermal unit (Btu)	= 1,055 joules (approximate) = 1.055 kJ = 0.2931 watt-hours (Wh)
1000 Btu	= 0.2931 kWh = 1.055 MJ
1 quad	= 1 quadrillion (10^{15} Btu) = 1.055 exajoules (EJ) = 293.1 TWh

ENERGY GENERATION, DEMAND, AND CONSUMPTION

Electricity generation capacity and electricity demand are "point in time" measures capturing how much power might be needed or available at any instant. Even though these quantities do not typically represent sustained production or use, they are important in designing and managing an electrical grid. For instance, we do not typically have multiple power-hungry appliances running all day, but our home's electrical system and our city's electric grid must be designed to support peak usage on any given day, with a margin of safety.

The SI uses the watt to measure power or the rate of energy transfer. In the energy sector, the maximum power output of an electricity-generating power station is typically reported in megawatts (MW) or gigawatts (GW). For instance, as of 2024 the Grand Coulee Dam complex in Washington state had an installed maximum generation capacity of 6,809 MW or 6.8 GW (Bureau of Reclamation, 2025). A large "utility-scale" solar farm might have a generation capacity on the order of hundreds or thousands of MW, while solar panels installed on a building's roof would come in under 1 MW. Data centers provide another point of reference from the demand side: a small data center might have an electricity demand on the order of tens of MW, while hyperscale data centers would be on the order of hundreds of MW (Spencer & Singh, 2024).

GENERATION OR CONSUMPTION OVER TIME

Electricity generation or consumption over time, at the scale of a building or a local area, is often measured in some multiple of a watt-hour (Wh), which is not an SI unit. One Wh represents the generation or consumption of 1 watt of electricity in 1 hour of time. For instance, a 60-watt incandescent light bulb, left on for one hour, will use 60 Wh of electricity. Single Wh are quite small at the scale of machines, buildings, and cities, so we typically encounter kilowatt-hours (kWh) and megawatt-hours (MWh) when considering power generated or used over some period of time, e.g., one year. Using the Grand Coulee Dam as an example: the dam provides around 21 billion kWh annually (Bureau of Reclamation, 2025). The electricity generated in the entire U.S. in a year amount to trillions of kWh (or thousands of TWh) (Energy Institute, 2025).

The joule (J) is the SI unit for measuring energy and can be defined as the use of 1 watt in 1 second.[5] In an hour (3,600 seconds), 3,600 J would be used, hence 1 watt-hour equals 3,600 J and 1 kWh equals 3,600 kilojoules (kJ) or 3.6 megajoules (MJ). Publications written by international teams will often talk about energy supply, production, and consumption in very large multiples of J; for instance, the 2025 Statistical Review of World Energy reported the global energy supply (across fossil fuels, renewable energy, and all other sources) in 2024 totaled about 592 exajoules (EJ) or 592 quadrillion kJ (Energy Institute, 2025).

We will also encounter energy production and use expressed in British thermal units (Btus). 1 Btu is the amount of energy needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit. We commonly encounter Btus on heating and cooling equipment in our homes and on our utility bills. Some data sources and research reports will express the total energy produced or used by an economy in Btus, typically at the scale of trillions or quadrillions of Btus (with a quadrillion Btus often called a "quad"). One Btu is roughly 1,055 J. A good rule for quick conversions is 1 Btu ≈ 1kJ, and hence if the global energy supply is about 600 quadrillion Btus, that is roughly 600 quadrillion kJ, also known as 600 EJ.

Other units commonly encountered in energy conversations are barrels of oil (bbl), which amounts to about 42 U.S. gallons or 159 liters; cubic feet or cubic meters for natural gas by volume; Btus for natural gas by energy content; and units of mass such kilograms (kg) or (metric) tonnes (t; 1000 kg) for minerals or fuels like hydrogen or ammonia.

MEASURING EMISSIONS

GHGs are airborne chemicals that trap heat in the Earth's atmosphere and contribute to a warmer planet and changes in the Earth's climate that are not explained by natural variation. Carbon dioxide (CO2) is perhaps the most well-known of the GHGs. As part of efforts to study climate change, scientists measure the amount of carbon dioxide released from human processes such as the combustion of fossil fuels. The base unit of measurement is the metric tonne (1000 kilograms), and at the scale of the world, millions or billions of metric tonnes.

Other greenhouse gases, such as methane (CH4) and nitrous oxide (N2O), as also important when it comes to climate change. The 100-year global warming potential (GWP) of a greenhouse gas, as defined by IPCC, is a scaling factor that

[5] Hence 1 watt, a unit of energy transfer, is 1 joule per second.

can be used to convert emissions of other gases to “equivalent” carbon dioxide emissions (CO_2e). Carbon dioxide has a GWP of 1 by definition, while CH_4 has a GWP of 27.9 and N_2O has a GWP of 273 (Smith, et al., 2021). The CO_2e measure of emissions for greenhouse gases is hence defined as the amount of gas (say, in metric tonnes) multiplied by the GWP of the gas (Eurostat, 2025). A single metric tonne of CH_4 thus has the same 100-year warming potential as 27 tonnes of carbon dioxide.

According to the 2025 Statistical Review of World Energy global emissions in 2024 totaled 40.8 gigatonnes of carbon dioxide equivalents (Gt C02e) (Energy Institute, 2025).

WSIB EMISSIONS MEASUREMENT DEFINITIONS

- Total financed carbon emissions (Mt CO_2e): emissions allocated to all financiers based on ownership. This metric measures the total carbon emissions attributable to an investor according to their share in the enterprise value including cash (EVIC) of an entity. EVIC represents the total value of an entity inclusive of equity value (market capitalization), debt, cash, and cash equivalents.
- Financed carbon emissions (Mt CO_2e / $million invested): emissions allocated to all financiers (EVIC) normalized by $million invested. This metric measures the carbon emissions attributable to an investor per USD million invested, based on their equity ownership percentage in the market capitalization.
- Scope 1 emissions: direct GHG emissions that occur from sources that are controlled or owned by an organization. Examples include emissions from company-owned vehicles, on-site manufacturing processes, and the burning of fossil fuels for heat or electricity generation within that organization’s facilities.
- Scope 2 emissions: indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling. These emissions occur at the facility where the electricity or other energy is produced but are attributed to the organization that consumes the energy. For example, if a company purchases electricity from a utility provider, the emissions produced by the utility’s power plants are categorized as the company’s Scope 2 emissions.
- Scope 3 emissions: all indirect GHG emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions. These are the hardest to measure and manage since they involve emissions that are not under the direct control of the company.
- Upstream Scope 3 emissions: emissions that result from activities in the supply chain prior to the company’s direct operations. This includes emissions from purchased goods and services, capital goods fuel- and energy-related activities (not included in Scope 1 or 2), transportation and distribution (upstream logistics), waste generated in operations, business travel, employee commuting, and upstream leased assets.
- Downstream Scope 3 emissions: emissions that result from activities related to the products and services provided by the company after leaving the company’s direct operations. This includes emissions from transportation and distribution (downstream logistics), processing of sold products, use of sold products, end-of-life treatment of sold products, downstream leased assets, franchises, and investments (MSCI, 2025).

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