



Setting the Pace

The economic case
for managing the
decline of oil and gas
production in Canada

IISD REPORT



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June 2023

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Executive Summary

From Energy Crisis to the End of Business as Usual

The world is emerging from a far-reaching energy crisis. As the pandemic hit in 2020, demand plummeted suddenly. In the years that followed, COVID-19 continued to impact energy supply and demand, as well as the broader economy. Instability turned into crisis when Russia's illegal invasion of Ukraine further tightened energy markets.

The result was unprecedented volatility and high oil and gas prices, leading to windfall profits for global oil and gas producers, including those in Canada. This influx of revenue has renewed interest in expanding Canadian production and infrastructure.

However, the current boom will not last. Despite the supply crunch, the shift away from oil and gas has only accelerated. The European Union has moved quickly to curb its use of Russian supplies, and global climate action is accelerating, including via the United States' Inflation Reduction Act. Though scenarios have yet to align with 1.5-degree pathways, it's clear that economic trends, including oil and gas demand, are swiftly departing from business as usual.

Since the most influential factor affecting the viability of the Canadian oil and gas sector is global demand, it will be impossible to avoid disruption to this industry.

Setting the Pace examines how global demand trends and increasingly volatile global markets will negatively affect Canada's oil and gas sector. We examine projections for oil and gas demand, what this means for end uses and exports of Canadian product, and the implications for Canada's economy. We then explore lessons from jurisdictions that have successfully managed to phase down fossil fuels. Finally, we propose a proactive role for the federal government to reduce risk, safeguard jobs and economic stability, and support Canadian communities by sending clear policy signals to the energy sector.

Findings

Overall, we find the Canadian oil and gas sector is set to decline and the industry is not well positioned to weather drops in global demand. The oil and gas sector's historic role as one of Canada's primary economic sectors is already changing. Given demand projections, business as usual in the sector is no longer an option. To minimize the risks to dependent workers, communities, and regions, governments must take an active role in overseeing a predicted phase-down of oil and gas production and diversifying the economy.



Oil markets will soon decline, with a poor outlook for Canada.

Global demand for oil will go into terminal decline by the end of the decade. The coming peak and decline of global demand are predicted by most for around 2030, primarily but not only driven by uptake of electric vehicles. Other end uses, such as plastics, will not make up the shortfall.

Canadian producers are vulnerable both to loss of markets and low and volatile prices. Canada will eventually be vulnerable to changes in U.S. and global demand for retail gasoline as transportation is electrified. Even the captive purchasers of Canadian heavy crude will ultimately be impacted. The oil that continues to be sold will fetch ever less revenue in the face of falling global prices. Volatility alone, which will be experienced by all producers, is a major negative influence regardless of price.

Canadian producers cannot preserve markets on price, nor on their reputation as clean or ethical producers. Buyers of Canadian oil are focused on price, reliability, and quality—*not* on environmental, social, and governance (ESG) credentials.

Gas market trends mean unsustainable economics for Canadian producers and projects.

Global demand projections for gas have been downgraded, including in Canada's export markets. Gas outlooks, which were growing only a couple of years ago, have been fundamentally altered by high prices, viable renewable alternatives, and energy transition responses by the European Union and United States. Natural gas demand in the United States will be reduced by the Inflation Reduction Act, limiting potential in Canada's only current export market.





Limiting climate change leaves no room for increased natural gas production. High-ambition climate scenarios show gas peaking in the near term and declining rapidly. Although liquified natural gas (LNG) demand is expected to grow, if governments meet their existing climate objectives, projects already under construction will be sufficient to meet global demand. New gas and LNG infrastructure risks being stranded if the world successfully limits climate change.

Canada's gas industry is facing unsustainable economics. Given declining demand in North America, maintaining momentum in Canada's natural gas industry hinges on new LNG markets. There is a fundamental mismatch between short-term European demand and Canada's ability to build export infrastructure on the east coast. Lacklustre demand growth in Asian markets combined with an anticipated glut of LNG supply beginning in the middle of the decade will drive down LNG prices. High-growth markets in emerging Asia are price-sensitive, making it questionable whether Canadian LNG exports—with relatively high capital and pipeline transportation costs—can compete with lower-cost suppliers.

Planning for climate success requires planning for declining oil and gas production.

In addition to market trends, the scientific evidence supporting phase-out is clear and should be a wake-up call to accelerate market decline. Based on credible 1.5°C-compatible scenarios, global oil and gas production must decrease by at least 65% by 2050. Research is clear that to meet the Paris Agreement goals, governments must not only stop new fossil fuel projects but also retire a significant number of existing projects ahead of schedule.

Canadians are already experiencing high economic and social costs from climate change. Although markets are shifting rapidly due to global climate action, they do not yet adequately reflect these costs. The health, economic, and environmental consequences of not aggressively mitigating climate impacts are enormous, including potentially hundreds of billions of dollars in annual losses for Canada if the world fails to act.

The Canadian oil and gas sectors are set to decline. Allowing markets to decide the timing and rate of change has unacceptable economic risks.

Letting markets decide when and how Canadian oil and gas are ramped down is not in the public interest. The history of resource dependence and collapse show us—even in Canada—that without a proactive approach, large numbers of workers could lose their jobs, with devastating impacts to communities and regions. If oil and gas infrastructure and investments are rendered uneconomic—that is, are stranded—by falling demand, the effects will go beyond the people employed in the sector to risk the destruction of a vast amount of national wealth, to the detriment of all Canadians. Canada also risks losing government revenues, incurring major opportunity costs if investment flows to sunseting industries rather than to emerging ones, and entrenching infrastructure that will make the energy transition more costly and difficult.



With declining prices and increased volatility, governments can expect more pressure to support the industry at the expense of economic and public interest. The oil price crash during the COVID-19 pandemic foreshadows what an unmanaged decline of the oil and gas sectors would look like in Canada. This includes massive remediation and cleanup cost burdens shifted to taxpayers; unpaid municipal taxes and landowner lease payments; and intense industry pressure on governments for fiscal supports, bailouts, and relief from important climate and environmental regulations. Meanwhile, workers in this sector continue to be exposed to job losses. The oil and gas sector terminated over 53,000 jobs from 2014 to 2019 even as oil production increased, and then terminated over 17,000 more jobs in the first year of the pandemic.

Canada has an opportunity: evidence from other jurisdictions shows a proactive, managed decline will yield more economic benefits at lower risk.

A proactive approach that includes policies to phase down production and use has clear advantages. These include limiting overinvestment and stranded assets; redirecting investment to viable alternative energy sources, industries, and jobs; establishing the time frame for effective economic transition planning; limiting economic and social disruption; and demonstrating global leadership to seize opportunities in emerging sectors while encouraging other jurisdictions to act.

Lessons from Illinois, Colorado, Germany, and Denmark illustrate the importance of clear policy direction, interjurisdictional cooperation, and inclusive processes with social engagement. Three central interacting policies can support an equitable transition and economic diversification:

1. **Ambitious climate policy** with clear targets and timelines for emissions reductions with near-term milestones, including by sector.
2. **Energy policy that prioritizes managing the decline of fossil fuel extraction and/or use.** This includes long-term and clear signals and information about the reality of the decline of the fossil fuel sector.
3. **Economic diversification policies.** Recognizing low-carbon sectors' economic and job growth potential, this strategy includes acting *proactively*, beyond retraining workers, to carry out large-scale green industrial policy through inclusive processes and significant public investment.

The federal government must signal that it is proactively guiding and preparing for the decline of the sector.

Protecting Canadians from a disruptive decline of the oil and gas sector requires governments to take an active role in phasing down production. Current federal climate policies focus on emissions, including fiscal policies to support oil and gas decarbonization. Initiatives such as the Regional Energy and Resource Tables seek to transform Canada's traditional resource industries and prepare the workforce via a sustainable jobs policy. While



Canada has made historic progress, these policies are insufficient to safeguard against economic risks without clear guidance on the direction of the sector.

The federal government must ensure no region is left behind by spurring a federation-wide approach to address oil and gas sector decline. Division of jurisdictional powers, including over natural resources, means that supply-side policy is not a simple issue in the Canadian context. But this complexity should not cause the federal government to refuse to broach the issue, as it is critical to ensure economic stability and to support Canadians through the energy transition. Models for such efforts exist in other countries with split jurisdiction, and Canada should explore ways to navigate phase-down in the interest of Canadians.

The federal and provincial governments coordinated similar work in the coal sector starting in 2005, and this effort must now be extended to oil and gas. In addition to positive economic benefits, it will also have knock-on effects for global climate action and international cooperation as we saw with coal.

The federal government should act in four complementary ways:

1. Continue to implement and strengthen climate policies and the Sustainable Jobs Action Plan. The government should base these policies on robust and internationally credible sectoral analyses of the future of the oil and gas sector, including projections for demand and employment.
2. Support subnational and Indigenous governments' plans and programs on economic diversification. The Regional Energy and Resource Tables are a start, but plans must be fully aligned with sectoral analysis, net-zero pathways, and inclusive processes, including social dialogue.
3. Align fiscal policy with the reality of the expected decline of the oil and gas sectors. This includes eliminating fossil fuel subsidies and public finance, regulating the financial sector, and ensuring that government spending is not risking taxpayer dollars by artificially prolonging or increasing production.
4. Explore tools within federal jurisdiction to end expansion and prepare for phase-down of the production and use of oil and gas. This includes discussion with subnational governments on collaborative solutions, considering the implications of declining production in areas of federal responsibility (such as the regulation of international and interprovincial pipelines), and exploring options and legal limitations that respect jurisdiction while addressing sectoral transformation.



Table of Contents

1.0 Introduction	1
1.1 Canada's Exposure to Global Markets	2
1.2 Sector Decline and Federal-Provincial Jurisdiction	3
1.3 Lessons from the Coal Power Phase-Out	4
1.4 Proactively Addressing the Canadian Energy Sector	5
2.0 The Climate Case for Phasing Out Oil and Gas	6
2.1 A 1.5°C World: Carbon Budgets and Emissions Pathways	7
2.2 What a 1.5°C World Means for Oil and Gas Production	9
2.3 Canada's Climate Policy and Fair Share of Oil and Gas Production Cuts	13
2.4 Conclusion	14
3.0 Outlook for Oil	16
3.1 Global Oil Production and Pricing	17
3.2 Global End Uses and Projections: Demand to Peak by 2030	18
3.3 Oil Production in Canada	23
3.4 The Outlook for Canadian Oil Is Poor	29
4.0 Outlook for Natural Gas	33
4.1 Global Gas Demand Hinges on Climate Ambition	35
4.2 COVID-19, the Invasion of Ukraine, and Global Gas Markets	38
4.3 Natural Gas Production in Canada	39
4.4 Canada's Declining Export Market	42
4.5 The Outlook for Canadian Gas is Unsustainable	45
5.0 Implications of Oil and Gas Decline in Canada	47
5.1 Canada Is Economically Exposed Due to Its Reliance on Fossil Fuels	49
5.2 Low and Volatile Global Prices Cause Negative Economic Impacts	54
5.3 Oil and Gas Subsidies, Support, and Liabilities	57
5.4 A Business-as-Usual Future Is High-Risk	58
6.0 Mitigating Risks: Lessons from Other Jurisdictions	61
6.1 The Coal Transition in the United States	62
6.2 Phasing Out Fossil Fuels in the European Union	67
6.3 Initial Insights from Alberta's Coal Transition	72
6.4 Conclusion: A Policy Trifecta for the Low-Carbon Transition	74



7.0 Managing Decline in Canada’s Oil and Gas Sector	78
7.1 Governments Need to Set the Pace of Decline	80
7.2 Recommendations for the Federal Government.....	82
References	85

List of Tables

Table 1.1. Canadian oil and gas production, export, and import in 2021.....	3
Table 3.1. Field gate oil sands supply costs, 2012–2019 (2020 USD/barrel).....	25
Table 3.2. GHG intensity of oil sands by technology (kg CO ₂ e/barrel).....	27
Table 5.1. Alberta resource revenues	52
Table 5.2. Saskatchewan oil and gas revenues.....	52
Table 5.3. Newfoundland and Labrador offshore royalties	52



List of Figures

Figure 2.1. Embodied emissions in global oil and gas fields compared to allowable emissions under IEA 1.5°C and selected IPCC pathways	11
Figure 3.1. Global oil production shares by country (2021).....	18
Figure 3.2. World Economic Outlook 2022 global oil demand	19
Figure 3.3. Global demand for oil (2021)	19
Figure 3.4. Global EV sales (light-duty vehicles)	20
Figure 3.5. Global EV sales share (light-duty vehicles)	20
Figure 3.6. Survey of Canadian oil production.....	24
Figure 3.7. Conventional crude oil production in Canada (2020).....	25
Figure 3.8. GHG intensity of Canadian crude oil production.....	26
Figure 3.9. U.S. destinations for Canadian crude exports.....	28
Figure 4.1. Natural gas demand by end use, 2021	35
Figure 4.2. Global gas demand in all IEA scenarios.....	36
Figure 4.3. Historical and projected global gas and LNG prices (USD/kcf)	38
Figure 4.4. Marketable natural gas production by province.....	41
Figure 5.1. GDP contributions from oil and gas	49
Figure 5.2. Canadian government revenues from oil and gas	51
Figure 5.3. Employment in Canada’s oil and gas sectors.....	53
Figure 5.4. Oil price volatility (1983 USD/bbl)	55
Figure 5.5. Gas price volatility (1983 USD/million BTU).....	55
Figure 6.1. Impacts of the Inflation Reduction Act.....	64
Figure 6.2. The European Green Deal.....	68
Figure 6.3. Policy moves for effective, equitable transition and economic diversification	76



Abbreviations and Acronyms

APS	Announced Pledges Scenario	OECD	Organisation for Economic Co-operation and Development
b/d	barrels per day	OPEC	Organization of the Petroleum Exporting Countries
bbl	barrel	SAGD	steam-assisted gravity drainage
Bcm	billion cubic metres	SEI	Stockholm Environment Institute
Bcm/d	billion cubic metres per day	STEPS	States Policies Scenario
BIPOC	Black, Indigenous and people of colour	TMX	Trans Mountain Expansion project
CCS	carbon capture and storage	U.S. EIA	U.S. Energy Information Administration
CEJA	Climate and Equitable Jobs Act	UNEP	UN Environment Programme
ESG	environmental, social, and governance	WTI	West Texas Intermediate
EV	electric vehicle		
GHG	greenhouse gas		
IEA	International Energy Agency		
IEEFA	Institute for Energy Economics and Financial Analysis		
IISD	International Institute for Sustainable Development		
IPCC	Intergovernmental Panel on Climate Change		
IRA	Inflation Reduction Act		
IRENA	International Renewable Energy Agency		
LNG	liquefied natural gas		
Mcm/d	million cubic metres per day		
MMb/d	million barrels per day		
Mtpa	million tonnes per annum		
NZE	Net Zero Emissions by 2050		

1.0 Introduction





Energy markets have changed rapidly in the past three years. In 2020, the global pandemic led to a sudden and unexpected drop in energy demand. An interrupted and intermittent restarting of the global economy led to imbalances in supply and demand for many commodities, including energy. By the end of 2021, Europe was already seeing unprecedentedly high prices for natural gas. These were driven by unexpected outages at liquefied natural gas (LNG) facilities, already reduced flows of Russian gas, and high gas demand in 2020, when prices were low (International Energy Agency [IEA], 2023a). The Russian invasion of Ukraine in February 2022 turned an already-tight market into a crisis characterized by extreme price spikes in both oil and gas markets.

High prices have led to high profits for producers. Canadian oil and gas companies made CAD 152 billion in profit in 2022 (Gorski & El-Aini, 2022), which renewed interest in expanding oil and gas production and infrastructure. However, in the era of climate change and shifting energy markets, it is important to look closely at global trends. While there are clear signals that the transition to clean energy has accelerated in the past year (The Economist, 2023), there is a danger that short-term supply crunches could be misread or improperly leveraged to slow the energy transition. This scenario has implications for climate change and our collective ability to address it. It also has potential implications for the long-term economic health of the energy sector and Canada's economy more broadly, since the delay would stymie economic benefits from aligning the Canadian energy sector with a low-carbon energy future.

1.1 Canada's Exposure to Global Markets

Global trends are especially relevant in the Canadian context. Canada is highly vulnerable to shifts in global oil and gas demand, given that the vast majority of oil and gas is produced for export (see Table 1.1). In the case of oil in particular, 80% of domestic production is exported, with nearly all of those exports (94%) going to the United States. Future production growth is also targeted for overseas markets: the Trans Mountain Expansion Project (TMX) is intended to increase exports, likely to Chinese and

Indian refiners. Roughly half of Canadian gas production is exported to the United States, although, since Canada also imports gas from the United States, net exports represent less than one third of production. Export volumes have been declining for over a decade and attempts to diversify markets have provided

the rationale for developing an LNG industry. However, with Canada's first LNG export facility still under construction, market diversification has yet to be realized. At the same time, the expansion of the U.S. LNG industry is more closely linking the North American natural gas markets to global dynamics. This has the potential to increase the volatility of natural gas prices in Canada.

In Canada the factor most likely to affecting the viability of the oil and gas sector is global demand.



Canada’s exposure to global oil and gas demand downturns was painfully evident in the pandemic-related downturn in 2020, a moment that was particularly difficult for the Canadian oil and gas sector. The impact on labour was especially dire. In early 2021, not even a full year into the pandemic, the oil and gas sector had terminated over 17,000 jobs (Stanford, 2021). The unemployment rate for oil and gas workers was 16.1% in the first year of the pandemic (Melnitzer, 2022). Put simply, global demand trends play an outsized role in the sector’s economic prospects. Therefore, while domestic climate policy can affect domestic demand and provide an important signal to investors and industry alike, in Canada, the factor most likely to affect the viability of the oil and gas sector is global demand.

Table 1.1. Canadian oil and gas production, export, and import in 2021

	Production	Export	Import	Global share of production
Oil	4.7 MMb/d	3.8 MMb/d	0.7 MMb/d	7%
Natural gas	0.47 bcm/d	0.22 bcm/d	0.07 bcm/d	5%

Source: Natural Resources Canada, 2022.

1.2 Sector Decline and Federal-Provincial Jurisdiction

This report examines how declining global demand and—significantly—volatile global prices will affect Canada’s oil and gas sector and its fossil fuel-dependent provinces. Examining case studies from four jurisdictions that have faced declining fossil fuel sectors, we make the case that the federal government should take a more active role in proactively managing the decline of Canada’s oil and gas sector.

In Canada, this situation is complicated by the division of responsibilities between the federal government and the provinces. Oil and gas production and climate policy in Canada are defined in great part by shared or split federal-provincial jurisdiction. The provinces’ property rights and regulatory authority over natural resources on land, established in Canada’s Constitution Act, 1867, includes jurisdiction over exploring for, developing, selling, and managing fossil fuels on provincial lands and for enforcing penalties for provincial law violations. Canada exhibits a “highly decentralized federalism,” where environmental policy is “dominated by the provinces” (Hoberg, 1997, pp. 355, 362). Given how intensely the provinces guard their authority over natural resource development, the federal government is cautious to avoid policy interventions that could be perceived as incursions on provincial jurisdiction.

Even so, the federal government has jurisdiction in multiple areas relevant to oil and gas production and climate policy. These include entering into international treaties; regulating interprovincial and international trade and commerce; legislating interprovincial and international pollution, including toxic substances; establishing peace, order, and good government; raising



money by taxation; managing federal lands, including resource development; and managing fisheries (including inland) and migratory birds, and to some degree, their habitat, regardless of land type—federal, provincial, public, or private (Chalifour, 2016; Kwasniak, 2017).

Federal government authority on climate policy was reinforced in 2021 by the Supreme Court of Canada decision that confirmed the constitutionality of federal carbon pricing. The majority justified the decision by underscoring that the climate crisis is a matter of national concern, drawing on the Peace, Order, and Good Government clause (Constitution Act, 1867, S.91). In so doing, the Court emphasized that climate change is “a grave threat to humanity’s future”: the majority of justices stressed that it is “a threat of the highest order to the country, and indeed to the world” (Greenhouse Gas Pollution Pricing Act, 2021, I[2] and (4)(a)[167]). Moreover, the Declaratory Power (S.92(10)(c) of The Constitution Act, 1867) could allow the federal government to intervene in activities typically under provincial jurisdiction if doing so would serve the “general advantage of Canada” (Chalifour, 2016, pp. 360–363).

1.3 Lessons from the Coal Power Phase-Out

While the division of powers between federal and provincial governments in Canada is both legally and politically complex, the coal power phase-out is an example of how governments in Canada can work within their jurisdictions to create highly effective, world-leading policy change.

In this case, provinces provided the initial leadership that then made it politically possible for the federal government to implement federal phase-out regulations. Ontario began its phase-out in 2005 and closed its last coal power plant in 2014 (Harris et al., 2015). In 2015, the Alberta government announced a coal phase-out by 2030. In practice, this timeline has been accelerated, with the last coal plant slated to be closed by the end of 2024—six years ahead of schedule (Thibault et al., 2021). In 2016, the federal government followed suit and announced a federal phase-out that affected the other provinces with coal power generation: Saskatchewan, Nova Scotia, and New Brunswick. This announcement was paired with the federal Task Force on Just Transition for Canadian Coal Power Workers and Communities in 2018. In addition, federal and provincial governments provided funding to support communities’ and workers’ transitions to a low-carbon economy.

Although this shift has not ended the production of thermal coal and important steps remain to improve support for workers and communities, phasing out coal power has driven greenhouse gas emissions reductions in Canada. Moreover, Canada has leveraged its experience in phasing out coal to provide international leadership as a founding member of the Powering Past Coal Alliance.

Within a complex and politically challenging jurisdictional landscape, the phase-out of coal power provides a compelling example of federal-provincial cooperation spurring effective and rapid policy change. Thus, while the challenges of federal-provincial relations should not be underestimated, the complexities of the Canadian federation are not a reason for inaction.



1.4 Proactively Addressing the Canadian Energy Sector

Our analysis demonstrates why protecting Canadians and ensuring a healthy economy in future decades requires a more proactive approach.

Setting the Pace examines how global demand trends and increasingly volatile global markets will negatively affect Canada's oil and gas sector. We examine projections for oil and gas demand, what this means for end uses and exports of Canadian product, and the implications for Canada's economy. We then explore lessons from jurisdictions that have successfully managed to phase down fossil fuels. Finally, we propose a proactive role for the federal government to reduce risk, safeguard jobs and economic stability, and support Canadian communities by sending clear policy signals to the energy sector.

Overall, we find that the Canadian oil and gas sector is set to decline and the industry is not well positioned to weather drops in global demand. Oil and gas's historic role as one of Canada's primary economic sectors is already changing. Given demand projections, business as usual in the sector is no longer an option. To minimize the risks to dependent workers, communities, and regions, governments must take an active role in overseeing a predicted phase-down of oil and gas production and diversifying the economy.

2.0

The Climate Case for Phasing Out Oil and Gas



Summary

- The window of opportunity to limit global warming to 1.5°C is rapidly closing. The profound economic, social, and environmental costs of climate change must be accounted for when assessing the economics of transition.
- Credible scenarios show that a rapid transition off oil and gas is needed to limit warming to 1.5°C globally. From an equity perspective, wealthy countries have a responsibility to reduce oil and gas production sooner.
- Planned oil and gas production globally currently far exceeds the amount allowed within a 1.5°C-aligned pathway.
- As a large oil and gas producer and a high-capacity country, Canada should reduce its greenhouse gas emissions quickly, but efforts to do so have been undermined by growth in oil and gas production and emissions.
- The risks and economic costs associated with continued reliance on fossil fuels and prolonged production will intensify as time goes on. These risks and costs must be factored into policy decisions and signalled to investors.

2.1 A 1.5°C World: Carbon Budgets and Emissions Pathways

The current ambition to limit global warming to 1.5°C above pre-industrial levels by 2100, as set out in the Paris Agreement, is a challenge that cannot be overstated. Already we are seeing widespread and rapid changes as a result of unprecedented human influence causing over 1°C of warming globally, and scientists widely agree that 1.5°C of warming is the limit that the planet can sustain before hitting dangerous tipping points (Intergovernmental Panel on Climate Change [IPCC], 2023). New research shows that we are even closer to that 1.5°C threshold than previously thought, with a 50% chance of breaching it between 2022 and 2026 (World Meteorological Organization, 2022). The window of opportunity to mitigate emissions rapidly and equitably and to get onto a pathway aligned with limiting warming to 1.5°C globally is quickly closing. To determine this pathway, the global temperature target of 1.5°C must be translated into emissions reductions equivalents, which can be done by budgeting the remaining allowable level of greenhouse gas emissions (see Section 2.1.3).

2.1.1 The Cost of Overshooting 1.5°C

The Paris Agreement sets a global target of limiting global warming to below 2°C, pursuing efforts to not exceed 1.5°C of warming above pre-industrial levels (United Nations Framework Convention on Climate Change [UNFCCC], 2015). Since this commitment was set in 2015,



research has shown that the differences in climate impacts between 1.5°C and 2°C of warming—and every increment in between—are even more dramatic than previously thought (IPCC, 2018).

While the cost of clean technology and the reduced profits and revenues from foregoing fossil fuel development may be cited as reasons to slow the energy transition, they are dwarfed by the anticipated costs of not acting to limit climate change. The global cost of unmitigated climate change has been modeled to USD 23,000 billion by 2050 (in 2020 dollars), between 11 and 14% of global GDP (Guo et al., 2021).



In the Canadian context, models of the macroeconomic costs of climate change find that it will lead to “cascading negative effects through Canada’s economy, as climate damages slow the level of economic activity across sectors and regions, strain government budgets, lower household income, and erode competitiveness” (Sawyer, 2022, p.4). The calculated costs—which are described as only the “tip of the iceberg”—are projected to be CAD 25 billion annually in 2025, ballooning to CAD 865 billion annually by the end of the century, relative to a climate-stable scenario. The analysis also shows that either pursuing adaptation or limiting global warming could cut the cost of damages in half, while pursuing both simultaneously could cut costs by 75% (Sawyer, 2022). Another assessment from the Institute for Sustainable Finance finds that total capital lost due to climate change in Canada from 2015 to 2100 varies between CAD 2,700 billion under a 2°C scenario and CAD 5,500 billion under a 5°C warming scenario (in 2020 dollars) (Cleary & Willcott, 2022).

Beyond the impacts on GDP are the devastating social and human costs that accompany climate-related disasters such as floods and heat waves. Though not accounted for by markets, the hidden social cost of carbon in Canada is currently estimated at CAD 261 per tonne of greenhouse gas emissions (Government of Canada, 2023b).

The massive economic and social costs of climate change—costs that Canadians are already paying—underscore the importance of rapid and coordinated action to ensure that 1.5°C of warming is not exceeded. Not acting, or not acting fast enough, comes with a monumental cost that is not often considered. Though the transition will require huge investment over the course of decades, not making this investment will result in even greater financial and human losses.



2.1.2 The Global Carbon Budget Associated with 1.5°C

Despite the Paris commitment of aiming to limit warming to 1.5°C globally, the policies and pledges of nations currently far exceed this threshold. The latest Emissions Gap Report shows that, as of September 2022, Nationally Determined Contributions are leading the world toward 2.4°C to 2.6°C of warming by the end of the century (66% chance) (UN Environment Programme [UNEP], 2022).

To course-correct to a pathway in line with 1.5°C of warming, that temperature target can be translated to global and national emissions reduction goals. One tool for doing so is a carbon budget—the amount of greenhouse gas emissions that can be produced while limiting warming to a given temperature target. Analogous to understanding how much money one has in the bank and adjusting spending accordingly, using carbon budgets can help align emissions reduction commitments with global temperature targets and ensure they are divided equitably. The remaining carbon budget for limiting warming to 1.5°C from 2020 onward is approximately half of what was used in the previous 30 years (1990–2019), at 500 gigatonnes of carbon dioxide (CO₂) for a 50% probability (IPCC, 2022). In other words, most of the carbon budget to limit warming to 1.5°C has been used, with only a fraction remaining.

The division of the global carbon budget among countries remains contentious. UN Agreements dating back to 1992 include the notion of “common but differentiated responsibility,” indicating that industrialized countries that have higher rates of emissions, both historically and at present, should contribute more to mitigation (United Nations, 2015). However, there is no clear guidance on how this idea should be implemented (Gibson et al., 2019). The UN Secretary General has called on developed countries to strive for net-zero by 2040 to give emerging economies more time to transition (United Nations, 2023).

Though the transition will require huge investment over the course of decades, not making this investment will result in even greater financial and human losses.

2.2 What a 1.5°C World Means for Oil and Gas Production

2.2.1 Modelling the Decline of Oil and Gas Production to Reach 1.5°C

A finite carbon budget and global net-zero ambitions require oil and gas production to peak in the near term and then rapidly decline over the next several decades, while coal must decline immediately and most precipitously. The IEA’s Net Zero Emissions by 2050 (NZE) scenario requires “a major contraction of oil and gas production with far-reaching implications for all the companies that produce these fuels” (IEA, 2021b, p. 160). Specifically, the NZE scenario indicates that no new fossil fuel exploration or new oil or gas fields are necessary to meet the energy needs of a net-zero world.



The IEA's most recent World Energy Outlook (IEA, 2022f) includes the NZE scenario and two additional scenarios, all updated in light of the upheaval brought from the Russian invasion of Ukraine: the Stated Policies Scenario (STEPS) and the Announced Pledges Scenario (APS). The STEPS models only current energy-related climate policies and those in progress, and is consistent with 2.5°C of warming in 2100. In contrast, the APS models climate pledges made by governments as of 2021, assuming they are fully achieved by 2050, and is consistent with 1.7°C of warming in 2100. The NZE scenario, however, is aligned with less than 1.5°C of warming, with little or no overshoot.

For the first time, the World Energy Outlook 2022 found that global demand for oil and gas peaks or plateaus in all three of these scenarios (IEA, 2022f), illustrating that global markets are beginning to shift regardless of whether or not additional climate action is taken. The peak for each fuel depends on the ambition for each scenario. The NZE scenario continues to find that no new fossil fuel fields are necessary.

Despite declines in oil and gas demand, the NZE scenario describes a future with net-GDP growth, net increases in jobs, universal energy access, and improved human health—and with global warming limited to 1.5°C (IEA, 2022f). The International Renewable Energy Agency (IRENA) has a 1.5°C scenario that similarly results in improved GDP, job creation, and human welfare globally, compared to its Planned Energy Scenario (IRENA, 2022b). Thus, while it will require substantial investment and global coordination, reducing reliance on oil, gas, and coal will have inherent and compounding benefits.

2.2.2 Planned Fossil Fuel Production Globally Overshoots 1.5°C

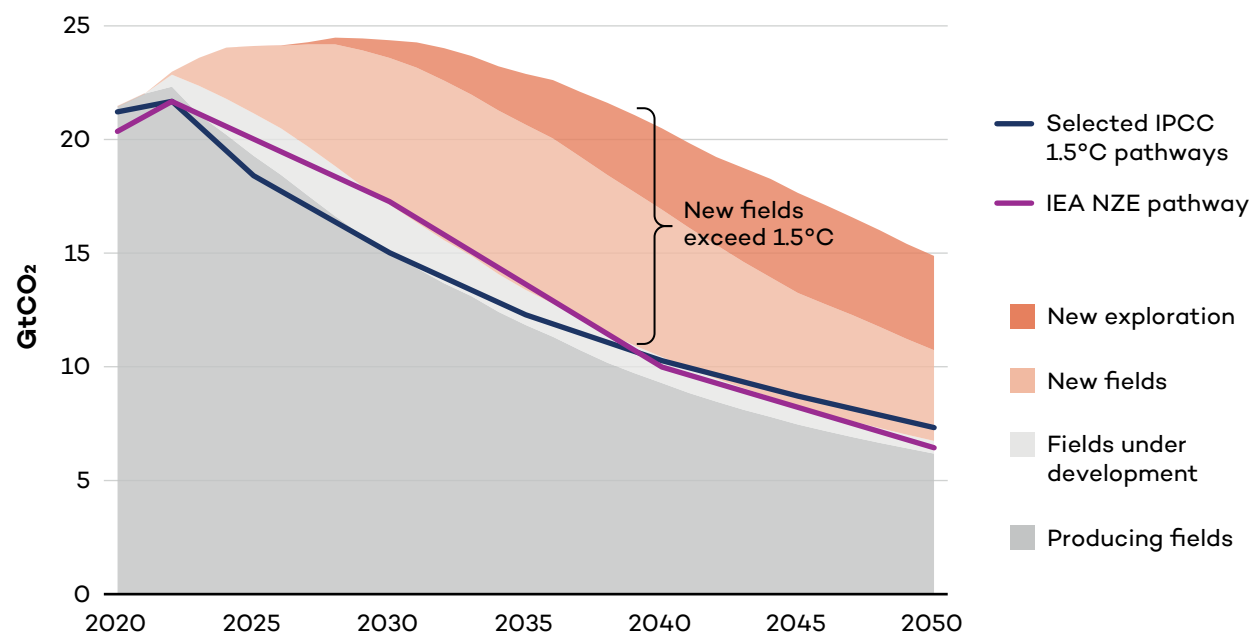
Analysis of the IEA's NZE scenario and a range of other credible 1.5°C scenarios finds that all require a rapid phase-down of oil and gas production (Bois von Kursk & Muttitt, 2022). Yet, current and planned production of fossil fuels is far out of line with the decline inherent to these scenarios. Despite increasing climate commitments, governments still plan to produce more than double the amount of fossil fuels in 2030 than 1.5°C scenarios would allow (Stockholm Environment Institute [SEI] et al., 2021).

Embodied carbon emissions in oil and gas fields currently operating and under construction exceed the entire 1.5°C carbon budget for the oil and gas sector (see Figure 2.1) (Bois von Kursk & Muttitt, 2022). In other words, in order to reach a 1.5°C target, global oil and gas production must rapidly decline.

In order to reach a 1.5°C target, global oil and gas production must rapidly decline.



Figure 2.1. Embodied emissions in global oil and gas fields compared to allowable emissions under IEA 1.5°C and selected IPCC pathways



Sources: Byers et al., 2023; IEA, 2021; Rystad Energy, 2023.

Note: Selected IPCC pathways include only those that use a feasible and sustainable amount of carbon sequestration and removal based on IPCC thresholds, as determined by Bois von Kursk et al. (2022).

From an equity perspective, as mentioned earlier, wealthy countries have a responsibility to reduce oil and gas production sooner, in order to give emerging economies more time. Calverley and Anderson (2022) argue that high-capacity oil- and gas-producing countries—those with the highest GDP per capita when oil and gas contributions are excluded from the economy—should reduce production 74% by 2030 and 100% by 2034.

Alongside considerations of global equity are those of feasibility, taking into account the scale of transition for different countries and energy systems. Current 1.5°C scenarios find that coal power must be phased out worldwide by 2030. However, energy transitions, including both ramping down existing energy supplies and scaling up alternative sources, are complex and will take decades to fully realize (Grubert & Hastings-Simon, 2022). Allowing countries that are heavily reliant on coal power more time to completely phase it out—consistent with the time that historical transitions indicate is needed for a large-scale energy transition—means that countries in the global north such as Canada need to reduce emissions even faster than they would if these feasibility considerations were ignored (Muttitt et al., 2023). A global energy transition with feasible timelines would require countries such as Canada to accept responsibility for accelerating their phase-out of oil and gas.



Unfortunately, fossil fuel reserves that are already under development (with companies having invested in their extraction) will be politically, legally, and economically difficult to leave undeveloped (IEA, 2022f; Oil Change International, 2019). The challenges of reorienting development away from fossil fuels is illustrated by the reality that countries that have made net-zero pledges have not, as a result, seen a reduction in fossil fuel investment (IEA, 2022f). And public investments are trending in the wrong direction; since the beginning of the pandemic, G20 governments have directed more public money to fossil fuels than to clean energy (SEI et al., 2021).

The failure to reorient public support and private investment away from fossil fuels has economic implications. If the nations of the world are successful in moving to a net-zero trajectory, the IEA anticipates “significant stranded capital and stranded value” (IEA, 2021b). Thus, planning for a wind-down of fossil fuel industries is necessary to prevent the worst impacts of climate change and to limit economic losses and social and economic disruption, especially in producer nations.

2.2.3 The War in Ukraine Has Accelerated the Energy Transition

The Russian invasion of Ukraine caused sky-high energy prices and led to serious concerns about gas supply shortages in Europe. While fossil fuel-producing nations and companies have made the case for ramping up investment to fill the gap (Yedlin, 2022), expanding oil and gas development remains incompatible with net-zero commitments (IEA, 2022f). Further, new oil and gas infrastructure would take years to come online, negating any potential short-term benefits for Europe and increasing the far-reaching climate and economic costs of further entrenching fossil fuel production. This approach would increase the risk of stranded assets and make the energy transition more costly, difficult, and disruptive. As the Director of the IEA recently wrote, “nobody should imagine that Russia’s invasion can justify a wave of new large-scale fossil fuel infrastructure in a world that wants to limit global warming to 1.5°C” (Birol, 2022).

Volatile fuel prices and energy security concerns have accelerated investment in clean energy technology and added momentum to the energy transition in Europe and beyond. The IEA now projects 2,400 GW of new renewable capacity being built between 2022 and 2027, 30% more than its 2021 projection (IEA, 2022f), despite increasing short-term demand for oil, gas, and coal. In fact, the IEA anticipates that renewables will become the largest source of global electricity generation in 2025 (IEA, 2022e). This shift is most extreme in the European Union, where the response to high prices and limited supply has been to double down on climate commitments and speed up a structural transition away from gas. The Inflation Reduction Act (IRA) in the United States has also accelerated clean energy and climate investments. In other markets, high prices and energy security concerns have lowered expectations for gas demand. These dynamics are explored in the chapters that follow.



2.3 Canada's Climate Policy and Fair Share of Oil and Gas Production Cuts

Despite a small population, Canada has among the highest greenhouse gas emissions per capita in the world, and ranks in the top 10 countries in terms of absolute greenhouse gas emissions as of 2019 (Environment and Climate Change Canada, 2022b). Both measures are trending downward, but Canada continues to trail its peers on policy and actions to reduce emissions (Climate Action Tracker, 2023).

2.3.1 The Gap Between Canada's Climate Policy and 1.5°C Pathways

The Canadian government has ramped up climate policies and commitments in recent years in an effort to curb domestic emissions. Policies include a national price on carbon ratcheting up to CAD 170 per tonne by 2030, climate accountability legislation that enshrines a mid-century net-zero target, and various measures set out in the 2022 Emissions Reduction Plan (Environment and Climate Change Canada, 2022a). Canada has also begun acting on its international commitments on just transition, creating a task force to support affected coal workers and and tabling of The Canadian Sustainable Jobs Act in June 2023. The federal government has also created targeted policies focused on reducing emissions in the oil and gas sector, including methane regulations, a proposed cap on emissions from the sector, and support for carbon capture and storage (CCS).



Delegates huddle during the contact group on the Global Stocktake at Bonn Climate Change Conference, June 2022. (Photo: Kiara Worth/IISD-ENB)

Provincial and territorial governments in Canada also have an important role to play in climate and energy policy-making, particularly given their jurisdiction over natural resources. A review of provincial and territorial climate policies found that most jurisdictions have not yet taken action to align their emissions reductions with net-zero targets, and 50% of national emissions are not covered by a subnational emissions target (Dusyk et al., 2021). However, some provinces have demonstrated strong leadership. Quebec, one of Canada's largest provinces, joined the Beyond Oil and Gas Alliance in 2021 and the following year became the first government in the world to explicitly ban all oil and gas development in its territory and mandate the shutdown of existing drill sites within three years (National Assembly of Quebec, 2022).



However, despite Quebec's leadership and the increasing ambition of federal climate policy, national emissions are not declining as fast as is needed to meet Canada's commitments, in part because emissions reductions have been outpaced by growth in the oil and gas sector. In 2021, the extraction, refining, and transport of oil and gas were responsible for 28% of total emissions in Canada, with the sector's absolute emissions growing 11.1% between 2005 and 2021 (Environment and Climate Change Canada, 2023).

2.3.2 Canada's Carbon Budget and Fair Share of Production Cuts

Canada's Nationally Determined Contributions under the Paris Agreement are to reduce greenhouse gas emissions 40% to 45% below 2005 levels by 2030 and reach net-zero by 2050. These targets, however, are not linked to an equitable carbon budget and do not account for the emissions embodied in oil and gas exports. Calculating Canada's remaining carbon budget by taking a cumulative per capita approach that considers historical emissions and economic capability finds that Canada has already gone over its fair share and is in "climate debt" to other countries (Gibson et al., 2019). In other words, Canada has no carbon left to spend. The Climate Equity Reference Project finds that Canada's fair share would require reductions of 123% to 138% below 2013 levels by 2030 (Holz et al., 2018), and the Climate Action Network similarly argues that a fair share would be 140% below 2005 levels by 2030 (Climate Action Network Canada, 2019). Meeting these targets would require Canada to rapidly scale up domestic decarbonization and carbon sequestration efforts, scale down oil and gas production, and subsidize greenhouse gas emissions reduction efforts in other countries.

Aligning Canadian oil and gas production with limiting warming to 1.5°C, based on IEA's NZE scenario, means that no new oil and gas fields can be developed. Limiting production to fields already producing or under development would lead to a decline in outputs in line with the field's natural decline rates. If no new oil and gas fields were developed, Canadian production would peak at about 60 billion barrels of oil and gas in 2023 before decreasing by about 20% by 2030 and 70% by 2050 (Rystad Energy, 2023).

A global energy transition with feasible timelines would require countries like Canada to accept responsibility for accelerating their phase-out of oil and gas.

2.4 Conclusion

There is a clear climate and economic case for guiding the phase-down of oil and gas production. Limiting climate change necessitates staying within a global carbon budget, which in turn requires limiting oil and gas production and use. Furthermore, the risks and costs associated with continued reliance on fossil fuels will intensify as time goes on, and these risks and costs must be factored into policy decisions. Ramping down the production and use of fossil fuels will take



several decades, so beginning now—and importantly, signalling the trajectory of the oil and gas sector—is crucial to reducing future risk.

Despite this clear need, most governments in Canada have yet to create a policy environment or send market signals that match a net-zero trajectory for the sector or address the reality that the global move away from oil and gas has already begun. To lay the groundwork for that effort, the following chapters explore the global markets for oil and gas in more detail and the implications for Canada. However, it is worth noting that markets do not yet adequately reflect the economic or social costs of climate change. Therefore, while the economic implications of declining oil and gas markets are discussed below, governments should not lose sight of the full cost-benefit equation of continuing to rely on oil and gas. This equation includes potentially hundreds of billions of dollars in annual economic losses that Canadians will pay if we fail to mitigate climate change.

3.0

Outlook for Oil



Summary:

- By around 2030, global demand for oil will peak and decline, driven mostly but not only by the electrification of transport—by far the biggest end use of oil.
- Plastics—the next biggest end use—will be a more durable source of oil demand in the near term, but not in the long term, and not enough to stop overall demand destruction.
- Canadian producers cannot count on ESG credentials as a means to preserve markets. Canadian customers—primarily Midwest U.S. refiners that are locked into using Canadian crude—are not interested in how the crude was produced.
- Shrinking global demand will stress OPEC+ discipline, leading to low oil prices, and may induce Canada’s global competitors to accelerate selling off reserves that will be worth less over time.
- The final result will likely be oil prices that are increasingly volatile and trending low, to which Canadian producers are vulnerable.

Global oil markets, cyclical by nature, have been on a veritable roller coaster the last few years. The COVID-19 pandemic rattled global demand, and a differing approach between the top two oil producers about how to respond briefly sent West Texas Intermediate prices negative in 2020. As demand recovered in 2022 and sanctions on Russia disrupted the market, low upstream investment meant oil companies pulled in record profits as prices surged to over USD 120 per barrel (Brent price). In early 2023, prices cooled considerably, but tight supply and high profits are still the short-term forecast (IEA, 2023b).

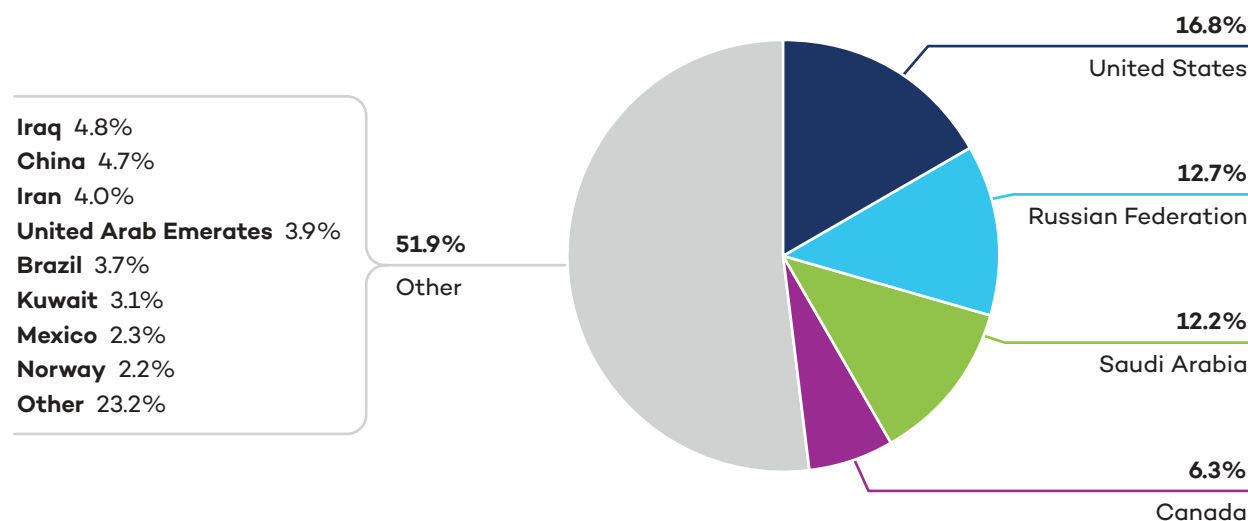
This chapter looks beyond that bright short-term outlook to explore the health of oil markets in the longer term, and particularly how governments’ climate policies and the advent of low-carbon technologies will affect global demand.

3.1 Global Oil Production and Pricing

Almost half of global oil production is concentrated in four countries (see Figure 3.1): the United States (17%), Russia (13%), Saudi Arabia (12%), and Canada (6%).



Figure 3.1. Global oil production shares by country (2021)



Source: BP, 2022.

Oil prices are set by global markets; however, transport costs and differing grades of oil result in several recognized benchmark prices.

Thirteen of the world’s major oil producers (not including Canada) coordinate via the Organization of the Petroleum Exporting Countries (OPEC), formed in 1960 with the intent of managing global supply and prices to the benefit of the membership.¹ In 2021, OPEC accounted for over 35% of total global production. Since the late 2010s, the organization has included non-OPEC countries to increase their influence. The resulting group, informally known as OPEC+, includes 11 other countries, notably Russia and Mexico, and accounts for more than 55% of global supply. This group’s agreements on supply significantly affect global prices, as do its disagreements. Most recently, disagreement between Russia and Saudi Arabia about how to respond to pandemic-related demand drops led to the oil price crash of 2020 (Stocker et al., 2018).

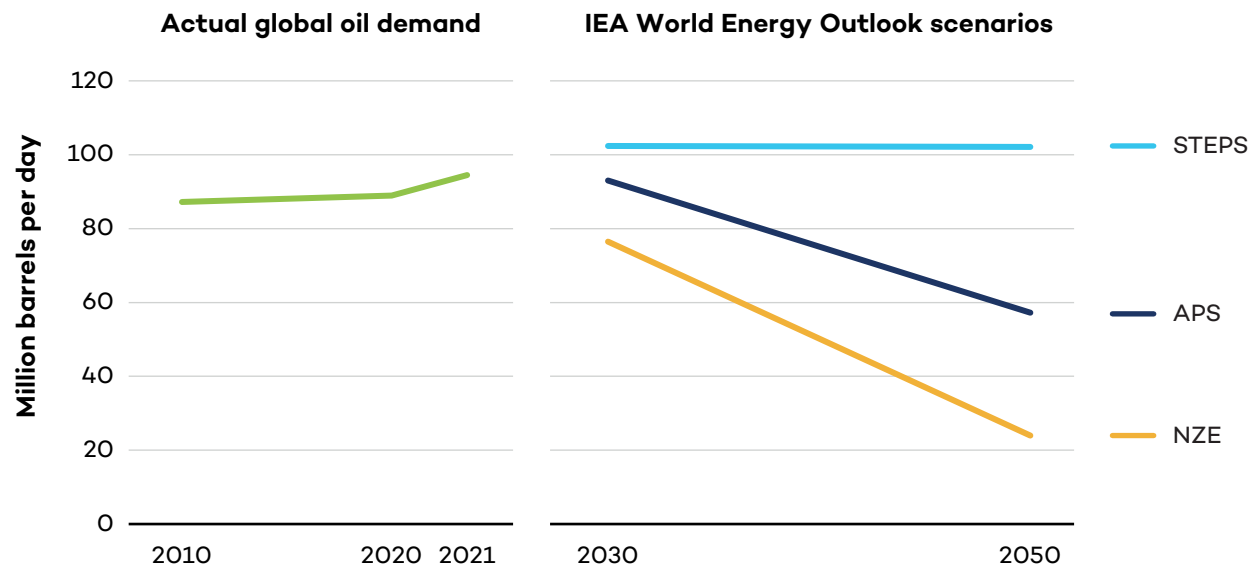
3.2 Global End Uses and Projections: Demand to Peak by 2030

All major credible analysts agree that global demand for oil will peak within the next 10 years, with most putting the peak at or around 2030 (BP, 2023; DNV, 2022; IEA, 2022f; McKinsey, 2022; Rystad Energy, 2022). All three scenarios in the IEA’s World Energy Outlook concur (Figure 3.2; IEA, 2022f). This timeline is only accelerating in the face of recent spikes in oil prices and intensifying global action on climate change.

¹ The member states as of 2023 are, in order of share of oil production: Saudi Arabia, Iraq, Iran, United Arab Emirates, Kuwait, Nigeria, Libya, Algeria, Angola, Venezuela, Republic of Congo, Gabon, and Equatorial Guinea.



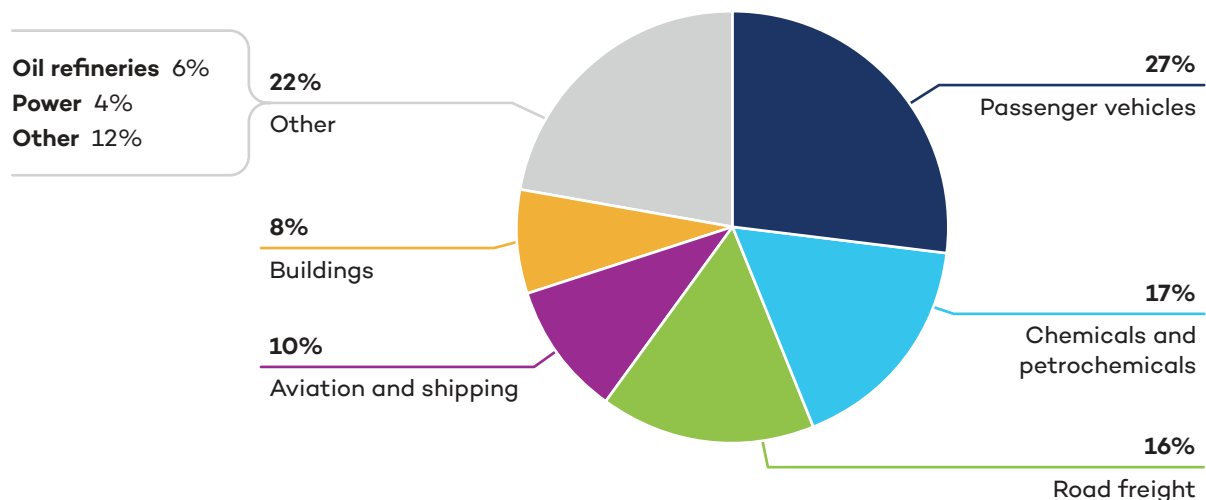
Figure 3.2. World Economic Outlook 2022 global oil demand



Source: IEA, 2022f.

The coming peak and decline in global oil demand is driven by the trends in how oil is used. As shown in Figure 3.3, 43% of oil demand came from the road transport sector in 2021. The next largest component was industry and petrochemicals—mainly plastics production—at 23%. Almost equal shares went to buildings and power, and aviation and shipping, at 12% and 10%, respectively.

Figure 3.3. Global demand for oil (2021)



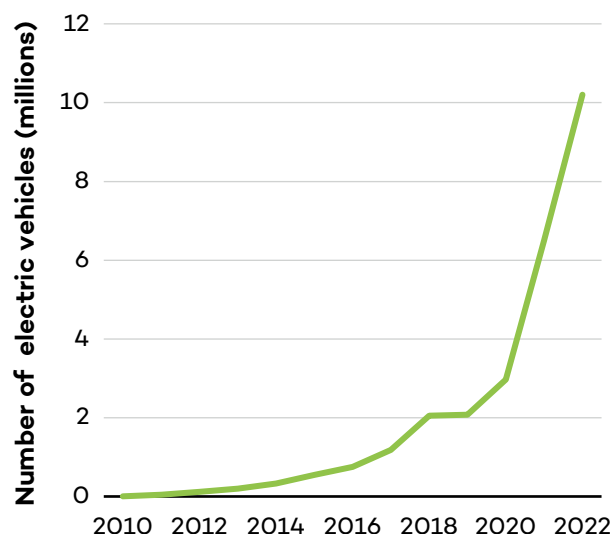
Source: Based on IEA, 2022f.



3.2.1 Road Transport

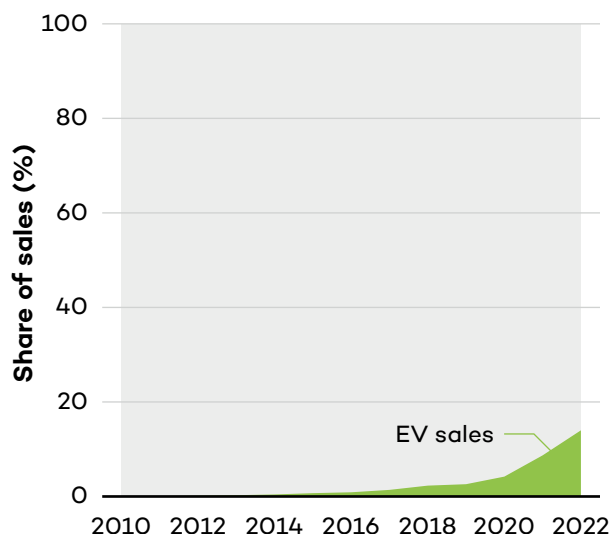
In road transport, Figures 3.4 and 3.5 show accelerating trends in favour of electrification, as shown by electric vehicle (EV) sales.

Figure 3.4. Global EV sales (light-duty vehicles)



Source: IEA, 2022b.

Figure 3.5. Global EV sales share (light-duty vehicles)



Source: IEA, 2022b.

In part, increased EV investment and sales are being driven by government policy. Governments covering 25% of the global market have announced 100% EV sales mandates for 2035, and EV-related subsidies doubled in 2021 to nearly USD 30 billion (IEA, 2022b). But consumer demand is increasingly also a factor, as trends in price, range, model choice, charging infrastructure, and familiarity all push toward increased uptake (IEA, 2022b). According to BloombergNEF, “The market is shifting from being driven primarily by policy, to one where organic consumer demand is the most important factor. As regulatory drivers begin to play less of a role, consumer adoption dynamics—the ‘S-curve’—take over” (2022, slide 2). The S-curve describes the uptake of new technology that eventually takes off not in a linear fashion but exponentially, with sudden and overwhelming effects (Foster, 1986).

Trends suggest that light-duty vehicle and truck sales are tracking toward the IEA’s NZE scenario, which requires that 64% of new passenger car sales and 5% of new truck sales be electric by 2030 (IEA, 2021b). Electric vehicles exceeded 13% of global passenger vehicle sales in the first half of 2022, a 50% jump from 2021’s 8.7% share (Bloomberg Professional Services, 2022). In China, the world’s biggest market for four-wheeled vehicles, 26% of all new passenger vehicle sales were EVs in July 2022, more than double the rate from the previous year (Bloomberg News, 2022).



For commercial users of medium-duty trucks on urban duty cycles, electric options are already the cheapest and face few infrastructure challenges (BloombergNEF, 2022). The outlook for uptake in heavy-duty vehicles is not as optimistic in the near term, with a key obstacle being the need for large investments in highway charging infrastructure. However, policy and technological developments for heavy-duty vehicles are accelerating, with China as an important early adopter (IEA, 2022b).



3.2.2 Industry and Petrochemicals

In the industry and petrochemicals sector, policies aimed at reducing plastic pollution constrain demand more than climate policies. In many parts of the world, oil is a raw material used to make plastics, which accounts for 63% of this sector's use of oil.

Analysts such as the IEA see increased plastics demand as the most consistent future demand for oil; in IEA scenarios, oil demand does not change much between now and 2050 (IEA, 2022f). This is based on assumptions that developing countries will catch up with Organisation for Economic Co-operation and Development (OECD) rates of plastic consumption as their economies grow (Cetinkaya et al., 2018; Nduagu et al., 2018). Other analysts, by contrast, argue that developing countries' plastic uptake will not mirror historical patterns in developed countries (McKinsey, 2022).

In the medium term, the demand for plastics will be undone by the steadily growing body of science testifying to the microplastic pollution crisis, particularly but not only in oceans (Hossain et al., 2021; Mukheed & Khan, 2020; Shen et al., 2020). Growing momentum is focusing on regulatory policies to reduce plastic use more broadly and accelerate recycling. For example, a new multilateral environmental agreement on plastics is progressing quickly (Earth Negotiations Bulletin, 2022). The resulting multilateral agreement is expected to facilitate national commitments and actions in the same way that the UNFCCC and its Paris Agreement do for climate change. Critically, the scope of these talks includes the entire life cycle of plastics, including production restrictions.



Tanya Plibersek, Minister for the Environment and Water, Australia, co-chairs the interactive dialogue on managing, protecting, conserving and restoring marine and coastal ecosystems. (Photo: Kiara Worth/IISD-ENB)

The demand for plastics will be undone by the steadily growing body of science testifying to the microplastic pollution crisis.



Although much depends on global action to limit plastic use, petrochemicals are the one end use for oil with growth potential. However, this trend will not be substantial enough to change the overall trend: oil demand will still decline, though slightly more slowly (Cosbey, 2022b).



3.2.3 Aviation and Shipping

In aviation and shipping, low-carbon policies and technologies are not as advanced as in other sectors. However, policy responses are beginning to take shape. In 2021, a flurry of net-zero pledges were announced by major global airline carriers and associations (Graver et al., 2022). In the same year, 28 states signed on to the International Aviation Climate Ambition Coalition (United Kingdom, 2021), committing to a pathway consistent with the Paris Agreement 1.5°C target, and the U.S. Federal Aviation Authority (2021) committed to reaching net-zero emissions by 2050. Proposed mandates such as ReFuel EU (European Commission, 2021b) and the United Kingdom’s Jet Zero Consultation (United Kingdom, 2022) will drive lower cost and greater uptake of sustainable aviation fuel, which will eventually anchor emissions reductions in long-haul flights (The Economist, 2022b). For short-haul flights, alternatives have advanced enough that Sweden and Denmark have announced that all domestic flights will be fossil fuel-free by 2030, with Norway aiming for 2040 (Frost, 2022).

While the shipping sector is unlikely to contribute significantly to oil demand’s decline before 2030, a 2022 revision to the International Convention for the Prevention of Pollution from Ships requires all ships to meet annual carbon intensity targets—a measure that could cut the sector’s emissions 11% from 2019 levels by 2026 if all ships complied (Brooks & Adler, 2021). There are also legislative proposals in the United States to mandate low carbon intensity for ships docking at U.S. ports (Clean Shipping Act of 2022). Beyond regulation, customer demand and the rise of ESG finance are also factors driving the decarbonization of the shipping sector (Jameson et al., 2021).



3.2.4 Buildings and Power

In most cases, cheaper and cleaner alternatives to oil already exist to generate heat and electricity (IRENA, 2021; Kelly et al., 2016), and even the IEA’s most conservative scenario (STEPS) shows demand for both uses falling by 2030.

By 2030, STEPS shows oil demand in the building and power sectors dropping a combined 2.5 million barrels per day (MMb/d) from 2021’s global demand of 11.2 MMb/d. The decline is even more significant in the IEA’s more ambitious scenarios: 3.1 MMb/d in the APS and 5.0 MMb/d in the NZE scenario (IEA, 2022f).

Like the impacts of transport electrification, these small but significant reductions in global demand would manifest in the near term—that is, by 2030.



3.2.5 Global Demand Will Be in Decline by 2030

Comparing the IEA's scenarios against observed trends suggests global demand for oil will peak before 2030 and then decline. Near-term decreased demand for oil will be driven primarily by the electrification of passenger vehicles, which currently account for 27% of global demand. Trends in climate policies, technological improvements, and consumer behaviour suggest demand reduction in line with the IEA's NZE scenario for that segment of demand. Trends for commercial road transport are probably more likely to cleave to the more conservative, but still ambitious, APS scenario.

Overall, the data suggest that structural changes in passenger vehicles, and trends in power generation and heating of buildings, will lead to a peak in global oil demand by the end of this decade. Post-2030, this shift will be compounded by reduced oil demand for other key uses. Plastics—the next biggest end use—will be a more durable source of oil demand in the near term, but not in the long term, and not enough to stop overall demand destruction.

3.3 Oil Production in Canada

Oil producers in Canada reported record profits in 2022 on the strength of tight global supplies, sanctions on Russian exports, and post-COVID demand recovery (Gorski & El-Aini, 2022). This cycle, however, seems different from others, and some analysts

predict this will be the last of the Canadian oil sector's booms (Fawcett, 2021; Webster et al., 2021). Indicators of confidence in the future of the sector, such as investment, well counts, and exploration capital expenditure, are all recovering weakly, below or barely above 2019 levels despite the record sales and profits.

Indicators of confidence in the future of the sector are all recovering weakly, below or barely above 2019 levels, despite the record sales and profits.

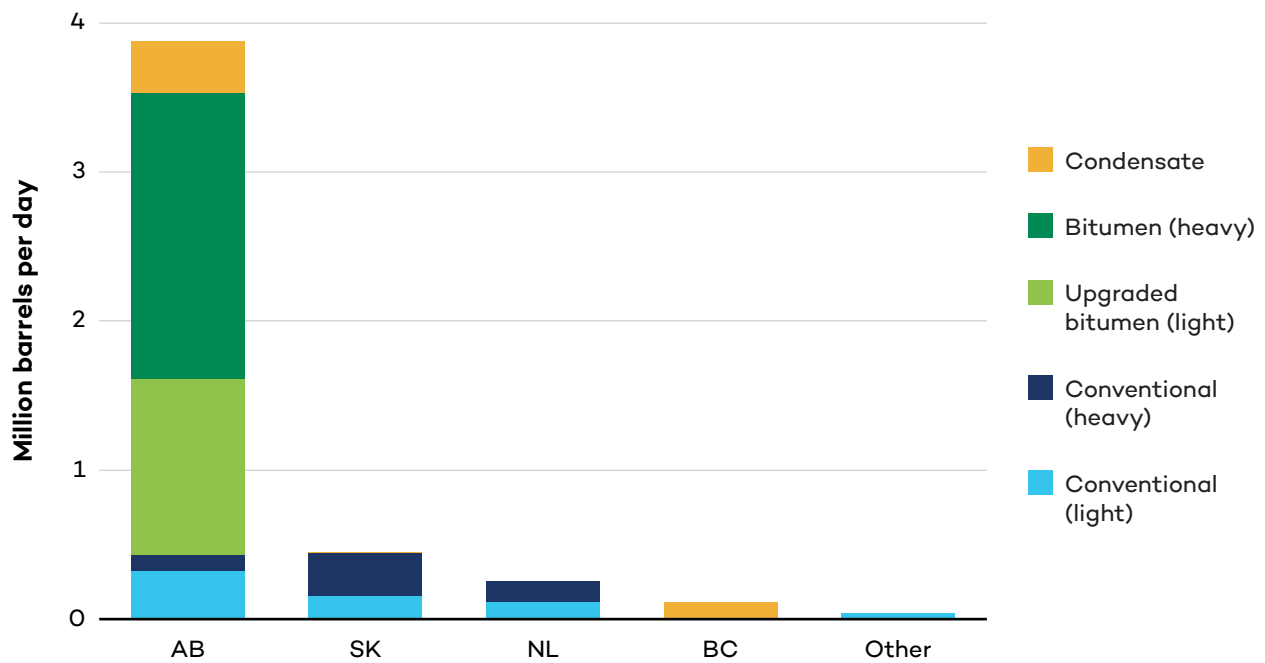
3.3.1 A Survey of Existing Canadian Oil Production

Figure 3.6 shows that most of Canada's crude oil (82% in 2021) is produced in Alberta. Saskatchewan produces 9.4% and Newfoundland and Labrador produces 5.4%. Most of Canada's production is heavy oil from oil sands, almost all of which comes from Alberta. Bitumen (heavy oil, almost solid at room temperature) and upgraded bitumen make up 65.4% of national production and 80% of Alberta's output.

Oil sands production is primarily of two sorts: in situ and mining. The latter involves surface mining (down to a depth of 75 m) a mixture of bitumen, sand, and water. About 20% of Alberta's oil sands are shallow enough to be mined in this way. At present, mining accounts for about half of total oil sands production, but that percentage is steadily falling, with in situ production taking an increasing share.



Figure 3.6. Survey of Canadian oil production



Source: Canada Energy Regulator, 2022b.

Most in situ production is now done by steam-assisted gravity drainage (SAGD), which involves forcing high-pressure steam via an injection well into an underground deposit to cause the bitumen to flow to a producing well, from which it is pumped up. Table 3.1 shows the supply costs to the field gate of a hypothetical oil sands operation, given typical costs. While SAGD is cheaper to produce on a life-cycle basis, mining has much lower operating costs, so once the high upfront investment in a mining operation is paid off, per barrel costs tend to be lower than those of a high-operating-cost SAGD operation.



Oil rig off the coast of Newfoundland. (Photo: iStock)



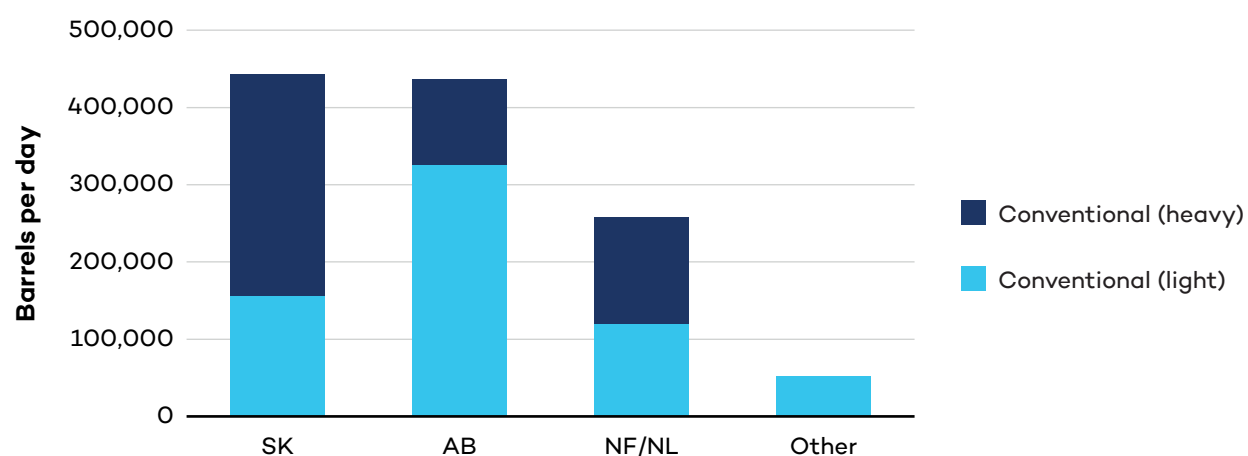
Table 3.1. Field gate oil sands supply costs, 2012–2019 (2020 USD/barrel)

	2012	2013	2014	2015	2016	2017	2018	2019
SAGD	51.07	54.94	55.12	58.11	–	36.64	36.18	32.16
SAGD expansion	–	–	–	–	–	–	23.20	21.86
Stand-alone mining	69.67	78.88	77.77	69.54	–	59.29	–	–

Sources: Canadian Energy Research Institute Canadian Oil Sands Supply Costs and Development Projects, various years; Statistics Canada Table 18-10-0005-01 (Consumer Price Index, annual average, not seasonally adjusted). Costs assume 10 percent real return on investment. USD-CAD exchange rates from OFX (n.d.).

Roughly a third of Canada’s oil production is conventional oil, which is accessed by the traditional method of drilling wells and pumping out product. Figure 3.7 shows that most of this oil comes from Alberta and Saskatchewan, followed by Newfoundland and Labrador. Production in Newfoundland and Labrador is entirely offshore, from four separate developments in the Jeanne d’Arc Basin: Hibernia (99,000 b/d); Hebron (139,000 b/d); White Rose/North Amethyst (20,000 b/d) and Terra Nova (not currently in production, but able to produce 29,000 b/d). All of that production is shipped to domestic and international refineries; Newfoundland’s only refinery closed in 2020.

Figure 3.7. Conventional crude oil production in Canada (2020)



Source: Canada Energy Regulator, 2022b.

Newfoundland and Labrador may account for significant additions to this mix within the decade. The West White Rose project is slated to come online in 2026, eventually reaching production of 75,000 bpd, and exploration permits show keen interest beyond the Jeanne d’Arc Basin. A final

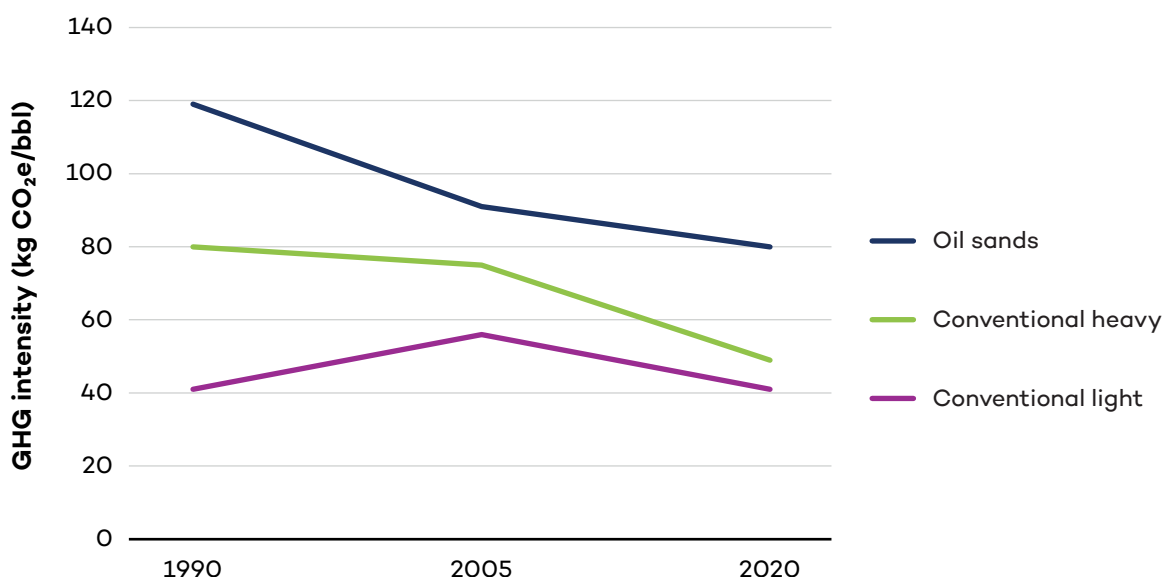


investment decision is expected soon on the Bay du Nord project in the Flemish Basin, a project capable of producing up to 188,000 b/d.

3.3.2 Emissions Intensity of Canadian Oil Production

The different types of oil produced in Canada have very different upstream emissions intensities. Figure 3.8 shows that oil sands production in 2020 was roughly twice as greenhouse gas (GHG)-intense on average as the production of conventional light crude, and almost 60% more GHG-intense on average than the production of conventional heavy crude.

Figure 3.8. GHG intensity of Canadian crude oil production



Source: Government of Canada, 2022.

Within oil sand production, the different production methods have different GHG emissions profiles. Table 3.2 shows that mining tends to be significantly less GHG-intense than SAGD.² Mined synthetic crude oil appears to be more GHG-intense than both other methods, but only because it involves upgrading from heavy to light crude oil, and the emissions of the upgrading process are included in the calculation, whereas they are not for the other types of crude shown here. Cyclic steam stimulation, an alternative to SAGD as an in situ production method, is the most GHG-intense.

If all new drilling and mining projects stopped tomorrow in Canada, production would not stay at current levels, but would decline. Conventional wells have significant rates of decline in early

² Note that there is a slight difference between the GHG intensity of oil sands production in Figure 3.6 and Table 3.2, accounted for by different boundary assumptions and methodologies.



years, slowing with age. The weighted average decline predicted for new Alberta crude oil wells in 2022 starts at 46% in the first year of operation, winding down to 8% by year 10 (Alberta Energy Regulator, 2022c). Across all operations and life cycles, global decline rates for oil fields—the “natural” decline rate—average 8% per year (IEA, 2018). Alberta’s oil sands mining operations are not subject to decline in the same way as wells, and they can more or less maintain steady production levels until their reserves are significantly depleted.

Table 3.2. GHG intensity of oil sands by technology (kg CO₂e/barrel)

Technology	Average 2018 GHG intensity
Mined dilbit	40
SAGD dilbit	65
Mined synthetic crude oil	89
Cyclic steam stimulation dilbit	109
Weighted average	72

Source: Birn & Crawford, 2020.

Note: These figures are for a system boundary that includes crude production and initial processing, as well as upstream production of diluent and natural gas used in production, and net electricity imports (per the standard HIS Markit methodology).

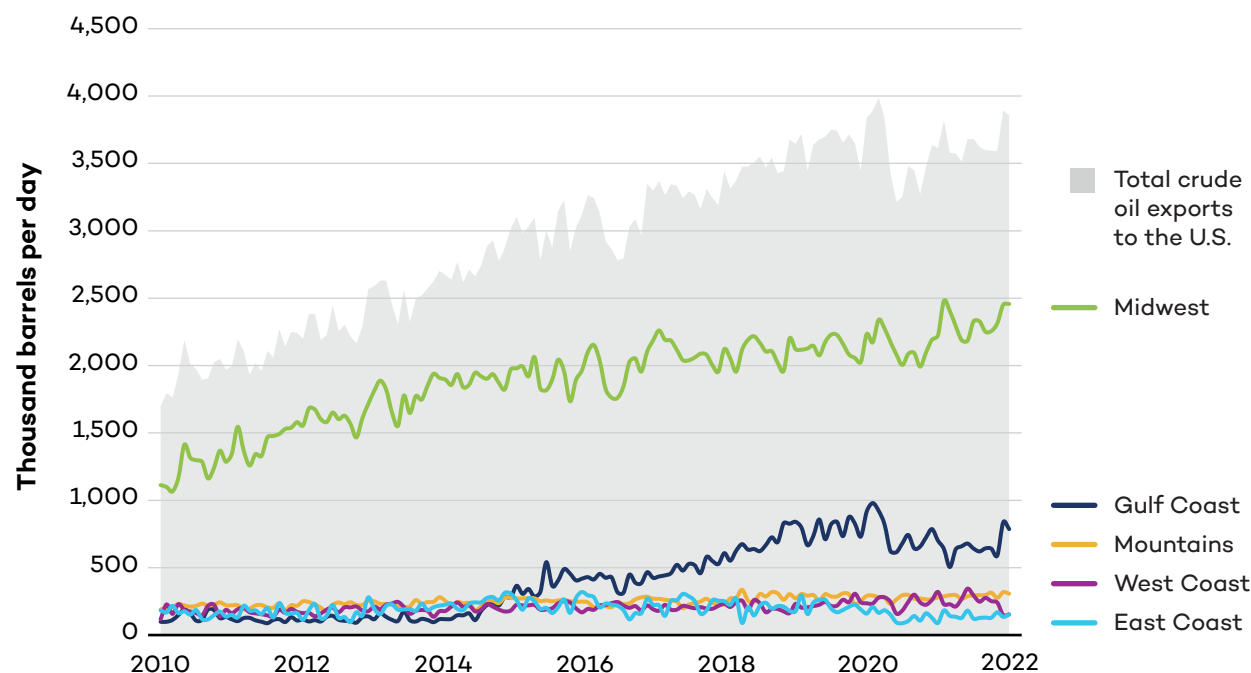
3.3.3 Canada’s Export Patterns and Infrastructure

In 2021, Canada exported 3.3 mbpd of crude oil, or 80% of domestic production (Canada Energy Regulator, 2022a; UN Comtrade, 2021). Over 94% of those exports went to the United States, and 80% were in the form of heavy crude of the type produced in Western Canada’s oil sands (Canada Energy Regulator, 2022a).

Figure 3.9 shows where those exports went: overwhelmingly to Midwest refiners in Illinois and Minnesota (primarily through the Enbridge mainline and Keystone pipeline systems), but increasingly also to the Gulf Coast refiners as U.S. pipeline reversals and transport by rail have increased Canadian producers’ ability to reach them.



Figure 3.9. U.S. destinations for Canadian crude exports



Source: Canada Energy Regulator, 2022a.

Several major Midwest refineries and some Gulf Coast refineries are deliberately set up to refine oil sands–type heavy crude. Many in the Midwest have made recent multi-billion-dollar investments in capacity specifically designed to do so (Hydrocarbons Technology, n.d.; Tippee, 2021). For the Midwest refineries, Canada is the only viable source of crude feedstock; they do not have tidewater access to imports (or exports). Gulf Coast refiners can import crude by tanker, but other global sources of heavy crude—primarily Mexico and Venezuela—have dropped to almost negligible levels of production, so Canada is a critically important source (Babb, 2016; Eaton, 2019).

A small but increasing amount of Canadian crude currently finds its way to markets beyond the United States through the Gulf Coast in flows that reached almost 300,000 b/d in 2021 (Kelly & Williams, 2022). The Trans Mountain Expansion Project (TMX) extending the pipeline to the Canadian west coast would,



Construction of Trans Mountain Pipeline in Edmonton, Alberta. (Photo: iStock)



if completed, add another 600,000 b/d of shipped export capacity, much of which would go to Chinese and Indian refiners (based on current exports) (Bloomberg News, 2023). Those two outlets combined would mean that 27% of exports would go beyond the United States (assuming that none of TMX's product shipped to California, which it probably would).³

3.4 The Outlook for Canadian Oil Is Poor

By itself, the fact that global oil demand will decline tells us very little about the fortunes of Canadian oil producers. Mature oil sands producers in particular, with low breakeven costs and no rate of decline, may fill a significant part of a shrinking total demand (Fellows, 2022). Whether that scenario is credible, or more broadly what happens to Canadian producers in a shrinking market, depends in large part on the answers to three questions:

- Can Canadian producers win markets with our ESG credentials?
- Can Canadian producers win markets on price?
- What can Canada expect from its global competitors?

Canadian producers will not be able to count on their reputation as clean or ethical producers to preserve market share.

3.4.1 Canadian Producers Cannot Win Markets with ESG Credentials

If Canada were vying to compete in a shrinking global market, would it matter how our oil was produced? Would GHG intensity matter, for example, or would it matter whether our oil was considered ethical or produced to high ESG standards? The short answer is: probably not.

When Canadian oil is finally sold in refined form at the pumps, it is indistinguishable from other gasoline, and tracking the source at the retail level would be practically impossible. But the original customers are mostly U.S. refiners, as detailed above, who depend on the supply of heavy Canadian crude, and whose focus is quantity, quality, and price—not ESG. Our growing exports from the Gulf Coast, and potential exports via the TMX, would probably go to Asia, where they would be used in Chinese petrochemical production, among others. Some might also go to California, which has a low-carbon fuel standard in place that would reward any low-GHG Canadian crude. But in the foreseeable future there is little political chance that such a mandate could apply to Midwest and Gulf Coast refiners, as it would increase their costs and the costs of gasoline to U.S. drivers. Absent such a mandate, buyers of Canadian crude are unlikely to care about production methods. ESG considerations clearly matter a great deal to oil sector *investors* (Flavelle, 2020; Graney, 2021), but they do not preoccupy most *customers*.

³ This percentage is based on 2021 levels of export. Note that it might be that not all the extra capacity is used to transport crude for export. Some may be taken up with refined products destined for BC's Lower Mainland—products that currently have to use rail, truck, and barge (Fellows, 2002).



3.4.2 Canadian Producers Cannot Win Markets on Price

Most of Canada's crude oil exports do not sell directly into global markets beyond the United States, though increasing exports from the U.S. Gulf Coast do, and substantially more could with the completion of TMX. In addition, Canadian crude does not compete directly with the lighter, sweeter (i.e., lower-sulfur) crude produced in most other countries. Nonetheless, the markets for crude oil are all ultimately global; even our exports to landlocked Midwest refiners are ultimately competing with imports at U.S. Gulf Coast refineries. As such, our costs of production relative to our major competitors still matter in the long run, especially in a shrinking post-peak global market.

While costs of production have come down dramatically in Canada over the last 20 years, and Canadian producers are competitive with U.S., Russian, and Chinese supply, weighted average breakeven costs in Canada are still two to three times higher than the five largest Middle Eastern producing nations, and total proved reserves in those countries are almost four times higher than Canada's (Cosbey, 2022a).

Weighted averages, though, cover up a wide diversity of cost structures. Some existing oil sands producers, particularly mining operations, have very low breakeven prices. For example, Canadian Natural Resources Limited's Horizon phase-1 open pit mine, operating since 2009 and with remaining reserves of almost 2 billion barrels of oil, has a breakeven price below USD 25 per barrel (bbl) (Rystad Energy, 2023).

Moreover, oil sands producers have low operating costs and do not experience decline the way conventional producers do. As long as they cover operating and sustaining capital costs, they will keep producing. For most of them, that means maintaining production even at prices as low as USD 45 per barrel (West Texas Intermediate, or WTI) (Fellows, 2022). By contrast, conventional oil producers have high operating costs and must invest continuously to maintain production in the face of decline, meaning they are not as willing to maintain production in low-price environments.

So yes, low-cost oil sands producers may be able to compete on price in a demand-constrained world. But that scenario has a few downsides. Canadian conventional producers (more than a third of Canadian production) would not fare as well, given the significant reserves and production in the Middle East that would still be profitable long after Canadian conventional production was not. A small number of higher-cost oil sands producers would also be vulnerable. Importantly, profits, and thus royalties, would follow prices down. And in such a future, any new production with associated capital costs would have to be very low-cost to compete. Almost all plans for new investment in productive capacity in Canada are for incremental expansions that will use existing processing facilities, or for process optimization at existing sites (Rystad Energy, 2020).



3.4.3 Canada Cannot Rely on Predictability from Global Competitors

In the face of lower returns driven by climate policy, some analysts have predicted a dynamic known as the green paradox, where producers predict that their reserves will be worth less in the future and therefore rush to extract and sell more of them in the present (Sinn, 2012). This scenario would mean lower prices for all (and more consumption of cheap oil—thus the paradox). Others have criticized this theory, noting that significantly ramping up production is not a simple matter for most producers, particularly in the short term (Cairns, 2014).

International (private) oil companies might change expansion plans in response to obvious decline trends; some shareholders would likely demand it. In the same vein, Cairns (2014) also criticizes the green paradox model on the grounds that it would be economically irrational for major producers to increase production and tank prices. But more than half of global oil supply comes from national oil companies (Natural Resource Governance Institute, 2019). These companies are not strictly profit-motivated, and they are usually mandated by national governments to contribute to broader policy objectives, such as employment creation (Losman, 2010). Some national governments will very likely demand a ramp-up of production in the face of declining demand and prices.

For decades, global oil markets have been protected at relatively high prices by the discipline of OPEC, and more recently OPEC+. But the organization has always been subject to tensions, with heavily oil-dependent members seeking to increase production to address their urgent development needs (Blas et al., 2020; Lee, 2020; Smith et al., 2020). Those tensions have been hard enough to manage in a world of increasing oil demand, where it was understood that any downswing would eventually be righted. But OPEC+ discipline may prove impossible in the new reality of post-peak global demand, with steeply declining oil demand and no long-term prospect for demand recovery. The result would likely be economically damaging low prices, and possibly even more price volatility than already plagues the global oil market.

3.4.4 Conclusions

Canadian producers are potentially vulnerable in two ways as demand for oil peaks and declines: loss of markets, and low and volatile prices.

They are somewhat insulated from loss of markets given that most of their buyers are captive purchasers of Canada's heavy crude and are relatively efficient refiners. But even the Midwest refiners will eventually feel the effects of demand decline, most acutely if it occurs in the U.S. markets, where state-level and federal climate policy is creating a trajectory to destroy significant demand.

With regard to price, post-peak demand destruction combined with production increases by competitors engaging in green paradox behaviour, as well as stresses on OPEC+ discipline, will likely mean low and possibly more volatile prices. That scenario means lower profits, less government take in the form of royalties and taxes, and fewer jobs.



As global demand for oil peaks and declines, Canadian producers will not be able to count on their reputation as clean or ethical producers to preserve market share. The buyers of Canadian oil—Midwest refiners and perhaps increasingly Chinese petrochemical producers—are focused on price, reliability, and quality. The same basic rule applies in the context of Canadian producers' GHG intensity: it is not part of our buyers' decision-making process.

Many oil sands operations with low operating costs and low rates of decline will survive even at low global oil prices, though their profits will diminish. Many other operations will not survive, and post-peak, it will be difficult to finance any new production, perhaps apart from process optimization or low-cost incremental expansion of existing operations.

4.0

Outlook for Natural Gas



Summary:

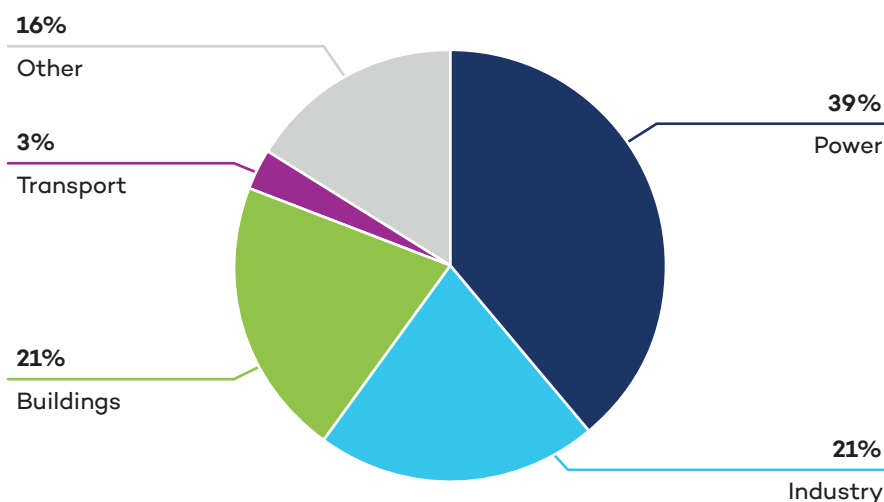
- The global outlook for gas has changed significantly in the last few years. Forecasts of growing global demand have been revised downward and become more uncertain due to supply shortages, surging LNG prices, and new investments in energy efficiency, renewables, heat pumps, and clean fuels.
- Ambitious climate scenarios show declining global demand, further questioning the claim of natural gas as a transition fuel.
- Demand is set to decline in the United States, Canada's only existing export market.
- Canadian LNG facilities cannot be operational in time to alleviate short-term supply shortages, especially in Europe.
- An anticipated glut of LNG supply mid-decade will likely drive down prices and make it even more difficult for Canadian LNG exports to compete.
- With dropping global demand, lacklustre demand growth in Asia, and high-growth markets being more price-sensitive than mature markets, the outlook for Canadian gas production is not optimistic.

Natural gas accounts for around 23% of the global energy supply (Ritchie et al., 2022). The largest end use is electricity generation, which is responsible for approximately 39% of global gas demand (Figure 4.1). Industrial uses, primarily process heating in the production of chemicals, fertilizer, and hydrogen, account for almost 21% of global gas demand. The buildings sector, where gas is mainly used for water and space heating, accounts for 21% of global gas demand.

Historically, natural gas has often been traded on long-term bilateral contracts, allowing for fewer arbitrage opportunities that characterize commodity global markets. As a result, gas markets and pricing are divided regionally. However, growth in the liquified natural gas (LNG) market has led to greater integration across markets. LNG trade has more than doubled since 2000 and, in 2022, accounted for around 50% of all natural gas trade (Filimonova et al., 2022). Increasingly, events in regional natural gas markets are spilling into other markets. As discussed in the following sections, this dynamic was evident in 2022, when the Russian invasion of Ukraine had repercussions for LNG and natural gas prices around the globe.



Figure 4.1. Natural gas demand by end use, 2021



Source: IEA, 2022f.

4.1 Global Gas Demand Hinges on Climate Ambition

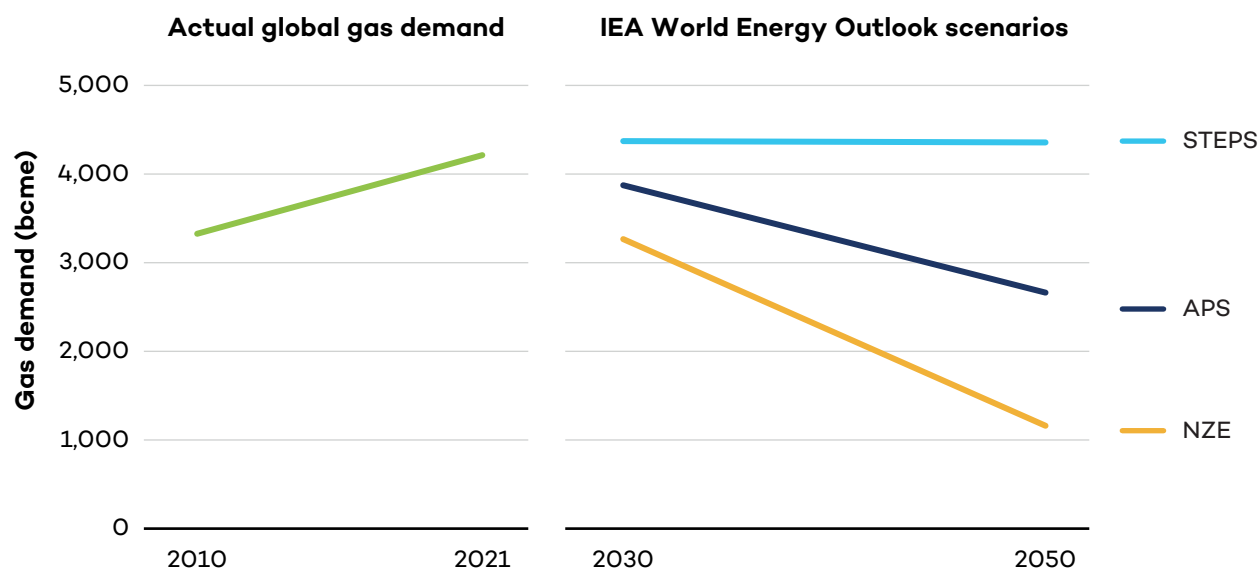
In its most recent outlook, the IEA shows natural gas demand peaking or plateauing in all scenarios (see Figure 4.2). In the most conservative scenario (STEPS), natural gas plateaus by 2030 and remains steady until 2050. If governments achieve their existing climate commitments (APS), the IEA expects gas to peak and be in decline by 2030, contracting by a total of 40% (below 2021 levels) (IEA, 2022f). The NZE scenario has natural gas demand dropping sharply toward 2030 before contracting by a total of 70% in 2050 compared to 2021. This decline is equal to a drop in global demand from around 4,213 bcm in 2021 to 1,200 bcm in 2050 (IEA, 2022f).

A comparison of 19 scenarios across seven energy outlook reports found that the majority of ambitious climate scenarios, even those produced prior to recent price spikes, show global gas demand peaking in the near term and dropping considerably before 2030 (Raimi et al., 2022). Scenarios that showed higher demand for natural gas relied on the assumption that emissions would be abated with carbon capture and storage technologies.

LNG demand may continue to grow even if global demand for gas declines. However, if governments around the world implement all existing climate pledges, as modelled in the IEA's APS, existing projects and those under construction are sufficient to meet demand. In the NZE scenario, existing and under-construction LNG developments risk being stranded (IEA, 2022f).



Figure 4.2. Global gas demand in all IEA scenarios



Source: IEA, 2022b.

It is important to note that a growing body of research finds that the climate impacts from natural gas, and particularly from methane leakage, have been grossly underestimated. Correcting estimates of methane leakage across the value chain could have an impact on future outlooks for gas, further increasing the imperative to reduce global gas demand and challenging the case for coal-to-gas transitions (Kemfert et al., 2022).

4.1.1 Power Production and Buildings Sectors Lead to Declining Gas Demand

While overall gas demand is expected to drop, the effect will not be uniform across all sectors. Demand reductions in the short to medium term are primarily expected for gas-fired power production and gas used for water and space heating in buildings.

In the U.S., 4.3 million heat pumps were sold in 2022; this outstripped the number of furnaces sold.

Like Canada, the European Union, United States, and United Kingdom have all committed to a net-zero electricity grid by 2035. However, deployment of renewables is increasingly driven by economics. The cost of new renewable energy has dropped so dramatically that, for many countries, it is cheaper to install new solar or wind infrastructure than to keep operating existing fossil fuel-based power plants (IRENA, 2022a). Investment in renewables was nearly USD 500 billion in 2022 (BloombergNEF, 2022). The IEA now projects 2,400 GW of new renewable capacity being built between 2022 and 2027, 30% more than its 2021 projection, with renewables



becoming the largest source of global electricity generation in 2025 (IEA, 2022f; Pannett, 2022). Once installed, wind and solar have very low operating costs; their growing share of global electricity capacity means that even new gas generation built to meet peak demand or balance the grid will see reduced utilization rates (IEA, 2023c). This shift, in turn, will reduce gas demand even further. One key assumption affecting the future demand anticipated across scenarios is the degree to which they rely on gas electricity generation paired with carbon capture and storage (IEA, 2023c)—although it should be noted that compared with the low costs of renewables (even with storage), the additional cost of adding unsubsidized carbon capture and storage (CCS) to gas power generation will likely make it the more expensive option.

In terms of heating, non-renewable energy heating sources for spaces and water in buildings still dominate all major markets, despite low-carbon technologies being available. In Europe, China, and North America, natural gas dominates for heating, with coal, oil, and electric heating also playing a role (IEA, 2022d). However, a recent surge in electric heat pump deployment is shifting this balance. In 2022, 3 million heat pumps were sold in Europe. With two years of annual sales growth exceeding 30%, approximately 16% of European residential and commercial buildings are now heated using heat pumps (European Heat Pump Association, 2023). In the United States, 4.3 million heat pumps were sold in 2022, outstripping the number of furnaces sold (Liebreich, 2023). By supporting both manufacturing and deployment, the Inflation Reduction Act (IRA) is expected to accelerate this trend even further.

Industrial end uses are the main unknown in terms of global gas demand. However, much of this demand can be electrified and almost half of industrial heat demand requires temperatures low enough that heat pump technology could be used (Liebreich, 2023). Thus, innovation and cost reductions in heat pump technology—and, in particular, tailoring heat pumps for district heating systems or industrial usages—offer promising options for accelerating industrial electrification.

4.1.2 The Role of the Hydrogen Market

Global outlooks for gas depend heavily on assumptions around the use of hydrogen. For instance, in IEA's NZE Scenario, by 2050, over 25% of hydrogen demand will be met using natural gas with CCS (IEA, 2022f), which accounts for 566 bcm of natural gas. Potential end uses for hydrogen include synthetic fuels in heavy transport, industrial heat processes (primarily for chemicals, iron, cement, and steel), and feedstocks in the production of materials such as steel, plastics, and fertilizers (Muttitt et al., 2021).

Currently, about 90% of hydrogen production uses natural gas as a feedstock (grey hydrogen). Going forward, this proportion is expected to change dramatically, with more hydrogen being produced via either electrolysis processes based on renewable energy (green hydrogen) or from gas production in combination with CCS (blue hydrogen).

Because hydrogen production plays such a significant role in the future demand for gas, overall gas demand will depend on both how much demand for hydrogen materializes and whether that demand is met with blue or green hydrogen. Most scenarios still assume that blue hydrogen will

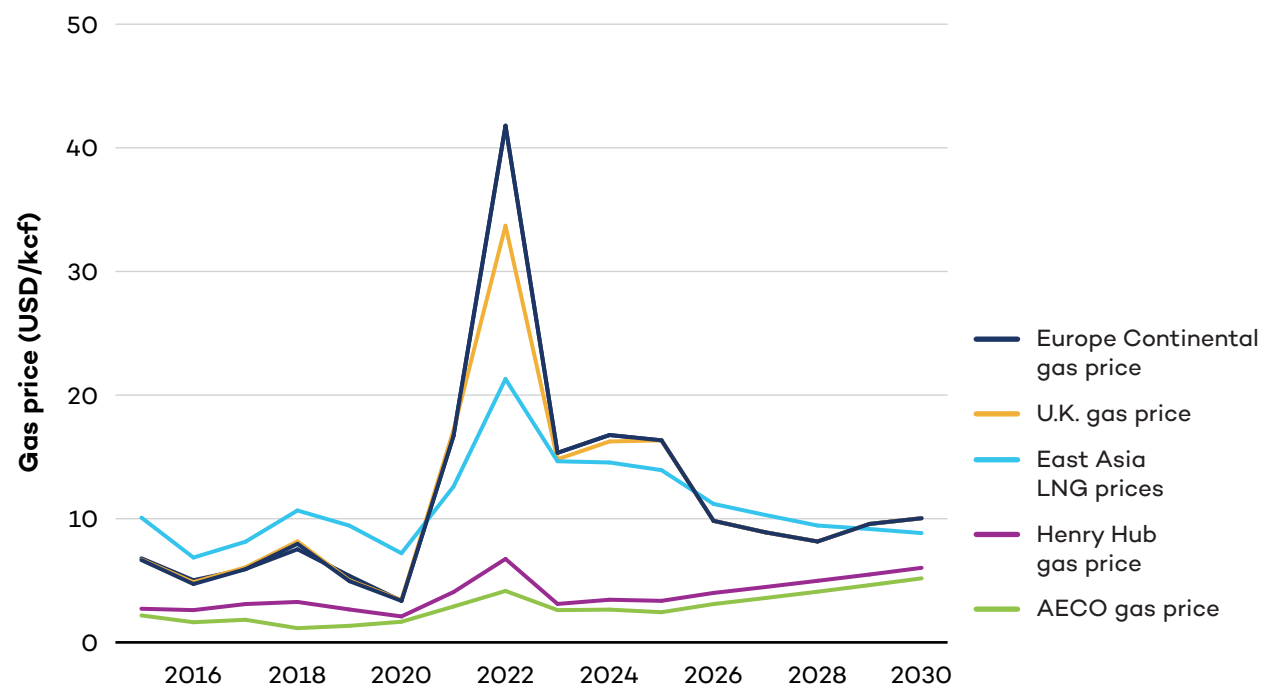


dominate the market and help keep gas demand afloat. Nevertheless, predicted price reductions of around 85% for green hydrogen and investment and production incentives for low-emissions hydrogen could tilt markets away from blue hydrogen (Eicke & Blasio, 2022). Moreover, some analysts argue that a green hydrogen market would be better sheltered from price volatility and geopolitical turbulence compared to hydrogen from gas with CCS (Willige, 2022).

4.2 COVID-19, the Invasion of Ukraine, and Global Gas Markets

Recently, the COVID-19 pandemic and Russia’s invasion of Ukraine have led to a series of changes in global gas markets. As shown in Figure 4.3, prices rose in 2021 as a result of strong economic recovery after the end of COVID-19 lockdowns, outages at key LNG supply facilities, colder-than-average winter temperatures, and a surge in coal-to-gas switching in 2020 when gas prices were low (IEA, 2022a).

Figure 4.3. Historical and projected global gas and LNG prices (USD/kcf)



Source: Rystad Energy, 2023.

Russia’s invasion of Ukraine exacerbated volatile price trends, leading to record prices in many markets. However, Europe’s efforts to displace Russian gas imports have now mostly succeeded, as European policy-makers moved to reduce their dependence on Russian gas through clean energy packages and import diversification. Over the whole year of 2022, gas consumption dropped by 85 bcm in Europe compared to the previous year (IEA, 2023a).



Nevertheless, the short-term price hikes and supply shortages led to new gas developments in the Middle East and North Africa. Combined with strengthened U.S. LNG export infrastructure capacity, these developments contributed to gas prices coming back down at the end of 2022. The Institute for Energy Economics and Financial Analysis (IEEFA) anticipates that 118 million tonnes of new LNG capacity will come online between 2025 and 2027, with a record capacity addition of 64 million tonnes in 2026 (IEEFA, 2023). This will create a global LNG supply glut that is expected to drive down LNG prices and keep them low (Stapczynski, 2023).

This situation underlines the conundrum in which the natural gas market currently finds itself. The LNG market is undersupplied in the short term, but anticipated demand in key growth markets for LNG has slowed and overall gas demand is expected to decline in the medium term. At the same time, new LNG supply already under construction will flood the market starting in 2025. This combination puts new LNG infrastructure at risk of becoming redundant even before it is built, which in turn significantly increases the risk of either locking in expensive fossil fuel infrastructure or adding to the burden of stranded fossil fuel assets.



European Commission headquarters in Brussels.
(Photo: Alexandros Michailidis/iStock)

New gas infrastructure is at risk of becoming redundant before it is even built, adding to the burden of stranded assets.

4.3 Natural Gas Production in Canada

In 2021, Canada was the world's fifth largest producer of natural gas, providing 5% of global production (Natural Resources Canada, 2022). Production was relatively stable between 2016 and 2020, with Canada producing between 429 million and 450 million cubic metres per day (Mcm/d) (Canada Energy Regulator, 2021). However, 2022 brought record production levels, reaching an all-time high of 506 Mcm/d in November (Canada Energy Regulator, 2023b). Domestic demand for natural gas has increased over the past five years from 274 Mcm/d in 2016 to 360 Mcm/d in 2021 (Canada Energy Regulator, 2021). The largest increase in demand has come from industrial use, and in particular, from oil sands development. In 2018, the oil sands



accounted for one third of domestic natural gas demand (Canada Energy Regulator, 2020). As a result, domestic demand is highly dependent on oil sands production levels.⁴

The North American market for natural gas is highly integrated, and natural gas flows in both directions via pipeline connections in all the provinces that share a border with the United States. Although Canada is a net exporter of natural gas, both the share of Canadian production and the absolute volumes exported have dropped over the last decade. In 2010, 92 bcm (61% of production) was exported, while in 2021, 82 bcm (48% of production) was exported (Canada Energy Regulator, 2022c). This shift corresponded to increasing domestic demand and increased U.S. production levels. In addition to pipeline imports, a small amount of LNG is imported each year through a marine terminal in New Brunswick, and very small amounts of compressed natural gas and LNG are exported via truck or ship, for instance via Fortis BC's Tilbury LNG facility. Canada's first large-scale LNG export facility, LNG Canada, is still under construction.

4.3.1 Market and Geographic Distribution of Production

Nearly all of the natural gas production in Canada comes from the Western Canadian Sedimentary Basin, which spans northeastern British Columbia (BC), most of Alberta, southern Saskatchewan, and some parts of southwestern Manitoba. Although some small pockets of natural gas exist in Ontario and New Brunswick and significant amounts are found offshore of Nova Scotia, Alberta and BC together account for 98% of Canadian production. In 2021, 69% of marketable production came from Alberta, 29% from BC, 1.5% from Saskatchewan, and 0.2% from other provinces (Natural Resources Canada, 2021, p. 117).



Eagle Ford Shale well in Texas. (Photo: iStock)

Natural gas resources are classed as either conventional or unconventional, with the latter category including coalbed methane, tight gas (produced from reservoir rocks with very low permeability), and shale gas (trapped within shale formations). In Canada, 72% of technically recoverable natural gas reserves are unconventional (Natural Resources Canada, 2022). As a result, much of the natural gas in Canada can only be accessed using unconventional removal technologies such as hydraulic fracturing.

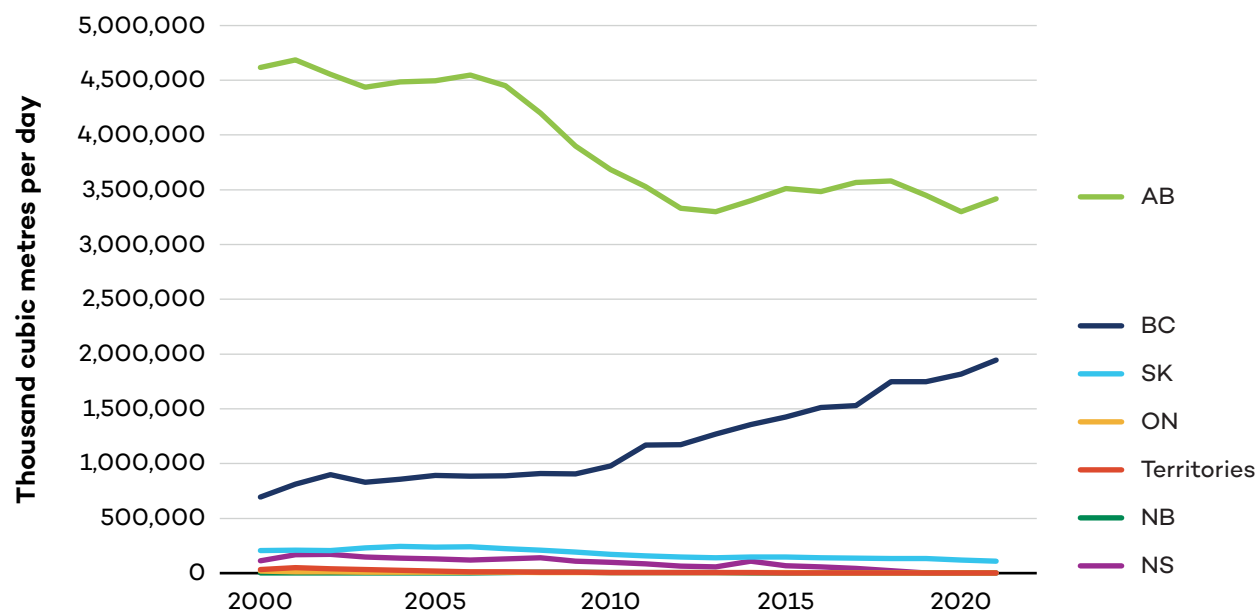
⁴ During the 2016 wildfire in Fort McMurray, the sharp decrease in oil sands production caused Alberta natural gas markets to tumble, with prices falling by half (Canada Energy Regulator, 2017).



Advances in drilling technologies, such as horizontal and directional drilling, that make unconventional resources accessible have led to major shifts in the North American and global natural gas markets. In particular, the dramatic growth of U.S. shale gas production, starting in 2005, propelled the country from a position of declining production to becoming a leading gas exporter. The glut of natural gas in North America has kept prices low and limited the U.S. demand for Canadian exports. Abundant shale gas production also drove the development of the U.S. LNG export industry.

In Canada, accessing unconventional gas production has corresponded with an increasing share of production in BC, primarily through expansion in the Montney basin. The first tight gas production in Canada began in BC in 2005 and the first shale gas in 2006 (Natural Resources Canada, 2020). As Figure 4.4 illustrates, although Canadian gas production has increased, the proportion of production coming from BC has grown relative to that from Alberta. The share of unconventional production in Canada is expected to grow as conventional gas reserves decline.

Figure 4.4. Marketable natural gas production by province



Source: Canada Energy Regulator, 2023a.

4.3.2 Liquefied Natural Gas

Declining prospects for exporting gas to the United States along with the overall growth in the global LNG market have spurred interest in the Canadian LNG industry, including projects in BC for the Asian market and projects in central and Atlantic Canada.

LNG Canada, under construction in Kitimat, BC, will be Canada’s first completed export facility. LNG Canada is a joint venture among Shell, Petronas, PetroChina, Mitsubishi, and Korea Gas



Corporation and is scheduled to come online in 2025 (Jang & Graney, 2022). The USD 30 billion project is intended to serve Asian markets. It will connect to the Coastal GasLink pipeline, a 650-km pipeline that continues to be contested by the Wet'suwet'en Hereditary Chiefs. To support project completion, the federal government has provided subsidies, including a direct investment of CAD 275 million and steel tariff exemptions worth CAD 1 billion, in addition to the significant subsidies offered by the BC government via the BC-LNG Canada Agreement. Export Development Canada has also provided the Coastal GasLink pipeline with CAD 500 million in loans (Gass & Corkal, 2019).

A study by the IEEFA analyzed the economics of LNG Canada. It argues that high and increasing capital costs (for LNG Canada) and pipeline transportation costs (via the Coastal GasLink pipeline) could make the cost of production double the cost of LNG produced on the U.S. Gulf Coast (Mawji, 2022).



Coastal GasLink pipeline protesters block a rail line in Seattle in support of the Wet'suwet'en First Nation. (Photo: Joseph Gruber/Shutterstock)

Other projects are still under consideration on both coasts of Canada. In BC, projects include a second phase of LNG Canada; Woodfibre LNG in Squamish; Cedar LNG, a floating LNG terminal in Kitimat; Tilbury Expansion Project in Delta; and Ksi Lisims LNG at Wil Milit, north of Prince Rupert.

The energy crisis in Europe has also revived interest in a number of East Coast projects, including Goldboro LNG, LNG Newfoundland and Labrador, Saint John LNG, and Bear Head LNG. None of these Atlantic projects has initiated the approval process.

4.4 Canada's Declining Export Market



4.4.1 Uncertainty in U.S. Markets

The United States is currently Canada's only export market for gas. Therefore, U.S. energy policy has important implications for Canadian production levels. The IRA is expected to drive down U.S. consumption of natural gas. Estimates suggest domestic gas consumption in 2030 will be 3% to 10% lower than it would have been without the legislation and that, overall natural gas consumption will drop between 2021 and 2030 (Jenkins et al., 2022; Larsen et al., 2022).. The IRA could also result in medium-term (2030–2035) natural gas prices



that are 10% to 20% lower than without the policy (Jenkins et al., 2022) and gas production levels that are 2% to 7% lower (Larsen et al., 2022).

The impact of the IRA is complicated by a growing LNG export industry. The United States currently exports 12% of natural gas production via seven LNG export facilities (Williams-Derry, 2023b). However, a slate of new facilities that are approved or under construction could have implications for North American natural gas prices. Similar to the situation in summer 2021, spikes in LNG prices could divert production away from domestic markets, driving up North American prices. This possibility is in addition to the impact of locking large shares of natural gas production into long-term export contracts that prioritize export markets over domestic markets (Williams-Derry, 2023b). New LNG facilities and their utilization rates depend heavily on global LNG markets, so the impact of growing LNG exports remains highly uncertain.

The IRA is expected to drive down U.S. consumption of natural gas.

Overall, pipeline imports to the United States could drop 9% to 11% as a result of the IRA (Larsen et al., 2022). However, there is the potential for an increased share of Canadian exports to be diverted to tight U.S. domestic markets or to U.S. LNG export terminals. The cost of producing LNG on the U.S. Gulf Coast is estimated to be half the cost of Canadian facilities, so independent gas producers in Canada may favour this option (Williams-Derry, 2023a).

Although the trade dynamics between Canada and the United States are influenced by a number of factors, overall U.S. domestic demand is expected to drop and result in Canadian exports continuing to decline. Even if Canadian producers increase export via U.S. LNG facilities, it may ultimately be at the expense of Canadian facilities. At the same time, a North American gas market that is increasingly tied to global LNG markets could, in turn, increase price volatility and imbalances in supply and demand. This would have knock-on effects for Canadian and U.S. consumers, with high and volatile prices encouraging additional demand reduction.



4.4.2 Asia's Demand for Gas Levels Off

Emerging Asia (Association of Southeast Asian Nations, Pakistan, and Bangladesh), India, and China are expected to be the single largest growth market for LNG (Shell, 2022). Thus, LNG export facilities around the world, including those proposed and under construction in Canada, aim to meet demand in this market.

However, the outlook for this region is quickly changing. According to the IEA, the days of rapid growth for natural gas demand in Asia are over. The Asian region is looking at very modest demand growth, from 920 bcm equivalent in 2021 to 983 bcm equivalent by 2030 in the APS scenario (IEA, 2022f)—a downward growth adjustment of 50% compared to the same forecast one year before. In addition, most countries in the region have adopted climate neutrality targets that will further impact power sector decisions. Even before the invasion of Ukraine, a large



majority of proposed LNG projects in emerging Asia were considered unrealistic for completion due a range of market constraints (Reynolds & Hauber, 2021).

Recent price records for gas have seen the economics for LNG change considerably, especially in emerging Asia, which is a more price-sensitive market than mature markets such as Japan and South Korea (Reynolds, 2022). In some price-sensitive markets in Asia, governments have faced a difficult short-term dilemma of either trying to purchase LNG supplies at unsustainable prices (ahead of European buyers) or not buying LNG at all. In more mature markets, long-term, oil-indexed contracts have so far been able to provide some comfort from price spikes, but LNG demand growth is still expected to underwhelm industry forecasts, (Reynolds, 2022).

In China, LNG demand fell by 19% in 2022 (Reynolds, 2023) and, overall natural gas demand is expected to linger around a very modest 1% to 2% growth rate toward 2030 (IEA, 2022f), compared to a 12% growth rate from 2010 to 2021. Moreover, pipeline contracts with Russia and Turkmenistan might further reduce the need for additional LNG imports. In Japan, historically the largest LNG buyer, imports fell 3% in 2022 (Reynolds, 2023).

These trends underline that the Asian market for LNG is at best uncertain for Canadian LNG producers. Forecasts for mature markets are flattening out. Significantly, lacklustre growth in emerging Asia will be coupled with a glut of LNG supply as new facilities come online starting in 2025, which will likely drive down prices. Since markets in emerging Asia are more price-sensitive than more mature markets in Japan and South Korea, they are likely to prefer the lowest-cost supplies—casting doubt on the ability of Canadian LNG, with high and escalating capital costs (Mawji, 2022), to compete in its target markets.



4.4.3 No Market in Europe for Canadian LNG

Prior to 2022, Europe was already beginning a structural transformation away from natural gas. The Russian invasion of Ukraine led the European Union to strengthen its commitment to reduce reliance on gas through its REPowerEU plan (European Commission, 2022b).

Overall, the European Union's Climate Law sets an emissions reduction target of 55% by 2030 and a climate neutrality target by 2050. Even before the current crisis, the Fit for 55 package alone anticipated that the European Union's gas demand would decline 116 bcm by 2030.

The REPowerEU plan, proposed by the European Commission in May 2022, aims to reduce demand for Russian gas by 310 bcm by 2030, including 60 bcm from gas diversification—with the goal of making Europe completely independent of Russian gas by no later than 2027 (European Climate Foundation, 2022). This goal will be accomplished in part by speeding up the deployment of wind and solar capacity, as well as efforts to retrofit buildings and roll out around 10 million heat pumps over the next five years to reduce gas demand for buildings, heating, and electricity (European Commission, 2022b).



These policies are already taking effect. In 2022, the European Union's gas consumption was around 524 bcm, down from 590 bcm in 2019 (IEA, 2023a). Acknowledgement of the transition away from gas is exemplified in a reluctance by some European countries to sign long-term contracts for LNG. Recognizing that supply shortages are short-term issues, some countries appear cautious about being locked into contracts in the medium term when both demand and prices are expected to be lower (The Economist, 2022a).

The result is a fundamental mismatch between Europe's short-term LNG needs and Canada's ability to construct LNG facilities on its east coast. It would take, at minimum, three years to get new LNG supply into operation, which would miss the window to supply European demand (Toft & Dusyk, 2022). Moreover, the anticipated glut of LNG (beginning in 2025) from global projects already under construction adds to the risk that new facilities on Canada's east coast aimed at European markets may become uneconomic even before they are operational.



4.4.4 Few Market Opportunities in Africa and Latin America

With global gas demand expected to drop considerably in coming decades, it is unlikely that new, large export markets will emerge. Across Africa and Central America, gas demand is currently very modest compared to global levels (IEA, 2022c).

In Africa, while natural gas demand might increase at very modest rates towards 2030, the continent currently does not import LNG at all. Egypt imported LNG for a short period in 2015, and Senegal received a floating storage and regasification vessel in 2021. Ghana has an import terminal underway, but it has been delayed several times, and is not expected to be operational in 2023 (Burkhardt, 2022).

It is unlikely that new, large exports markets for gas will emerge.

In sum, there is essentially no experience in Africa with importing LNG, and infrastructure development for imports looks unlikely on economic terms alone, due to both high prices for gas and the fact that most markets are small and not interconnected (Chianese, 2022).

4.5 The Outlook for Canadian Gas is Unsustainable

The outlook for natural gas is faltering. After two decades of rapid growth, “the era of rapid global growth in natural gas demand is drawing to a close” (IEA, 2022f, p. 365). While renewable energy was already the cheapest source for new power in many markets prior to 2022, recent price spikes and tight supply have been a turning point for natural gas as a fuel that was thought to be both cheap and reliable. The use of natural gas supplies as a geopolitical tool has further eroded the notion that natural gas can provide energy security.

The role of natural gas as a transition fuel is challenged by the fact that most ambitious climate scenarios show global demand growth rapidly declining during this decade. In these scenarios, gas



demand is maintained, albeit at much lower levels, only if CCS is successfully deployed at scale to lower the emissions of natural gas use in electricity generation and as a feedstock for hydrogen. However, dramatic cost reductions and the scaling up of supply chains for wind power, solar power, batteries, heat pumps, and clean fuels will continue to erode the economics of natural gas, especially with the added expense of CCS.

Existing trends have only been accelerated by the Russian invasion of Ukraine. Both the European Union's REPowerEU plan and U.S. investments via the IRA will continue to drive down costs and scale up the deployment of clean competitor technologies.

As a result, recent declines in U.S. demand for Canadian gas exports will be accelerated. From a North American perspective, it is also important to note that over a third of natural gas demand in Canada is used for oil sands production. Therefore, any significant change in oil sands production levels, as discussed in Chapter 3.0, will have knock-on impacts for Canadian natural gas prices and production levels.

Growing or even maintaining Canadian production levels amid waning demand in North America hinges on selling LNG to Asian markets. However, high LNG prices and tight supplies have resulted in lacklustre growth rates in markets previously expected to drive demand for new supply. Demand growth

has slowed in China and Japan and high prices have illustrated the extent to which emerging Asian markets are price-sensitive. In some countries, governments have had to shut off gas power completely for periods of time due to high prices, and most other governments have diverted the use of gas for power due to high prices and increased investments in other energy types, primarily renewable energy and nuclear power. Although natural gas and LNG demand are both expected to continue to grow in Asia, growth projections have been significantly downgraded.

More significantly from the Canadian perspective, the potential glut of LNG supply beginning in 2025, combined with the price sensitivity of key growth markets in emerging Asia, calls into question the economics of Canadian LNG. The high and escalating costs of Canadian facilities will make it difficult to compete with supply from the lower-cost suppliers (such as Qatar). With North American demand set to decline and Canadian LNG's questionable ability to compete with international competitors, the outlook for Canadian production is not positive.

This situation risks taking Canada's natural gas pipeline, particularly for LNG, to a situation of unsustainable economics that will either result in stranded assets or require substantial public subsidies to stay afloat. Neither of these scenarios is desirable, underlining that it is more important than ever for Canada to get the analysis right before supporting further LNG development. With the "golden age of gas" drawing to a close (IEA, 2022f, p. 407) governments need to prepare for declining markets.

The global energy crisis has significantly dampened demand forecasts for gas.

5.0

Implications of Oil and Gas Decline in Canada



Summary:

- Oil and gas have outsized shares of GDP, employment, and government revenues in Canada's major producing provinces, leaving these provinces vulnerable.
- Independent analysis and modelling show that low prices have major negative impacts and that volatile prices are even worse. This vulnerability means economic risk for Canada as the world continues to progress toward ambitious climate change targets.
- The less the oil and gas sectors are prepared for downturn, the more economically and socially painful the transition will be. As such, there is a strong public interest in ensuring that the eventual decline of Canada's oil and gas sectors is well managed.
- Measures are needed to ramp down supply to prevent overinvestment, minimize asset stranding, prevent financial fallout for Canada, and signal the need for diversification to investors, communities, and workers.
- Proactive action will minimize chances that an unprepared sector in decline seeks or benefits from assistance and exemptions from regulations and burdens taxpayers with unpaid leases, taxes, and environmental cleanup of abandoned infrastructure.

The outlook for both oil and gas in Canada is not optimistic. There is widespread agreement that oil markets will peak by 2030 and begin to decline. Gas markets are less certain, but cost-effective alternatives combined with recent price spikes have led to global demand projections being revised downward. Modelling shows that if the world continues to take climate change as a serious and immediate threat, gas markets will also peak this decade. A post-peak period will be characterized by low and possibly more volatile prices.

This chapter explores how Canada will fare in that mid-transition period. It first lays out the extent to which Canada and specific regions within the country are currently dependent on oil and gas, and then looks at the likely impacts of low and volatile prices. It next explores the risks inherent in maintaining the status quo, asking what is at stake if governments and stakeholders take no action to anticipate the coming transition away from oil and gas as primary drivers of Canadian prosperity.

Oil and gas have outsized shares of GDP, employment, and government revenues in Canada's major producing provinces, leaving these provinces vulnerable. Independent analysis and modelling show that low prices have major negative impacts, that volatile prices are even worse, and that this vulnerability means economic risk as the world gets serious about addressing climate change. As such, there is a strong public interest in ensuring that the eventual decline of Canada's oil and gas sectors is managed, including by taking measures to ramp down supply to avoid overinvestment. The less prepared those sectors are for downturn, the more economically and

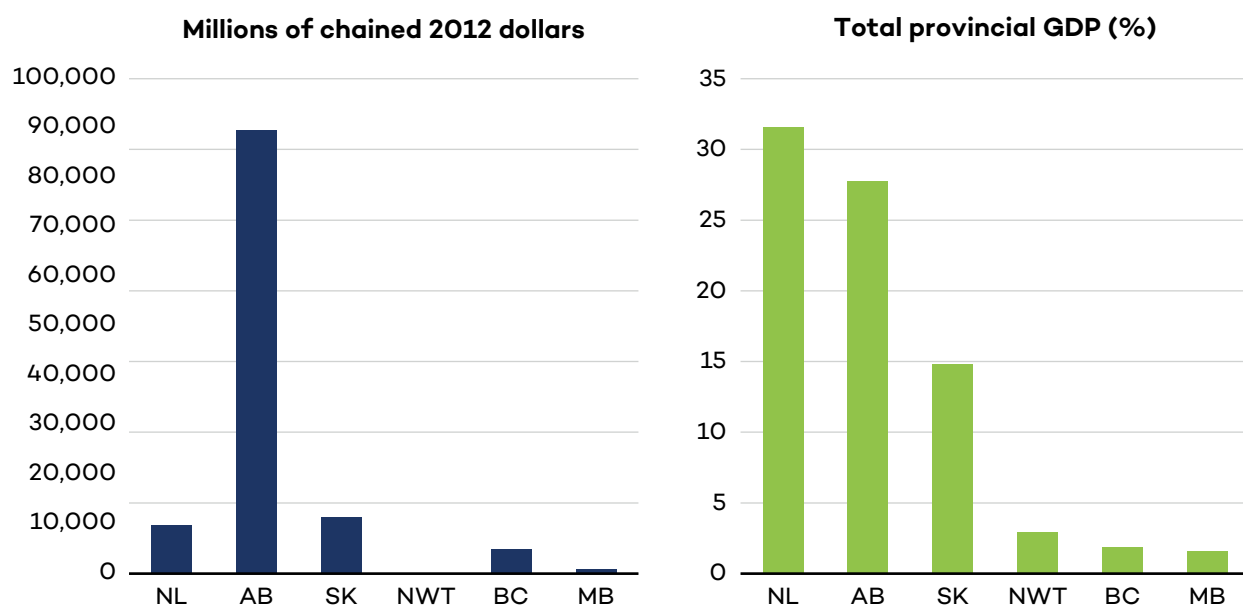


socially painful the transition will be. Ramping down oil and gas production would minimize asset stranding and the financial fallout it would entail for Canada, and it would also signal the need for diversification to investors, communities, and workers. As well, ramping down would minimize the chances that an unprepared sector in decline will have to plead for assistance and exemptions from regulations or will saddle taxpayers with unpaid lease and tax bills and the cleanup of abandoned infrastructure.

5.1. Canada Is Economically Exposed Due to Its Reliance on Fossil Fuels

Canada's oil and gas sectors provide substantial economic benefits both nationally and to the provinces in which they operate. Given the weak long-term outlook for both sectors, the greater those current benefits, the greater the vulnerability to the loss of those benefits in the face of global demand destruction.

Figure 5.1. GDP contributions from oil and gas



Source: Statistics Canada, 2022b.

Note: Amounts shown here cover oil and gas extraction, as well as service activities related to oil and gas. Provinces and territories not shown have less than 0.2% of GDP contributions from oil and gas.

In terms of GDP contributions from the oil and gas sectors, the picture is highly concentrated. Figure 5.1 shows that total economic activity in those sectors is much higher in Alberta than in any other province or territory. But it also shows that in terms of share of total economic activity, Newfoundland and Labrador stands out at 32%, with Alberta close behind at 28%. Saskatchewan



A rig worker climbs a drill tower at a fracking site in Dawson Creek, Canada. (Photo: iStock)

is the only other significant case, with a share of 15%. Such high numbers are markers of vulnerability to any decline in the fortunes of these sectors.

In terms of export dependency, the pattern is similar. Cosbey et al. (2021) assessed export dependence globally and found Canada to be 32nd on the list of countries dependent on energy exports in 2018, with 24% of exports in that category. If Alberta were a country, however, it would rank 11th in the world, with just over 70% of exports as energy products.

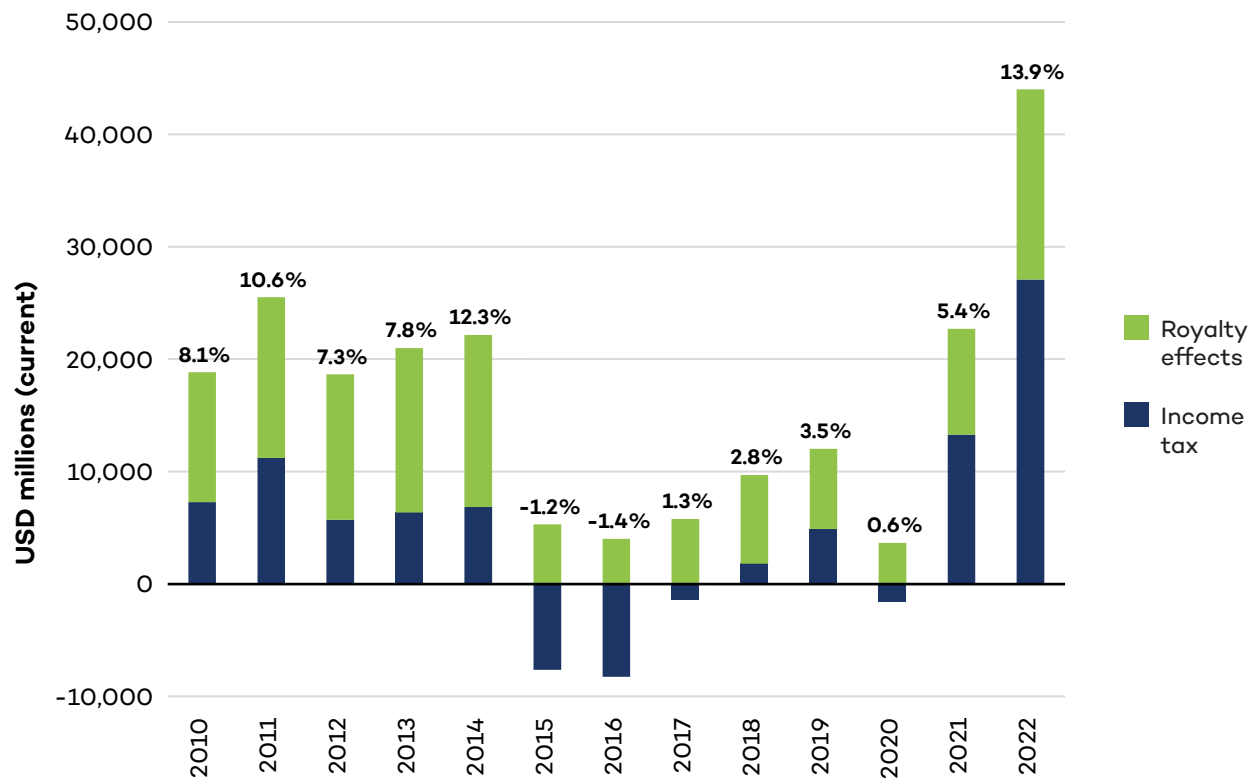
5.1.1 Government Revenues from Oil and Gas

It is also important to look at the revenues derived by the various governments in Canada from oil and gas operations, in terms of both royalty payments and corporate income tax. Figure 5.2 shows both historical and projected royalties and taxes from the oil and gas sectors in Canada. Several trends are notable here. First, revenues are highly variable, reflecting the cyclical nature of oil and gas markets. Second, revenues are significant, ranging as high as 12% of total federal revenues in a single year. Finally, projections of future government take fall off markedly post-2025. Variability is a problem for governments that need to plan for multi-year program spending. Low revenues in the future means shortfalls in the budgets of local, provincial, and federal governments, resulting in a lower level of services such as health care and education.

Oil and gas government revenues will be far more significant at the provincial level in Newfoundland and Labrador, Alberta, and Saskatchewan, given their share of GDP contributions as illustrated in Figure 5.1. Tables 5.1, 5.2, and 5.3 show those contributions ranging as high as 23.7% of total revenue in Alberta, Saskatchewan and Newfoundland, and averaging 13.0%, 3.8% and 15.3% in those provinces, respectively, over the last five years. Note that these figures do not include corporate income tax from oil and gas operations, which is a substantial contributor to provincial coffers.



Figure 5.2. Canadian government revenues from oil and gas



Source: Rystad Energy, 2023.

Note: Percentages are share of total federal government revenues.

Revenues include all royalties and corporate income tax at both federal and provincial levels. Shares of total federal government revenues are indicative only; oil and gas revenues are reported here on a calendar-year basis, and total federal government revenues are reported on a fiscal-year basis from April 1 to March 31, and are shown here as occurring in the first of the two years in which they occur. As well, oil and gas revenues are collected at both the provincial and federal levels.



Table 5.1. Alberta resource revenues

	2017–18	2018–19	2019–20	2020–21	2021–22
Conventional oil royalty (CAD millions)	965	1,149	1,175	466	1,947
Oil sands royalty (CAD millions)	2,643	3,214	4,089	2,066	11,650
Gas and by-product royalty (CAD millions)	645	536	371	465	2,227
Bonuses and sales of Crown leases (CAD millions)	564	360	120	24	228
Rentals and fees (CAD millions)	153	160	169	118	153
Resource revenues as % of total revenue	10.5%	10.9%	12.8%	7.1%	23.7%

Sources: Government of Alberta (2021, 2022b)

Table 5.2. Saskatchewan oil and gas revenues

	2017–18	2018–19	2019–20	2020–21	2021–22
Oil and gas revenues (CAD millions)	670	700	691	175	505
Oil and gas revenues as % of total revenue	4.7%	4.9%	4.6%	1.3%	3.5%

Sources: Government of Saskatchewan (2020, 2021, 2022).

Table 5.3. Newfoundland and Labrador offshore royalties

	2017–18	2018–19	2019–20	2020–21	2021–22
Offshore royalties (CAD millions)	920	1,061	1,009	567	1,105
Offshore royalties as % of total revenue	15.8%	17.4%	16.9%	10.3%	16.0%

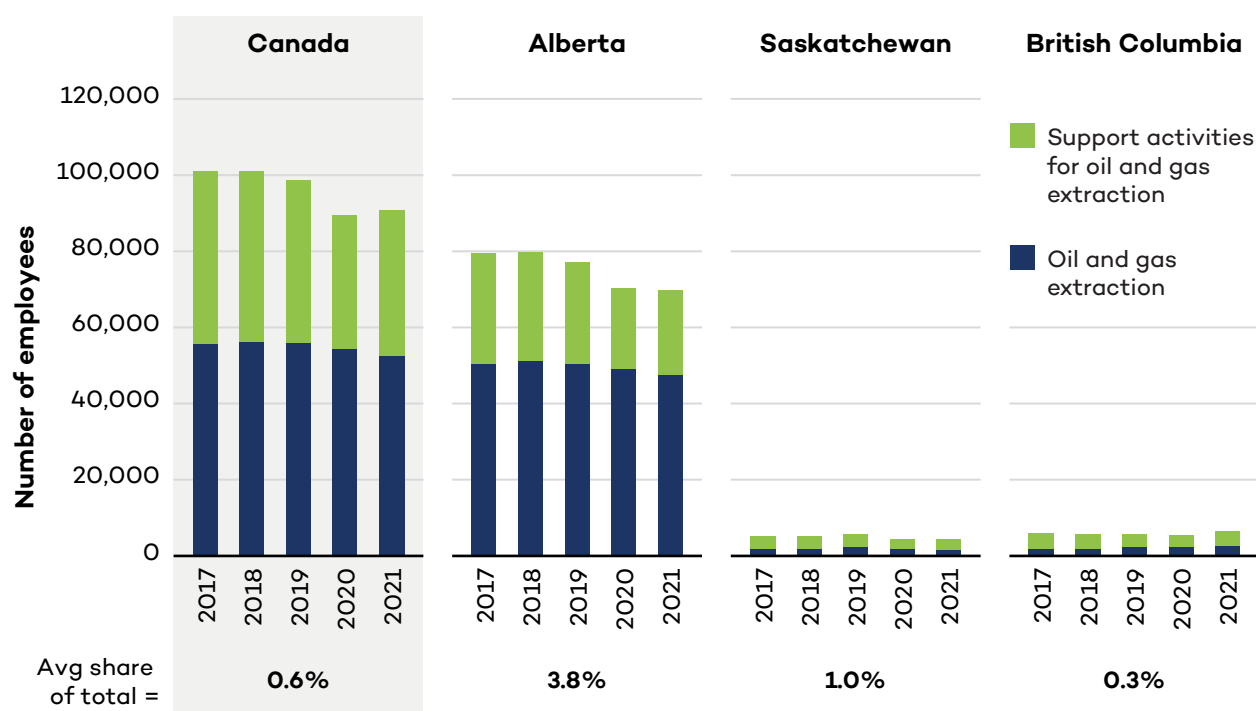
Sources: Government of Newfoundland and Labrador (2020, 2021, 2022).



5.1.2 Oil and Gas Employment

The oil and gas sector employs a significant number of Canadians but holds a low share of total employment—and oil and gas jobs are in decline. Direct employment in oil and gas extraction, as well as in support activities such as contracted well drilling, totaled just over 90,000 people Canada-wide in 2021 (see Figure 5.3).⁵ Counting indirect jobs (those jobs needed to create inputs to the oil and gas sectors, such as steel pipes) would yield a much higher number. These numbers do not include employment at pipelines, gas distribution, refineries, or upgraders, for which data are not available for most provinces. As a percentage of total Canadian employment, however, the direct employment numbers are low, averaging 0.6% over the last six years. The share is much higher in Alberta, averaging 3.8% over the same period (Statistics Canada, 2022a).

Figure 5.3. Employment in Canada’s oil and gas sectors



Source: Statistics Canada, 2022a.

Notes: Data are unavailable for Newfoundland and Labrador, Prince Edward Island, New Brunswick, Yukon, Northwest Territories and Nunavut. Data were withheld for confidentiality reasons for Quebec. The assumed oil and gas share of all mining, oil, and gas service jobs is equal to the share of oil and gas in total mining, oil, and gas employment (excluding services).

⁵ Figures used in this section are for all employees, both salaried and hourly. Employment numbers are for oil and gas extraction and for services related to oil and gas extraction. Numbers for the oil and gas service sector are estimates, since there is no disaggregation of service employees for oil, gas, and mining. The assumed oil and gas share of those service jobs is equal to the share of oil and gas employment in total mining, oil, and gas employment (excluding services).



Oil production and employment have been moving in opposite directions for nearly a decade. Notably, in Alberta from 2000 to 2018, bitumen production grew 376% but jobs peaked in 2014. Since 2014, oil sands production has increased 23% while jobs declined by 23%. This trend was evident across the sector: the oil and gas industry in Canada cut over 53,000 jobs from 2014 to 2019 (Hussey, 2020). Job losses deepened with the COVID-19 pandemic and resulting recession: writing in early 2021, Stanford found that 17,500 jobs had been terminated from the oil and gas sector in Canada (Stanford, 2021). The majority of job losses (81%) between 2014 and 2022 were in Alberta (Hussey, 2023).

5.1.3 Overall Dependence on Oil and Gas

Overall, the extent of dependence on oil and gas is significant for Canada on a few indicators, such as exports and government revenues. Oil- and gas-producing provinces, however, are particularly susceptible to future declines in the sector. Moreover, dependence is unevenly concentrated within provinces. Stanford (2021) found 18 Canadian communities (in Alberta, Saskatchewan, and BC) with a high degree of dependence on fossil fuels (including coal), averaging 9.3% of total direct employment in 2016 and ranging as high as over 30%. That overdependence makes those communities particularly vulnerable to a downturn in the fortunes of the oil and gas sectors.

5.2 Low and Volatile Global Prices Cause Negative Economic Impacts

Given the extent of Canada's dependence on the oil and gas sectors, and the more intense dependence in specific regions within Canada, what types of economic impacts can we expect in a future that involves the destruction of demand for both commodities along with low, volatile global prices?

Volatility alone, regardless of price, is a major negative influence on the economic contributions of the oil and gas sectors.

To get a rough sense of those impacts, Cosbey et al. (2021) modelled the Alberta-specific impacts of the difference between two oil price cases going out to 2050: a baseline case of USD 70/bbl (West Texas Intermediate, or WTI) as projected by the Canada Energy Regulator (2019), and a lower-price case based on BP's forecasted average price of USD 55/bbl (Brent) (BP, 2020)—a difference of USD 15/bbl.

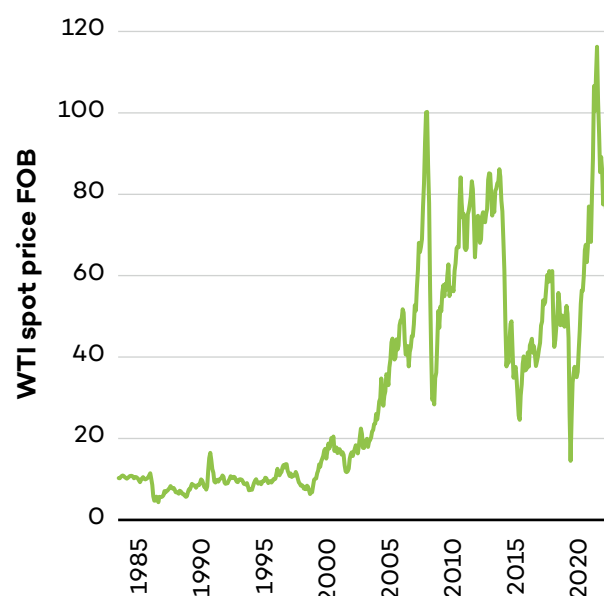
The lower-oil-price scenario shaved 5.2% off the oil and gas sectors' annual contributions to Alberta's GDP relative to the reference case, or an average of CAD 4.4 billion per year between 2021 and 2050. Employment in the oil and gas sectors dropped an average of 6,300 jobs, but numbers for the province overall were slightly positive, as the decline in the oil sector opened up employment opportunities and economic activities in other, more labour-intensive sectors. Investment in the oil and gas sectors dropped by an average of 5.3%, or CAD 2 billion per year



over the period. Provincial and federal tax revenues also fell by an average of 1.7% and 1.8%, respectively, or just under CAD 1 billion and CAD 1.38 billion per year, respectively.

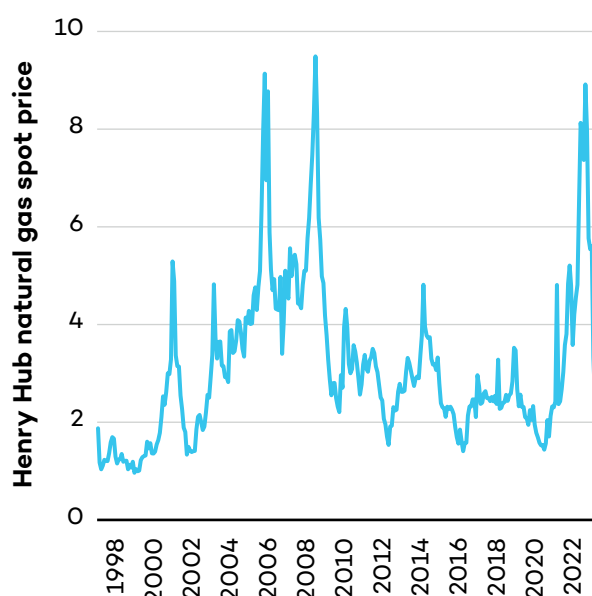
The impacts of lower oil prices are significant for the Albertan and Canadian economies, which is not surprising. But they are dwarfed by the impacts of price *volatility*. Most projections assume a steady price going out into the future, but the historical reality is nothing like that (see Figures 5.4 and 5.5). Cosbey et al. (2021) sought to understand how volatility would affect future economic contributions from the sector. To do so, they modelled the contrast between two volatile oil price scenarios (created based on historical realities) and a stable price scenario, with all three having the same *average* price out to 2050.⁶

Figure 5.4. Oil price volatility
(1983 USD/bbl)



Sources: RI, n.d.; U.S. Energy Information Administration, 2022a.

Figure 5.5. Gas price volatility
(1983 USD/million BTU)



Sources: RI, n.d.; U.S. Energy Information Administration, 2022c.

⁶ Cosbey et al. (2021) created two deterministic price shock scenarios that varied the future oil price to capture observed long-term trends in price volatility. To determine the range of oil price volatility to model, 17 historic oil shocks were examined over the last 37 years to look at the magnitude and probability of events occurring at any given time. This historical data was used to develop the two oil price shock scenarios, with five-year average prices deviated to represent the observed distribution of price volatility. The first scenario was built using the 20th-percentile, 30th-percentile, 40th-percentile, 60th-percentile, 70th-percentile, and 80th-percentile price distributions. Each of the five-year percentile changes in oil price were applied randomly to one of the six five-year forecast periods (2025, 2030, 2035, 2040, 2045, and 2050). In the second scenario, we used the 10th-percentile, 30th-percentile, 40th-percentile, 60th-percentile, 70th-percentile, and 90th-percentile price distributions. In both scenarios, the average price was held at USD 55/bbl (WTI) out to 2050. The USD 55/bbl price was used as the reference case to which the scenarios were compared.



In the volatile scenarios, GDP contributions from the oil and gas sectors in Alberta drop by an annual average of 19% to 21% out to 2050 compared to the reference case, or an average of CAD 21.8 billion to CAD 24.3 billion—more than five times the impact of the stable price scenario. Investment in the oil and gas sectors was particularly strongly affected, dropping 26% to 30% per year on average, or CAD 9.6 billion to CAD 11.2 billion. Alberta's net exports also suffered in both volatile scenarios, and the province's oil and gas sectors shed between 21,000 and 24,000 workers on average compared to a steady price scenario.

These findings matter for a few reasons:

- They highlight that volatility alone, regardless of price, is a major negative influence on the economic contributions of the oil and gas sectors.
- They argue that we should heavily discount projections of future benefits from oil and gas that assume a steady price path.
- The findings are likely understated. The scenarios were based on historical volatility over 37 years, but volatility in oil prices has markedly increased in recent years. Moreover, it may increase further, with increased likelihood of climate-related shocks like the Fort McMurray wildfire, health-related shocks like the COVID-19 pandemic, and volatile markets in the face of declining demand.
- The modelling assumes a seamless transfer of labour out of the oil and gas sectors and into others, but the reality is that such major shifts are anything but smooth, and they are difficult for the workers involved. (Chapter 6.0 looks at the ways in which governments can make such shifts less disruptive.)

Another approximation of the risks of demand destruction comes from Rystad Energy's estimation of "transition risk." They contrast two scenarios: a relatively unambitious one where the world achieves a 2.2°C global temperature increase, and a more ambitious one where the increase is held to 1.6°C. The largely negative impacts on the oil and gas sectors in the ambitious scenario compared with the unambitious scenario are framed as the risk of transition to a low-carbon future.

The analysis is based on Rystad's detailed database of 85,000 individual upstream assets from around the world and is built from the ground up at the country level. The results of this exercise for Canada are striking, with the transition implying that:

- The value of economically recoverable resources risks will be 48.3% lower (lower prices mean fewer resources are economically recoverable).
- The net present value of future free cash-flow risks will be 64.2% lower (in other words, profits will be much lower).
- The generation of government revenue of all types (including taxes and royalties) risks being 72.6% lower.
- Capital expenditure on exploration risks being 51.7% lower.



- Overall capital expenditure risks being 60.3% lower.

The specific numbers are almost unimportant in these sorts of scenario exercises. The real point is the unmistakable message: in the transition from today's world to the carbon-constrained future, demand for oil and gas will be destroyed, prices will drop, and the economic contributions of those sectors to Canadian well-being will be much lower.

5.3 Oil and Gas Subsidies, Support, and Liabilities

The oil and gas sectors in Canada benefit from a wide variety of financial support, some of which is in the form of subsidies, extended by both the federal and provincial governments. In the calendar year 2020, the federal government gave CAD 1.91 billion in non-tax subsidies to the oil and gas sectors, with the lion's share coming from a CAD 1.5-billion program to clean up inactive wells in western Canada and CAD 320 million to support Newfoundland and Labrador's offshore oil industry (Corkal, 2021). These amounts are complemented by tax subsidies, for which data are not available. In addition to subsidies, government also provides other forms of support via public finance that can't be quantified due to lack of data. This support includes, for example, over CAD 21.27 billion in loans and equity infusion to the TMX (Corkal, 2021; Thurton, 2022), a CAD 675 million commitment to the Emissions Reduction Fund, and CAD 200 million in loans (with high credit risk) to Alberta's Orphan Well Association. While it is not a current expense, the burgeoning costs of the TMX, coupled with fixed toll rates for eventual users, means that taxpayers will likely be on the hook for at least CAD 17 billion if the asset is sold to private investors as planned (Allan, 2022). This figure is an estimate from 2022; as of early 2023, the cost for the project has increased to CAD 30.9 billion (Thurton, 2023).

Canadian provinces also give substantial support to the oil and gas sectors. For example, in 2021, Alberta incurred a one-time cost of CAD 1.3 billion for its support of the cancelled Keystone XL pipeline (Government of Alberta, 2022a). Among other support, it also incurred costs of CAD 866 million for divestment from the crude-by-rail program set up by the previous government; Alberta was also granted CAD 170 million in credits under legacy royalty adjustment programs (Government of Alberta, 2022a). The BC government has heavily supported the LNG export sector, including with special breaks for LNG Canada that add up to over CAD 100 million per year, locked in for 20 years (Lee, 2019).

Continued support of the oil and gas sector, including measures intended to provide environmental benefits, indicate a trend of governments providing support for projects for which the private sector has low interest in taking on risk on its own—passing on the financial risk for such projects to Canadian taxpayers.

Failing to make oil and gas operators fully responsible for their legal obligations to remediate their end-of-life assets is also a form of public support.



One could argue that failing to make oil and gas operators fully responsible for their legal obligations to remediate their end-of-life assets is also a form of public support. These liabilities are growing, meaning that risk to governments may also increase. As of June 2023, 3,118 oil and gas sites in Alberta are considered orphaned, meaning the original owners failed to fulfill their responsibility for costly end-of-life decommissioning and restoration (Orphan Well Association, n.d.). Many of those sites were strategically sold to insolvent operators (Lewis et al., 2018). Responsibility for them now falls to the industry-funded Orphan Well Association, but current industry contributions are grossly inadequate. The Association has CAD 169 million in assets against orphaned sites that it estimates will cost almost CAD 700 million to clean up (Orphan Well Association, 2022). Liability estimates for *all* existing sites are much higher, by some estimates reaching up to CAD 260 billion (De Souza et al., 2018). The difference has partly been borne by taxpayers through government loans and bailouts to treat inactive and orphaned wells (Government of Canada, 2020), violating the polluter-pays principle. But most orphan wells remain unremediated, and a large proportion of “active” wells are, in fact, inactive but not declared as such, meaning the farmers and ranchers on whose land they sit suffer the environmental and economic consequences (Boychuk et al., 2021).

5.4 A Business-as-Usual Future Is High-Risk

Canada’s oil and gas sectors, as described above, face peak demand within the next decade and poor market fundamentals thereafter, as climate and energy security policies worldwide work to replace fossil fuels as sources of energy. But both sectors are planning significant investments in increased capacity; Rystad’s E&P Country Analysis (as of February 2023) predicts that Canadian production of oil will increase by 14% between 2022 and 2030, and the figure for gas is 29%. For comparison, the Canada Energy Regulator’s Evolving Policies Scenario sees a 3% drop in gas production over the same period, but a comparable increase in oil production at 11% (Canada Energy Regulator, 2021). Those projected increases reflect a prevailing view in Canada’s oil and gas sectors—refuted in the previous two sections of this report—that climate policy will not effectively destroy demand for fossil fuels on the timelines demanded by the Paris Agreement targets, and that even if it does, Canada will find ample buyers and decent prices for its products in shrinking global markets.

This tension—between plans to increase production and predictions of demand destruction—translates into two important problems for Canada, and particularly for oil- and gas-dependent regions.

5.4.1 Overinvestment Will Result in Stranded Assets

First, there is a basic risk that overinvestment in these sectors will result in stranded assets (van der Ploeg & Rezai, 2020). Stranded assets in the oil and gas sectors are capital goods such as pipelines, upgraders, refineries, and wells that lose value prematurely or unexpectedly, in this case because demand for their products has dropped. At the global level, the potential loss of asset



value from fossil fuel stranding has been estimated at between USD 1,000 billion and USD 4,000 billion—a loss comparable to what occurred during the 2008 financial crisis. Canada has been singled out among the most vulnerable countries to such losses (Mercure et al., 2018). Mercure et al. (2018) calculate that, relative to a baseline scenario with no new climate policies, a scenario in which the Paris Agreement 2°C target is met and there is a rush to sell off fossil fuel reserves will feature the mass stranding of fossil fuel assets and a loss of GDP for Canada of over 20% per year throughout the 2030s. There is 7% less employment over the same period.

On its face, this looks like a risk that private sector investors have considered and accepted on the basis of different expected future scenarios, and it could be argued that such risks are not a matter for public policy concern. It is worth noting, though, that investment decisions are in part influenced by the structure of executive pay rather than by informed predictions about the future. For example, 45% of the management compensation packages at Canadian Natural Resources Ltd., Canada's largest oil and gas producer, are directly or indirectly linked to growth in production (O'Connor, 2022). However, even if we accept that overinvestment in oil and gas is purely a matter of private sector risk and choice, the reality of overinvestment in the oil and gas sectors should at least lead to a policy of no public financial support that would help increase productive capacity. Private risk is one thing, but risking taxpayer dollars to prop up a sunset sector with ever-diminishing returns in terms of jobs and government revenue is quite another.

5.4.2 Loss of Asset Value Impacts the Financial System

The second problem is that, even though increased oil and gas investment amounts to the private sector risking its own funds, overinvestment and the risk of stranded assets have broader public impacts. Loss of asset value is not something that happens to faceless companies; it is financial losses for equity investors, including pension funds, mutual funds, and other vehicles for private investment (Semieniuk et al., 2022). Given the significant value of fossil fuel loans and assets held by Canadian banks and insurance companies, high levels of stranding could be economically destabilizing. A scenario exercise focused on six federally regulated institutions found that they had credit exposure in the fossil fuel sector totaling CAD 71.6 billion (Bank of Canada & Office of the Superintendent of Financial Institutions, 2022).⁷ The scenarios, which are based on a global achievement of the Paris Agreement 2°C goal, describe a number of potential material risks to the Canadian economy and financial system. These risks include net loss of income for the oil and gas sectors of CAD 100 billion by 2050, and greater than double the risk of default for sectors such as oil and gas, crops, livestock, and refined oil products. They also include significant changes to the value of assets in a number of sectors—primarily related to fossil fuels—that, especially if they occur abruptly because climate action is backloaded to the future, may pose risks to the financial system and financial stability (Bank of Canada & Office of the Superintendent of Financial Institutions, 2022).

⁷ Credit risk is the amount the institutions would lose in the event of default. The six institutions were RBC, TD Canada Trust, Sun Life, Manulife, Intact Financial Corporation, and the Co-operators Group.



Moreover, we have seen what happens when the oil and gas sectors take an unexpected downturn. The COVID-19 pandemic and the associated oil price crash gave us a glimpse into what fossil fuel sector market correction would look like in Canada, and it has very clear public interest elements:

- Remediation and cleanup costs from abandoned oil and gas wells and facilities would be dumped onto taxpayers, to the tune of hundreds of millions of dollars (Corkal, 2020).
- Major portions of municipal taxes and landowner lease payments in producing regions would go unpaid (Boychuk et al., 2021).
- Governments would face pressure to stave off the inevitable: to grant oil and gas companies fiscal support and to sacrifice human health and the environment for their survival, exempting them from the burden of climate policies and other environmental regulations (Meyer, 2022).

In conclusion, there is a strong public interest in avoiding the disruptive crash that would result from overinvestment in Canadian oil and gas capacity in the face of predicted loss of demand and low prices. Much is at stake if governments and stakeholders take no action to anticipate the coming transition away from oil and gas as primary drivers of Canadian prosperity.

6.0

Mitigating Risks: Lessons from Other Jurisdictions



Summary:

- Evidence from case studies in other jurisdictions shows that a successful economic diversification from dependence on a declining fossil fuel sector involves implementing a three-part policy program:
 - Ambitious climate policy.
 - Energy policy that prioritizes managing the decline of fossil fuel extraction and/or uses.
 - Economic diversification policies to transition from fossil fuel extraction that prioritize social equity.
- This policy trifecta must be supported by a context of both top-down and bottom-up interjurisdictional governance dynamics with inclusive cross-society engagement. Clear policy direction and significant investment come from higher levels of government, while transition and diversification plans are developed and implemented with active engagement from communities and are adapted to local conditions and priorities.
- The primary insight from Germany, Denmark, Illinois, and Colorado is that to respond successfully to a declining fossil fuel sector requires proactive policy-making, responding to early signals of sector decline.

Given Canada's precarious dependence on oil and gas and the socioeconomic and climate benefits of shifting to low-carbon energy, an energy system transition is now a pressing policy priority. Other governments offer examples of successfully implementing economic diversification and equitable transition policies. This chapter presents the experiences of four jurisdictions: the U.S. states of Illinois and Colorado, as well as Denmark and Germany. Each of these examples, as well as Canada's initial effort to transition away from coal, demonstrates that Canada can weather the imminent decline in global oil and gas demand, and—if this decline is managed well—stands to gain considerable social and economic benefits.

6.1 The Coal Transition in the United States

The United States is a major global oil and gas producer that continues to expand production. Yet the United States has also managed economic diversifications away from coal that can inform responses to transitions away from fossil fuels more generally. Over the last decade, mine closures and early plant retirements meant that coal's contribution to the U.S. energy supply fell by half (Jakob & Steckel, 2022, p. 96), resulting in significant losses in government revenues and negative impacts on workers. Between 2011 and 2016, the nearly 700 coal-mine closures



resulted in the industry losing 43% of jobs, roughly 40,000 positions (Egli et al., 2022). Meanwhile, since 2021, the renewable energy sector (predominantly solar and wind) added 24,006 jobs to the economy (U.S. Department of Energy, 2022, p. 3). Paired with a growing awareness of the coal industry's health, environmental, and worker-safety risks, labour unions across the United States have begun to focus on creating decent jobs that build a low-carbon economy. Coal transitions in U.S. state cases are focused on eliminating coal use (coal-fired electricity generation). These bans exert downward pressure on coal production, which is predominantly used domestically.⁸

Canada can weather the imminent decline in global demand while gaining considerable social and economic benefits.

6.1.1 The Federal Framework for State-Based Energy Transitions

The Biden administration has positioned a decarbonization agenda at the forefront of post-pandemic economic recovery efforts. Given the coal sector's decline and high oil prices (IEA, 2022a, pp. 337, 419), developing clean energy and reducing American demand for oil is vital to the U.S. economy and global competitiveness. This agenda has been advanced by two recent pieces of legislation: the Infrastructure Investment and Jobs Act (2021) and the IRA (2022).

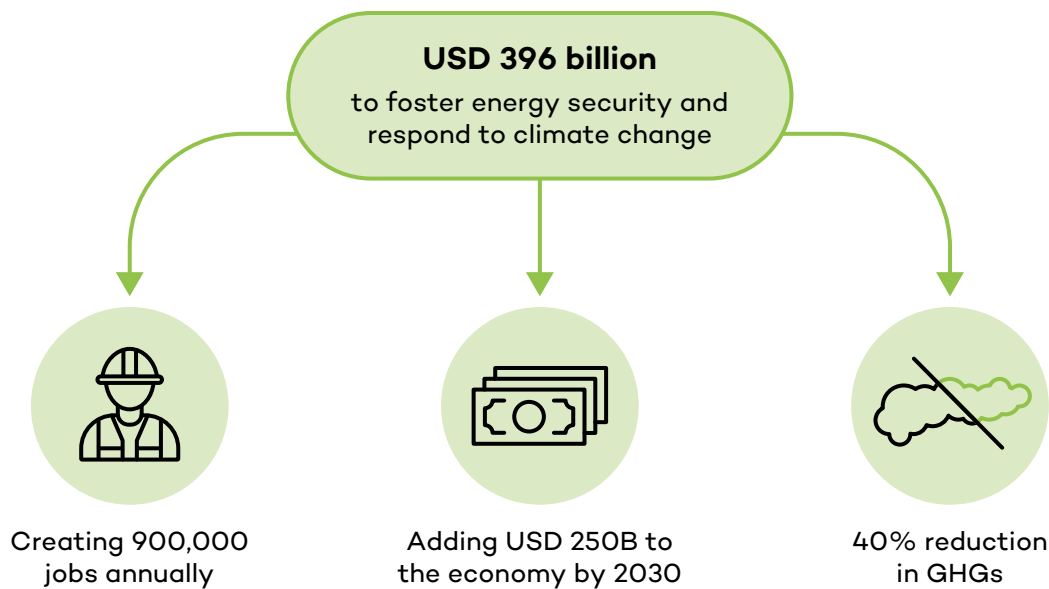
The Infrastructure Investment and Jobs Act focuses on enhancing infrastructure and bolstering the country's competitiveness while tackling the climate crisis with consideration for environmental justice and vulnerable communities. This Act commits to investing USD 65 billion in improving power infrastructure to produce and deliver clean energy and technologies to accomplish the country's net-zero commitments. As a result, reliance on fossil fuels would decline. The job-creation payback of this investment is substantial, particularly in the transportation, construction, and manufacturing sectors: the Act supports an estimated 770,000 jobs per year on average over 10 years (Hersh, 2021, p. 9).

Environmental justice and equity are at the core of the IRA, with funds earmarked for communities dependent on fossil fuel extraction, transportation, and storage, as well as disadvantaged and low-income communities generally. The IRA allocates USD 396 billion for energy security and climate change efforts via a combination of tax credits, grants, and subsidies, including a full suite of initiatives to move coal-dependent communities toward clean electricity (U.S. Senate, n.d.). The IRA is projected to add an estimated USD 250 billion to the economy by as early as 2030, reduce GHG emissions by almost 40%, decrease energy use via innovation and efficiency efforts, and add over 900,000 jobs annually to the U.S. economy in the next decade (Labor Energy Partnership, 2022; Pollin et al., 2022).

⁸ Nearly half of the coal produced in recent years in the U.S. was bituminous or thermal coal used primarily for electricity generation and in iron and steel production, and nearly half was subbituminous or brown coal, used mainly for electricity generation.



Figure 6.1. Impacts of the Inflation Reduction Act



Despite the continued expansion of U.S. oil and gas production and no explicit government regulation phasing out coal production at any level, federal decarbonization efforts and state bans on coal use have effectively resulted in declines in coal production.

6.1.2 Illinois's Transition Away from Coal

Illinois has produced primarily thermal coal for well over a century and today has the second-largest coal reserves in the United States (U.S. Energy Information Administration [EIA], 2022b). However, in response to declines in the coal sector and other risks, Illinois became the first among coal-dependent Midwestern states to commit to eliminating coal-fired power. While this commitment does not explicitly reference the phase-out of coal mines, phasing out coal plants is effectively winding down extraction in Illinois, as roughly 80% of the state's coal production is used primarily for in-state electrical generation (U.S. EIA, 2022b).

Coal mining has historically been a major employer in the state, as well as a significant economic driver, contributing approximately USD 1 billion to state revenue in 2021 (Statista, 2021). Yet the industry is declining. Since 2015, seven mines have closed (Callahan, 2020, p. 8). Coal jobs fell by half between 2013 and 2021, from 4,164 employees to 2,017 (Garside, 2022).

In response to the well-documented impacts of the climate crisis and documented health effects of coal on workers and citizens, Illinois's broad network of labour, business, and civil society groups articulated the need for an equitable clean energy transition (Crowe & Li, 2020; Sattler et al., 2018). Central to this effort was the Illinois Clean Jobs Coalition, led by grassroots groups focused on environmental justice and climate advocacy.



With growing discourse over a clean energy transition in Illinois, concerns started emerging over the possibility of diminished property values, noise, quality of life issues, and health worries (Brumleve, 2019; Marsh et al., 2021, pp. 12-13). Residents were concerned about losing tax funding and the economic activity historically attributed to the coal industry and were skeptical that renewable energy projects could provide the same level of economic activity to those communities (Lydersen, 2021). Illinois instituted a “coal to solar” initiative with the Future Energy Jobs Act (2016) to alleviate these competing public pressures, supporting the development of technology to replace coal while emphasizing community-based projects.



A coal storage and distribution facility in Illinois near St. Louis, Missouri. (Photo: Art Wager/iStock)

6.1.2.1 Climate and Equitable Jobs Act

Coal-to-solar efforts grew into the Climate and Equitable Jobs Act (CEJA; 2021), the state’s framework for transitioning Illinois to 100% clean energy by 2045. This Act sites solar and wind projects at retired coal-fired plants, helping to reduce local resistance to renewable energy creation and storage. The Act legislates all investor-owned coal plants to “permanently reduce all CO₂e and copollutant emissions to zero” by 2030, and requires the same of municipally owned coal-fired plants by 2040 and of gas-fired plants by 2045 (Climate and Equitable Jobs Act, 2021, 9.15). Though these requirements leave open the possibility for CCS to play a role, the environmentally focused Act encourages the shuttering of coal plants. It allocates USD 694 million a year to expand renewable energy projects and subsidize nuclear power development while transitioning workers via a set of workforce development initiatives and assistance programs (Gillus & McKibbin, 2022; CEJA, 2021).

The CEJA mandates that the Illinois Department of Commerce and Economic Development engage with community-based organizations to administer these programs. These organizations will be contracted to manage 13 hubs that establish formal partnerships with new and existing industries to bridge labour demand and offer worker training programs. They include technical skill development and certification test preparation (State of Illinois, 2021), with a specific focus on readying a workforce in solar and wind energy, energy efficiency, energy storage, and industry related to electrifying the automotive industry (Gillus & McKibbin, 2022). The programs particularly target workers and contractors who are Black, Indigenous and people of colour (BIPOC), as well as low-income and BIPOC communities.

Illinois’s transition and diversification policies have incited rapid growth in clean energy and transportation jobs, which grew by almost 5% in 2021 (Clean Jobs Midwest, 2022). The state



anticipates that thousands of jobs in renewable energy production will be created (State of Illinois, 2021).

6.1.3 Colorado's Phase-Out of Coal

Colorado's once-significant coal production has declined since peaking in 2007 (U.S. EIA, 2020).⁹ Employment has dropped from 2,537 employees in 12 active mines in 2012 to only 1,100 in six active mines in 2020 (Just Transition Advisory Committee, 2020, p. 14). In light of this decline, combined with growing environmental, climate, and health concerns, Colorado became one of the first U.S. states to manage a declining coal sector via an equitable transition that garnered significant political and public support (Mayer, 2018, 2022; The Office of Just Transition, 2022). Like Illinois, rather than banning coal production, Colorado has eliminated coal-fired electricity plants that were increasingly unprofitable compared to cheaper energy source alternatives (The Office of Just Transition, 2022).

Cross-society calls for an equitable transition translated into policy advances. Labour organizations were central to this effort, collaborating in inter-union discussions and working alongside local and national environmental, faith, and justice groups via events such as the 2018 Colorado Climate, Jobs, and Justice Summit (Cha et al., 2021). Despite some isolated instances of local resistance (Dabbs, 2021; Marsh et al., 2021, p. 7), Colorado's transition away from coal production was framed as an economic and moral imperative—a shift needed to protect communities from air pollution and water contamination associated with coal mining and the impacts of climate change, such as intensified droughts, heat waves, and wildfires in the state (Just Transition Advisory Committee, 2020, p. 10). In 2019, the state legislature established a binding 90% GHG emissions reduction relative to 2005 levels by 2050 (Williams et al., 2019).

6.1.3.1 Just Transition from Coal-Based Electrical Energy Economy Act

The Just Transition from Coal-Based Electrical Energy Economy Act (2019)—drafted in collaboration with unions and civil society organizations—legislated strategies to support workers and communities as the state exited coal production. For example, the Act created the Office of Just Transition in collaboration with the Colorado American Federation of Labor and Congress of Industrial Organizations, an assembly of union members across 180 affiliated unions (Colorado Department of Labor and Employment, 2022). The Office delivers funding and programs, which are shaped by unions' demands, to communities and workers affected by the transition away from coal production—for example, supplemental income for workers who lost pay when they transitioned to a new industry (Colorado Department of Labor and Employment, 2022).

The Just Transition Advisory Committee, also created under the Act, is composed of representatives from labour unions, coal communities, utility providers, and the public. It was established to develop an equity-based transition plan for the state (Colorado Department of Labor and Employment, 2022). The Office and its committee manage funding allocation for

⁹ Bituminous (thermal) and subbituminous coal has been mined in Colorado mainly for electricity generation.



worker-assistance programs, such as individualized financial planning programs, job search assistance, apprenticeship programs, and community economic development initiatives.

In addition to this support, IRA spending is expected to generate nearly 100,000 new jobs in Colorado over the next decade (Pollin et al., 2022). The state is already experiencing impressive growth in employment in the clean energy sector, up by 10% from 2017 to 2020. Today, about one in 50 workers in Colorado are employed in clean energy, primarily energy efficiency, renewable energy, and electric vehicles (E2, 2021; United States Energy & Employment, 2021).

6.2 Phasing Out Fossil Fuels in the European Union

The European Union provides a second major framework for economic diversification from fossil fuels to support its member states. Phasing out coal power generation is a European Union priority, given emissions from coal and the economic decline in the sector (World Resources Institute, 2021a). The European Union supported coal regions initially through the Initiative for Coal Regions in Transition launched in 2017 (European Commission, n.d.b). The 2019 European Green Deal (European Commission, 2021a) broadened the overarching policy to guide European Union member states in confronting the climate crisis. The 2021 European Climate Law then established a legally binding target for net-zero emissions in the region by 2050, with a 2030 target of at least 55% emissions reduction (compared to 1990 levels), to be achieved through “socially fair” and cost-effective policies (European Commission, n.d.a).

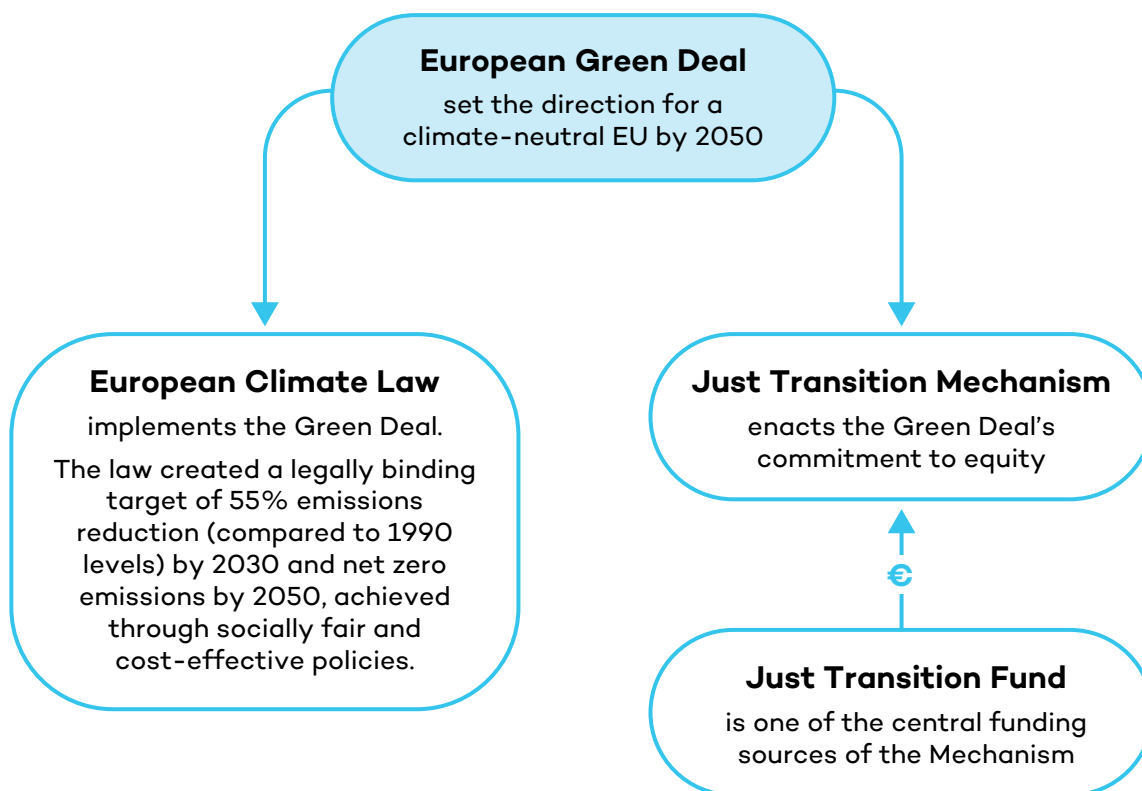


A wind turbine and coal power station in Germany. (Photo: iStock)

The Just Transition Mechanism is a framework that enables nation-states’ just transitions through policy support and direct funding via the EUR 17.5 billion Just Transition Fund and EUR 13.3 billion in grants and loans. The Fund primarily supports the transition away from fossil fuels in the most carbon-intensive regions that are likely to experience the most job losses. To access these funds, member states must develop equitable transition plans with support from the European Commission (European Parliament, n.d.). After Russia’s invasion of Ukraine, the European Commission launched REPowerEU in 2022 to hasten an end to fossil fuel dependence via a green transition.



Figure 6.2. The European Green Deal



In contrast to U.S. state cases that focus on eliminating the use of coal for electricity generation, resulting in further reductions in already-waning coal production, the European examples demonstrate an explicit phasing-out of fossil fuel production (oil in Denmark; coal in Germany).

6.2.1 Denmark's Wind-Down of Oil and Gas

Denmark is a globally significant example of a successful transition from oil and gas dependence to clean energy. The country has long been a major oil and gas producer, gaining extensive economic benefits from the sector—approximately DKK 544 billion since 1972 (Nordsøfonden, n.d.). However, aware of declining oil and gas production trends, the mounting urgency to act on climate, and the growing revenue and employment benefits from renewable energy, Denmark has chosen to phase out oil and gas production and implement policies to support a transition (Danish Ministry of Climate, Energy and Utilities, 2020).

Despite its considerable oil and gas reserves (BP, 2021; OECD, 2020), Denmark's oil and gas production peaked in 2005 and has been in steady decline. Existing oil and gas fields are anticipated to be largely depleted by 2040 (Danish Energy Agency, 2018; Sperling et al., 2021).



Firm interest in bidding on new licences in the North Sea has also waned, leading to losses and volatility in state revenue (Danish Energy Agency, 2016).

In response, Denmark has developed an equity-centred transition framework and funding package via its Climate Act (2020), with the tangential 2020 North Sea Agreement providing a particular focus on the seaport town of Esbjerg, where oil and gas activity is concentrated (Danish Ministry of Climate, Energy and Utilities, 2020).

6.2.1.1 Social Engagement in Denmark's Energy Transition

Denmark's transition effort is premised on open, transparent, and collaborative dialogue with government, industry, and labour organizations (Sperling et al., 2021). This dialogue, as well as awareness about a declining sector, minimized industry and local resistance to phasing out oil and gas production.

Experts and civil society organizations are also engaged in Denmark's energy transition via, for example, the national Climate Change Council, Climate Citizens Assembly, and Youth Climate Council. Based on the input of these groups, government then makes strategic investments to enable economic diversification. For example, DKK 90 million was allocated to support Esbjerg's transition, offsetting losses from ending oil and gas production (Krawchenko & Gordon, 2022), with investments in green energy industry development and expanding sustainable infrastructure (Port Esbjerg, 2019). Denmark supports green economic diversification by establishing and fostering partnerships and initiatives with businesses and labour groups. Denmark has supported the business community in establishing 13 climate partnerships with ambitious goals to reduce emissions and spark a green transition. Also, through close cooperation with energy enterprises and trade unions, the Danish government has developed training and retraining programs through the Offshore Academy (Port Esbjerg, 2020) that provide workers with the skills to work in the renewable energy industries and ensure that Denmark has the workforce it needs to become a global leader in the offshore wind sector. European Union funding has also been essential.

6.2.1.2 Political Agreements to Shift to New Industries

Denmark entered a Partnership Agreement with the European Commission on a EUR 808 million investment strategy for 2021 to 2027, focused on developing both green and digital sector growth (European Commission, 2022b). EUR 89 million in funds from the European Union's Just Transition Fund will assist Danish regions in their transition to a low-carbon economy, attending to expertise development, evaluating and demonstrating various circular economy pathways, and developing new technologies for emissions reductions and clean energy. Additionally, under the European Regional and Development Fund, EUR 247 million will aid in advancing Danish research and innovation and supporting the adoption and proliferation of advanced technologies.

In December 2020, the Danish Parliament signed into law the North Sea Agreement, cancelling all future licensing rounds for oil and gas and establishing 2050 as the end date for oil and gas



extraction, which was met with little local resistance from either the public or the oil and gas sector (Danish Ministry of Climate, Energy and Utilities, 2020).

Denmark's transition away from oil and gas production is occurring within the context of a growing renewable energy sector, which receives active support from both government and firms. In the late 2000s, the 50% state-owned former oil and gas company Ørsted (formerly Danish Oil and Gas) shifted its focus to wind energy (van Est, 2022). Through the 2012 Energy Agreement, Denmark committed to achieving 100% renewable energy (predominantly wind) by 2030, phasing out fossil fuel use (IEA, 2020). As of 2021, fossil fuel sources made up less than 30% of Denmark's electricity production, while renewable energy production increased by approximately 300%. Wind energy is now the largest share of primary energy consumption and electricity (IEA, 2021a). In 2019, 1,565 people were directly employed in Denmark's oil and gas sector (Statista, 2022), while the wind industry alone directly employed 33,159 people (State of Green, 2021). As for revenue, the wind industry contributes substantially to taxes, providing DKK 13.8 billion in revenue in 2018 (State of Green, 2021). While oil and gas production is in decline, and therefore so are revenues and employment from the sector (Sperling et al., 2021, p. 20), the renewable energy sector is more than offsetting those losses.

6.2.2 Germany's Pivot from Coal

Germany has had over three decades of experience restructuring its economy to end its reliance on coal, a shift initially driven by declining prices for coal and later by ambitious climate policy since the mid-2000s (Gärtner, 2019). Coal mining has been a fulcrum of the economy since the late 1800s. However, black (also called anthracite or hard) coal production, used mainly in iron and steelmaking, declined sharply in the 1960s and has continued to decline since the 1980s due to competition from cheaper imported coal (Furnaro et al., 2021; Galgóczi, 2014; Ruppert Bulmer et al., 2021). Germany remains the largest global producer of lignite or brown coal, the most carbon-intensive form of coal used primarily in electricity generation, and continues to burn the most coal in the European Union (Furnaro et al., 2021; SEI et al., 2021, p. 50).

Germany has unified its energy and climate policy, notably via its Integrated National Energy and Climate Plan (2019), which includes phasing out black coal mining according to social justice principles to meet its decarbonization goals (SEI et al., 2021, p. 52). Though it is the last wealthy Western European country to phase out coal and among the last in the European Union, Germany continues to ratchet up climate ambitions: it made amendments to the Climate Change Act (2021) enhancing targets to reach carbon neutrality sooner (by 2045) and committed to achieving at least 65% emission reductions by 2030 (up from 55%) compared to 1990 levels (Federal Cabinet of Germany, 2021).

The coal industry and unions at first resisted the German federal government's top-down effort to transition from coal from the late

Colorado's transition away from coal production was framed as an economic and *moral* imperative.



1960s to the early 1980s. Large companies instead sought continued subsidies to stabilize coal demand (Gärtner, 2019). However, Germany's history of a more cooperative approach established before the 1980s—involving local, state, and national governments, combining union and private firms, and including workers' participation—was preserved and enhanced, helping to lessen local resistance in the 1980s (Galgóczi, 2014; World Resources Institute, 2021b). Increased stakeholder engagement came not from explicit policy agendas, but from the downscaling of the coal and steel industries due to harder-to-reach reserves and trade liberalization (Galgóczi, 2014, p. 221). In 2007, coal companies, unions, and governments (federal and state) agreed to a managed closing of anthracite (hard) coal mines by 2018.

6.2.2.1 German Coal Commission and Policy Frameworks

The 2019 Commission on Growth, Structural Change and Employment (known as Germany's Coal Commission) proposed that regions dependent on coal mining be the sites of pilot programs to build up low-carbon industries, with funds allocated by the Commission. In 2020, Germany enacted the Coal Power Generation Termination Act to end lignite production and use for electricity generation by 2038, paired with the Structural Support for Coal Regions Act, which provides investments for economic restructuring and employment creation in regions affected by the phase-out (Corkal & Beedell, 2022; Federal Government of Germany, 2023a, 2023b).

Germany developed a comprehensive policy framework for an efficient and renewable energy economy through substantial public investments made by local, state, and federal governments, as well as the European Union (Galgóczi, 2014). Funding has been used to diversify coal-dependent regions through innovative industrial policy (Galgóczi, 2014; World Resources Institute, 2021a). Germany's Structural Development Act (2020) earmarked EUR 40 billion to support the transition of formerly coal-dependent regions and compensation for coal-fired plant operators (SEI et al., 2021, p. 52). National diversification and transition funds are supplemented with European Union funds, such as the Just Transition Fund, which will transfer EUR 2.5 billion to German coal regions between 2021 and 2027 to support new industries (district heating, land rehabilitation, and green hydrogen) and job training to ensure that coal workers can retain employment in emerging sectors (European Commission, 2022a).

These investments focus on developing infrastructure; new manufacturing sectors such as steel; new post-secondary education in coal areas; and the cultural, tourism, and service sectors. Workers directly impacted by the phasing-out of coal mining also receive targeted support. For example, the 2007 agreement by the government, firms, and unions to close black coal mines included a comprehensive package for workers, with wage safeguards, opportunities to transition to another region and sector, job retraining based on labour market data, support for finding new work, and early retirement options, all overlaid on Germany's existing social welfare systems (Galgóczi, 2014; World Resources Institute, 2021a). The Ruhr Coal Vocational Training Society developed a strategy to secure employment for every displaced coal worker with input from local governments, firm management, and other community partners (Goel et al., 2023). Such efforts are helping to advance Germany's role in new and emerging sectors.



Germany's restructuring efforts significantly impacted its employment growth and its energy transition. Virtually all jobs lost in the coal sector were replaced with jobs in manufacturing over the 1960 to 2001 time frame (World Resources Institute, 2021b). The number of jobs in the renewable energy sector almost tripled between 2000 and 2021. In 2021, the industry was responsible for 340,000 jobs, with wind and biomass power accounting for the largest share (Wilke, 2020).

6.3 Initial Insights from Alberta's Coal Transition

Canada has already experimented on a small scale with a coordinated transition from coal-powered electricity. Ontario was the first jurisdiction in Canada to phase out coal power generation. It successfully completed the transition in 2014 (Harris et al., 2015). In 2012, the federal government implemented the Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations, which established standards for both new and end-of-life coal-fired electricity generation units (Government of Canada, 2023a) but would not have phased out coal power before 2050. In 2015, the Government of Alberta committed to phasing out Alberta's coal-fired electricity by 2030. This commitment was based on the Alberta government's 2015 Climate Leadership Plan commitment to eliminate emissions from coal power generation by 2030, which it planned to accomplish by converting coal power stations to burn natural gas (Government of Alberta, 2018). In practice, this phase-out has been implemented ahead of schedule, with the last coal-to-gas conversions scheduled for 2024—six years ahead of the regulated timeline. Via its Renewable Electricity Act (2016), Alberta also committed to ensuring that 30% of electricity produced in Alberta comes from renewable energy sources by 2030. In 2016, to complement Alberta's leadership, the federal government committed to a national phase-out of coal power.

6.3.1 Task Force on Just Transition for Canadian Coal Power Workers and Communities

To support these commitments, Canada initiated the Task Force on Just Transition for Canadian Coal Power Workers and Communities in 2018 and launched the Canada Coal Transition Initiative that same year, providing CAD 35 million over five years for skills development toward a low-carbon economy. The 2020 Canada Coal Transition Initiative—Infrastructure Fund committed another CAD 150 million over five years to infrastructure investments fostering communities' transitions away from coal. For its part, the Alberta government supports transition programs for coal workers through the Coal Community Transition Fund, focused on community initiatives enabling a transition away from economic reliance on coal-fired

Aware of declining production trends and the growing economic benefits from renewables, Denmark has chosen to phase out oil production and implement policies to support a transition.



generation, as well as the Coal Workforce Transition Program that provides financial assistance for re-employment, retirement, relocation, and education for workers.

This joint federal-provincial coal phase-out was in partnership with the Alberta Federation of Labour, which coordinated labour-movement involvement in administering transition support measures for workers via the Coal Transition Coalition (Krawchenko & Foster, 2021). One strength of this federal-provincial effort was the involvement of stakeholders across environmental groups, labour unions, and civil society organizations in developing a transition plan that would respond to specific communities' needs (Corkal & Beedell, 2022, p. 5). However, it provided only short- to medium-term solutions, with little commitment to long-term resources (Corkal & Beedell, 2022; Krawchenko & Foster, 2021). Also, fund allocation was not guided by a coherent plan for economic diversification, and there was insufficient collaboration and information-sharing from private firms to other impacted stakeholders (Corkal & Beedell, 2022).

6.3.2 Impacts of Coal Phase-Out in Alberta

Phasing out coal power generation appears to have reduced coal extraction in Alberta, yet even so, mining continues as exports remain steady. Since 2016, coal production has declined, notably over the most recent period: from 2021 to 2022, subbituminous (or brown) coal production declined by 36% and bituminous (thermal) coal by 22% (Alberta Energy Regulator, 2022d). The Alberta Energy Regulator predicts that total coal production will fall significantly between 2023 and 2031 as Alberta transitions away from coal-fired power generation (Alberta Energy Regulator, 2022b). Subbituminous coal production is expected to decline to nearly zero by 2024. Yet international demand for thermal coal and metallurgical coal remains significant. Exports of metallurgical and bituminous coal have held steady in the past decade (Statistics Canada, 2018). Still, the Alberta Energy Regulator anticipates that competition from increased international supply of bituminous coal production will result in declines in Alberta (Alberta Energy Regulator, 2022a).

The Alberta government has sent mixed signals on possible mining expansion. In 2020, it rescinded a decades-old Coal Development Policy that banned open-pit coal mining in ecologically sensitive areas. After public opposition, the policy was reinstated in 2022, with a commitment that all future coal explorations in ecologically sensitive lands would be prohibited pending public consultation. These instructions, however, exclude coal mine proposals outside of sensitive lands and have yet to become legislation.

Germany's restructuring effort significantly impacted employment growth and its energy transition.

Through the joint federal-provincial Alberta coal power phase-out, Canada has had some initial experience with implementing a transition away from coal use, which also appears to impact production, by establishing federal environmental regulations that promote transition policies



within its provinces. In 2021, the federal government also made a commitment to end thermal coal exports—of coal originating from Canada, as well as that imported from the United States—by no later than 2030.

Now, to support a much larger transition, Canada can learn from outstanding cases of governments that have managed declining extraction in their fossil fuel sectors by creating a new industrial strategy to diversify the economy—all while securing social equity and reducing emissions to aid in minimizing local and provincial resistance to the transition.

6.4 Conclusion: A Policy Trifecta for the Low-Carbon Transition

The U.S. state cases and European Union examples show how global leaders have advanced economic diversification and equitable transition policies with both socio-economic and climate benefits. Notably, governments that have successfully managed the transition chose to provide clear and long-term signals to the fossil fuel sector about the necessity to cut emissions in addition to the ongoing decline in fossil fuel production. Even though, in some cases, significant short-term revenue from extraction was still flowing, each government acknowledged the dual realities that their fossil fuel sector was waning and that there was a real imperative to reduce fossil fuel use and extraction to meet climate goals and mitigate climate impacts. Each also recognized the low-carbon sector's economic and job growth potential. Therefore, these governments invested in a diversified economy by developing low-carbon energy industries and transitioning oil and gas workers to new sectors.

6.4.1 The Need for Proactive Response

Importantly, these governments acted *proactively* to transition in response to early signals of fossil fuel sector decline.

- From the 1960s onward, **Germany** actively responded to coal production downturns and continues to enlarge economic and transition policies to support communities impacted by the demise of the coal sector.
- After a particularly sharp decline in coal production in 2015, **Illinois** introduced comprehensive state legislation to respond to this challenge. Illinois's first major economic diversification legislative response, the Future Energy Jobs Act, was passed in 2016.
- **Colorado**'s response was slightly slower: While coal production had been falling since peak production in 2007,

These governments acted *proactively* to transition in response to early signals of fossil fuel sector decline.



the Just Transition from Coal-Based Electrical Energy Economy Act was not passed until 2019.

- Similar to Colorado, oil production in **Denmark** peaked in 2004–05, and the country reshaped its approach to the sector, notably by cancelling future licensing rounds in 2020.

The experiences of these governments indicate that successful transitions take time, and it is better to start early—at the earliest sign of sector decline—as diversification can require a multi-decade policy effort, as shown in the case of Germany. Advance preparations are needed to forestall the kind of socio-economic disruption and dislocation caused by a sharp decline in the fossil fuel sector that is anticipated for Canada’s oil sector after 2030 (Cosbey, 2022a, pp. 5-11). Encouraging and supporting a managed decline of fossil fuel extraction across Canada’s provinces is preferable to an unmanaged crash.

Encouraging and supporting a managed phase-out across Canada’s provinces is preferable to an unmanaged crash.

6.4.2 Economic Diversification and Industrial Policy

These cases also demonstrate that a successful transition away from dependence on a declining fossil fuel sector hinges on large-scale economic diversification and the renewal of industrial policy, achieved through inclusive processes and significant public investment.

- Illinois’s CEJA allocates USD 580 million a year for developing wind and solar energy and transitioning the workforce from coal to renewables.
- Germany’s Structural Development Act (2020) earmarks EUR 40 billion until 2038 to remake the labour forces and communities of formerly coal-dependent regions (Federal Government of Germany, 2023a).

The employment and revenue gains from growing new and low-carbon industries reinforce support for the transition in these jurisdictions. More ambitious climate policy, notably aggressive emission reduction targets, would likely have been impossible without the surge in wind energy jobs poised to overtake oil sector job losses.

6.4.3 Three Critical Policies for Equitable Transition

When looking across these cases (see Figure 6.3), we can see three central interacting policies that together support an equitable transition and economic diversification.

1. The first is **ambitious climate policy**: ambitious targets and timelines for emissions reductions with near-term milestones.
2. This policy is aligned with **energy policy that prioritizes managing the decline of fossil fuel production and/or use**. Though Canada is unique in the sense that provincial

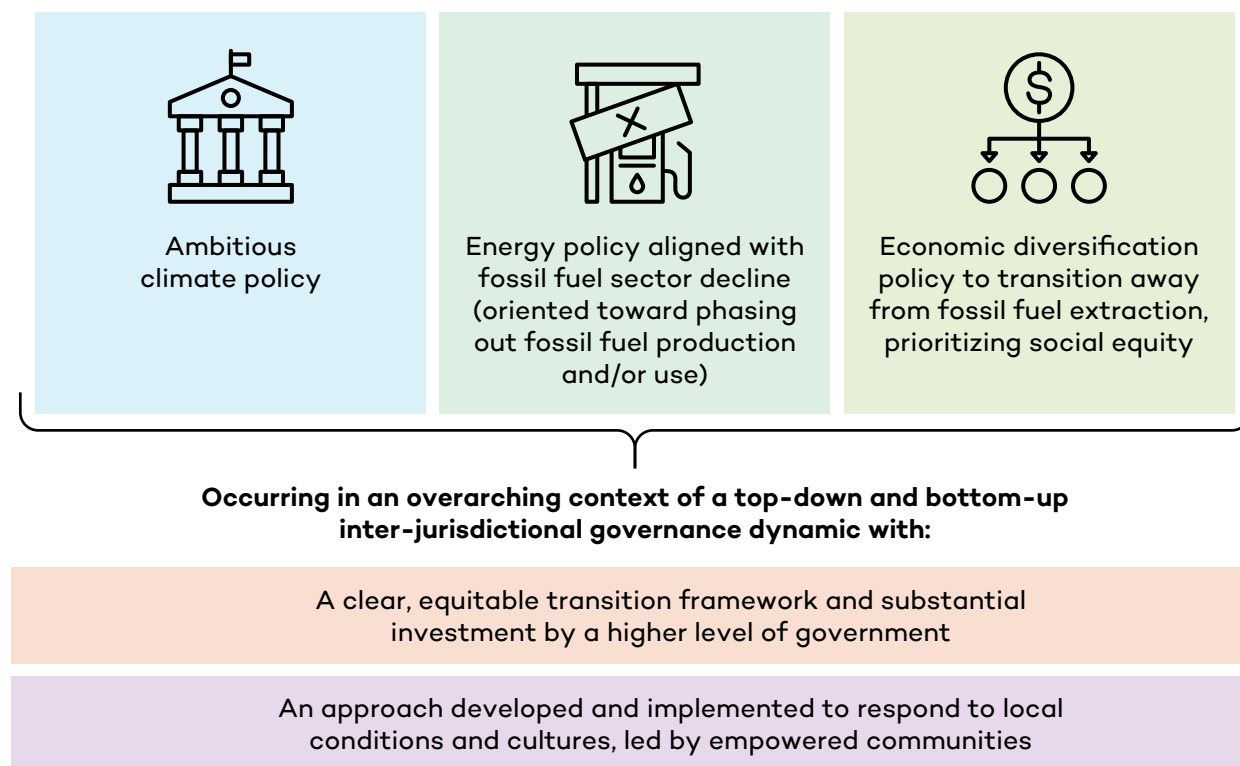


governments control resource extraction within their borders, federal governments can provide accurate signals about the precarious future of the sector by, for example, removing subsidies that create market distortions, putting an end date on fossil fuel extraction, and, in some cases, ending major fossil fuel uses.

3. Finally, these governments also have developed **economic diversification policies to transition away from fossil fuel extraction, prioritizing social equity** for workers, impacted communities, and society.

This policy trifecta unfolds in the broader context of a clear, equitable transition framework and substantial investment by a higher level of government (the federal government in the U.S. state cases; the European Union in Denmark and Germany). Canada’s energy and climate policy landscape is complex, in great part due to the intricacies of federal-provincial relations and split jurisdiction. Yet Canada is not unique in this regard. The cases presented here demonstrate that a dual top-down and bottom-up interjurisdictional governance dynamic supports effective transitions. Funding and overarching direction come from the top (the European Union or U.S. federal government), while transition and diversification policies and plans are developed and implemented from the bottom, where they can be adapted to local conditions and cultures.

Figure 6.3. Policy moves for effective, equitable transition and economic diversification





6.4.4 Embedding Social Engagement

A successful transition thus requires **early, continuous, transparent, and inclusive engagement with a full spectrum of stakeholders**, including labour, business, civil society, all levels of government, and the wider community, as well as vulnerable groups in affected communities. In this way, transition plans are implemented to respond to the priorities of impacted communities.

All the cases explored here exhibit deep societal engagement in the transition and economic diversification process via broad coalitions. In Illinois, the Department of Commerce and Economic Development is mandated through the CEJA to work with community organizations to deliver transition programs. Colorado engaged the labour movement and civil society organizations in drafting the 2019 Just Transition from Coal-Based Electrical Energy Economy Act. In both these U.S. states, political pressure for equitable transition and economic diversification was developed and channeled via broad-based coalitions involving labour, environment, faith, justice, and other groups.

Similar society-wide engagement can be seen in the two European cases. For example, a growing social movement for climate action in Denmark was central to the country's ambitious climate policy and ban on oil and gas licencing. Labour, business associations, civil society organizations, and experts participated in energy and climate policy through formal partnerships and institutions such as the Climate Change Council and initiatives such as the 2020 Climate Citizens Assembly. Meanwhile, Germany has developed a cooperative approach to economic restructuring since the late 1980s, seen most recently in the 2019 Coal Commission to create a strategy to transition away from coal extraction through deep social engagement.

To find socio-economic stability at a time of increasingly precarious global oil and gas demand, as well as mounting climate crisis impacts, Canada can follow the lead of other jurisdictions that have successfully navigated similar pressures by implementing the policy trifecta of climate, energy, and economic diversification in the context of top-down and bottom-up interjurisdictional governance dynamics with inclusive cross-society engagement.

7.0

Managing Decline in Canada's Oil and Gas Sector





Canada's oil and gas sector provides economic benefits both nationally and to the provinces in which they operate. In 2021, with the sector rebounding from the pandemic dip, oil and gas activities comprised a significant portion of the GDP for Newfoundland and Labrador (32%), Alberta (28%), and Saskatchewan (15%). However, increased profits that began in 2021 and reached record levels in 2022 (Bakx, 2023) do not represent a lasting recovery for the sector. Driven by global dynamics, the energy sector, as a whole, is rapidly changing. With clear signs of significant technological disruption, business as usual in the oil and gas sector is no longer an option.

The implications for the Canadian oil and gas industry could be severe. The impact of the pandemic illustrated how unexpected disruption can affect investment and employment in the sector, as well as the reliability of government revenues. However, even in upswings, the industry has shown signs of weakness. Since 2014, employment in the sector was already trending downward: as detailed in Chapter 5, the oil and gas industry in Canada cut over 53,000 jobs from 2014 to 2019 (Hussey, 2020). The sector then shed over 17,000 more jobs within the first year of the pandemic (Stanford, 2021).

At the same time, oil and gas companies have built up significant liabilities and do not have the financial reserves to pay them down. Even in years like 2022, with record production and profits, the oil and gas sector continued to accumulate liabilities—which will most likely be borne by the public—while drawing on extensive public subsidies and hinging investments in emissions reductions on additional public supports. This situation is problematic and unsustainable, given that the sector is entering a period of permanent decline and will not rebound.

A key driver of declining global demand is cost-effective, low-carbon alternatives for key oil and gas end uses. The primary end use for oil is road transportation. The rapid uptake of EVs, now driven up the S-curve by market forces rather than climate policy, will lead to the permanent destruction of demand for oil. Since new demand in plastics and petrochemicals will not offset the losses, global oil demand will peak and begin to decline around 2030. The largest share of global gas demand (39%) goes to electricity generation. The costs of wind, solar, and storage technologies are now competitive with combined-cycle gas in many jurisdictions. Similarly, heat pumps are now emerging as an efficient means to electrify heating and cooling in residential applications, as well as in some industrial processes (Liebriech, 2023).

A key driver of declining global demand is cost-effective, low-carbon alternatives.

Deployment and the scaling-up of supply chains has been accelerated by responses to Russia's invasion of Ukraine and the resulting energy crisis. To limit reliance on Russian gas and manage supply disruptions, the REPowerEU package increased targets for energy efficiency, clean fuels, wind power, solar power, and heat pump deployment—accelerating the structural transformation away from gas. In the United States, the IRA has injected USD 370 billion into clean energy infrastructure and supply chains (The White House, 2022). This investment will drive innovation and learning for competitor technologies, lead to reduced demand in Canada's main export



market, and potentially drive down prices for both oil and gas (Jenkins et al., 2022). While many jurisdictions faced record prices and serious supply constraints in 2022, the response in key markets has been increased investment and deployment in the competitor technologies that will ultimately result in global demand destruction for both oil and gas.

These trends in the deployment of clean technologies will have implications for domestic demand for oil and gas. Even more importantly, because the Canadian industry is export-oriented, the overall outlook for the sector depends almost entirely on the global outlook. While the declining trajectory for global oil demand is clear, the global outlook for gas is more uncertain. However, high LNG prices have slowed demand in growth markets while also leading to a rush of new LNG developments. The anticipated result is a glut of LNG, starting in 2025, that will drive down prices and make it difficult for Canadian exports to compete, even if low prices keep demand high.

While current scenarios are not aligned with 1.5°C pathways, they are veering away from business-as-usual pathways.

Global climate ambition has increased exponentially in recent years and it is reasonable to expect governments around the world to continue to accelerate market shifts away from fossil fuels and toward clean energy. Thus, while current scenarios are not aligned with 1.5°C pathways, they are veering away from business-as-usual pathways at a rate that signals significant disruption for the oil and gas sector.

From a climate perspective, every fraction of a degree of warming matters. The consequences, for Canadians and the planet, of not aggressively mitigating climate impacts are unacceptable; significant economic, social, and environmental costs are associated with failing to act with the needed urgency. Thus, the question is not whether governments should act decisively to mitigate climate change; it is how to best determine and incentivize the pathways that will deliver more secure socio-economic returns.

Scenarios that are aligned with 1.5°C and include feasible amounts of carbon removal and storage show that planning for climate success requires planning for the declining production of both oil and gas (Bois von Kursk & Muttitt, 2022). Since there is no reason to believe Canadian exports will have an advantage in declining energy markets based on either cost or ESG considerations, preparing for and managing the decline of oil and gas production is also economically prudent. Regardless of whether the world successfully moves to a 1.5°C pathway or the current pace of change continues, governments need to prepare for declining fortunes in the oil and gas sector that, if unmanaged, will result in reduced and unreliable government revenues, job losses, community disruption, and increased pressure for government subsidies.



7.1 Governments Need to Set the Pace of Decline

Although policies to limit climate change are driving supply and demand trends, such policies alone are not able to facilitate soft transitions. Market-led transitions, for their part, can be brutally hard on workers and on dependent communities. Markets alone cannot provide the necessary long-term planning or support the overall public interest in a rapidly changing context; this is the role of government.

The federal government's current approach is to focus on driving down emissions in the oil and gas sector through regulations and incentives, and to support workers impacted by the global energy transition via sustainable jobs policy and legislation. As the analysis in Chapter 6 illustrates, these strategies are foundational to managing a declining industry, but they are insufficient. Fiscal policy continues to subsidize the sector without strategically preparing the Canadian economy for structural decline.

Given the plans for increased production in Canada's oil and gas sectors, allowing markets to decide the rate of change in Canadian oil and gas production comes with a number of risks. These include:

- An unpredictable rate of change, making planning difficult and leaving workers and the economy exposed to volatile market dynamics.
- The potential for overinvestment, leading to significant stranded assets and the potential destabilization of the Canadian economy.
- Not decarbonizing the economy fast enough to avoid the worst climate impacts, including economic costs related to climate change.
- Opportunity costs from private and public investment flowing to sunseting industries rather than growth-oriented industries.
- A greater chance of disruptive shocks or collapse without adequate time for workers and communities to adapt or for alternative economic pathways to be developed.
- Further entrenchment of infrastructure and investment making the transition more difficult and costly.

An economic sector in decline does not necessarily equate to a smooth transition—especially for workers and communities that depend on the sector. As examples from other jurisdictions illustrate, limiting disruption and shocks, diversifying economies, adjusting labour markets, and redirecting investment all require time and deliberate planning. In the transition away from oil and gas, there is also a need to ensure that clean energy infrastructure and capacity is scaled at a pace that aligns with the decline of fossil fuel supplies. A more proactive approach to managing a declining industry, that includes the deliberate phase-down of production, has numerous advantages.

Deliberately setting the pace for decline can provide:



- A clear trajectory and end-point for the sector to spur planning and help ensure that investment and resources support matching supply with demand, transitioning workers, and avoiding environmental liabilities.
- Early signals that a transition is underway to allow time for the necessary adjustment of capital, infrastructure, and labour markets—a process that may take decades.
- A signal to investors to avoid overinvestment.
- A signal to investors to redirect investment toward clean energy sources and industries.
- Direction and incentives to disentangle the economy from the oil and gas sector—a necessary step to limit the economic and social disruption of the sector's decline.
- Opportunities for global leadership by being an early mover and spurring other countries to overcome the collective action problem that drives climate inaction.
- A rationale for redirecting government dollars toward supporting workers, communities, economic diversification, and critical components of net-zero pathways.

7.2 Recommendations for the Federal Government

Governments have an important role to play in ensuring that the coming transition away from oil and gas is as smooth as possible for Canadian workers and businesses. Most significantly, this involves sending a signal that investors and firms should be proactively preparing for and guiding the decline of the sector.

Federal action to manage a declining oil and gas sector is not a straightforward issue in the Canadian context. Provinces have jurisdiction over natural resource development and there is a pattern of provincial governments challenging federal environmental policies based on the claim of federal overreach. Nevertheless, the federal and provincial governments have shared jurisdiction over the environment, and the federal government has other avenues for action, for instance via fiscal or export policy. Further legal and economic analysis is needed on the options and policy pathways available to the federal government. However, the federal government has a clear role to play in ensuring that all Canadians are supported in the transition, with a focus on those workers, communities, and provinces that are over-dependent on oil and gas. The federal government also has a clear role to play in preparing Canada's economy for a decline in the sector.

The phase-out of coal power provides a compelling example of federal-provincial cooperation spurring effective and dramatic policy change and demonstrates how the federal government's approach enabled action across the country. In this case, provinces provided the initial leadership. First Ontario and then Alberta regulated provincial phase-outs of coal power. These changes made it politically possible for the federal government to regulate the phase-out of coal power in the remaining provinces. Although this shift has not ended the production of thermal coal, and the process has provided important lessons on how to improve support for workers and communities, phasing out coal power has nonetheless driven GHG emissions reductions in



Canada. It has also been an important enabling policy that, by reducing the emissions of the electricity grid, has increased the impact of electrification (for example, in transportation), since electricity is no longer fossil fuel-based.

Although the federal government must tread carefully in policies that will influence the production of oil and gas, there are four immediate policy areas that can begin the work of preparing for and guiding a declining oil and gas sector.

Recommendations



1. Continue to implement and strengthen climate policies and the Sustainable Jobs Action Plan. The government should base these policies on robust and internationally credible sectoral analysis of the future of the oil and gas sector, including projections for demand and employment.
 - a. Ratchet up ambition to align federal climate policy with 1.5°C pathways for individual sectors and the economy as a whole.
 - b. Strengthen the Sustainable Jobs Action Plan to ensure that policy is informed by sectoral analysis, including clear projections for the oil and gas industry with modelled net-zero pathways and projected future job levels.



2. Support subnational and Indigenous governments' plans and programs on economic diversification. The Regional Energy and Resources Tables are a start, but they must be fully aligned with sectoral analysis, net-zero pathways, and inclusive processes, including social dialogue.
 - a. Build on the existing Regional Resource and Energy Tables, ensuring that they are clearly linked and accountable to sustainable jobs principles and legislation and that participation includes Indigenous and subnational governments and organized labour and workers, with additional engagement with civil society organizations.
 - b. Ensure that industries and projects supported through the Tables, including via the Futures Fund, align with 1.5°C pathways, do not prolong oil and gas production, and are informed by credible sectoral outlooks.
 - c. Establish additional mechanisms, via forthcoming sustainable jobs legislation, to enable regional and sectoral transition planning and implementation to support a managed decline.
 - d. Increase funding to existing agencies and initiatives that seek to foster economic diversification in over-dependent regions, working through, for example, Alberta Innovates, Prairies Economic Development Canada, Pacific Economic Development Canada, Atlantic Canada Opportunities Agency, Innovation, Science, and Economic Development Canada and others. Ensure that their results are fully aligned with 1.5°C pathways and sustainable jobs principles and legislation.



3. Align fiscal policy to the reality of the expected decline of oil and gas sectors. This includes eliminating fossil fuel subsidies and public finance, tightening regulation of the financial sector, and ensuring that government spending is not risking taxpayer dollars by prolonging or increasing production.
 - a. Move decisively on existing commitments to remove fossil fuel subsidies and domestic public finance for fossil fuels. No additional public support should be provided for decarbonization in the oil and gas sector.
 - b. Assess federal spending to ensure that it is not artificially prolonging the industry and is instead aimed strategically at smoothing the transition and supporting Canadians.
 - c. Regulate the financial sector, requiring financial institutions to develop and regularly report on credible climate plans that align with 1.5°C pathways.
 - d. Divest federal public investment funds, such as the Canada Pension Plan and Investment Board, from fossil fuel production.



4. Explore tools within federal jurisdiction to limit expansion and prepare for the phase down of production and use of oil and gas. This step includes discussion with subnational governments on collaborative solutions, considering the implications of declining production in areas of federal responsibility, and exploring options and legal limitations that respect jurisdiction while addressing sectoral transformation.
 - a. Explore the options and legal limitations for federal action to phase down oil and gas production.
 - b. Use existing authority under the Impact Assessment Act to limit new oil and gas projects and expansions.
 - c. Begin a discussion with provinces, perhaps beginning with leaders such as Quebec, on collaborative approaches to phasing down the use and production of oil and gas. Include Indigenous, municipal, and regional governments in areas related to their rights and jurisdictions.
 - d. Consider the implications of declining oil and gas production in areas of federal responsibility—for example, the regulation of interprovincial and international pipelines.
 - e. Examine the decline rates of existing oil and gas fields and determine 1.5°C-aligned phase-down pathways that match domestic demand with the planned scale-up of clean energy supplies.



References

- Alberta Energy Regulator. (2022a). *Coal demand*. Alberta Energy Regulator. <https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/coal/demand>
- Alberta Energy Regulator. (2022b). *Coal production*. Alberta Energy Regulator. <https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/coal/production>
- Alberta Energy Regulator. (2022c, May 30). *Crude oil methodology*. Alberta Energy Regulator. <https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st98/crude-oil/methodology>
- Alberta Energy Regulator. (2022d). *Highlights: Alberta energy outlook 2022*. Alberta Energy Regulator. https://static.aer.ca/prd/documents/sts/ST98/2022/ST982022_highlights_infographic.pdf
- Allan, R. (2022). *Trans Mountain: Compromised viability to cost taxpayers more than \$17 billion*. West Coast Environmental Law. <https://www.wcel.org/publication/trans-mountain-compromised-viability-cost-taxpayers-more-17-billion>
- Babb, C. (2016). *Mexico's oil market challenges and Canada*. Policy Options. <https://policyoptions.irpp.org/fr/magazines/novembre-2016/mexicos-oil-market-challenges-and-canada/>
- Bank of Canada & Office of the Superintendent of Financial Institutions. (2022). *Using scenario analysis to assess climate transition risk*. <https://www.bankofcanada.ca/wp-content/uploads/2021/11/BoC-OSFI-Using-Scenario-Analysis-to-Assess-Climate-Transition-Risk.pdf>
- Bakx, K. (2023). *Historic profits in oilpatch on track to continue as global oil demand set to jump yet again*. CBC. <https://www.cbc.ca/news/canada/calgary/bakx-oil-profit-cashflow-climate-1.6750496>
- Birn, K., & Crawford, C. (2020). *The GHG intensity of Canadian oil: A new analysis*. IHS Markit.
- Birol, F. (2022). *What does the current global energy crisis mean for energy investment? – Analysis*. International Energy Agency. <https://www.iea.org/commentaries/what-does-the-current-global-energy-crisis-mean-for-energy-investment>
- Blas, J., Smith, G., & El Wardany, S. (2020, April 9). *Global oil deal at risk after Mexico refuses Saudi-Russia plan*. Bloomberg Markets. <https://www.bloomberg.com/news/articles/2020-04-09/opeac-agrees-on-deep-oil-output-cuts-to-fight-market-slump>
- Bloomberg News. (2022, August 9). *China EV sales are forecast to hit a record 6 million this year*. Bloomberg Markets. <https://www.bloomberg.com/news/articles/2022-08-09/china-s-july-car-sales-rise-20-on-demand-for-electric-vehicles>



- Bloomberg News. (2023, January 25). *Canadian crude oil shipments to Asia surge to year high on U.S. refinery outages*. Financial Post. <https://financialpost.com/commodities/energy/canadian-crude-oil-shipments-to-asia-rise-us-refinery-outages>
- Bloomberg Professional Services. (2022). *2022 Zero-emissions vehicle factbook*. <https://www.bloomberg.com/professional/download/2022-zero-emissions-vehicle-factbook/>
- BloombergNEF. (2022). *Electric vehicle outlook 2022*. BloombergNEF. <https://about.bnef.com/electric-vehicle-outlook/>
- Bois von Kursk, O., & Muttitt, G. (2022). *Lighting the Path: What IPCC energy pathways tell us about Paris-aligned policies and investments*. International Institute for Sustainable Development. <https://www.iisd.org/publications/report/ipcc-pathways-paris-aligned-policies>
- Bois von Kursk, O., Muttitt, G., Picciariello, A., Dufour, L., Graaf, T. V. de, Goldthau, A., & Hawila, D. (2022). *Navigating Energy Transitions: Mapping the road to 1.5°C*. International Institute for Sustainable Development. <https://www.iisd.org/publications/report/navigating-energy-transitions>
- Boychuk, R., Anielski, M., Snow, J., & Stelfox, B. (2021). *The big cleanup: How enforcing the polluter pay principle can unlock Alberta's next great job boom*. Alberta Liabilities Disclosure Project. https://www.aldpcoalition.com/files/ugd/6ca287_aebaacad30bd4dfe90fe7784a45e7bd1.pdf
- BP. (2020). *Energy outlook 2020*. <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2020.pdf>
- BP. (2021). *Statistical review of world energy 2021 (70th Edition)*. <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf>
- BP. (2022). *Statistical review of world energy 2022*. <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>
- BP. (2023). *Energy outlook 2023*. <https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html>
- Brooks, C., & Adler, K. (2021, July 6). *IMO has a new plan to reduce shipping's carbon emissions; will it be enough?* IHS Markit. <https://cleanenergynews.ihsmarkit.com/research-analysis/imo-has-a-new-plan-to-reduce-shippings-carbon-emissions-will-i.html>
- Brumleve, W. (2019, January). *Board sides with rural residents in approving more restrictive setback for wind turbines*. National Wind Watch. <https://www.wind-watch.org/news/2019/01/26/board-sides-with-rural-residents-in-approving-more-restrictive-setback-for-wind-turbines/>
- Burkhardt, P. (2022, October 20). *Ghana sees delayed Tema LNG terminal completed next year*. Bloomberg. <https://www.bloomberg.com/news/articles/2022-10-20/ghana-sees-delayed-tema-lng-terminal-completed-next-year>



- Byers, E., Krey, V., Kriegler, E., Riahi, K., Schaeffer, R., Kikstra, J., Lamboll, R., Nicholls, Z., Sandstad, M., Smith, C., der Wijst, K., Lecocq, F., Portugal-Pereira, J., Saheb, Y., Stromann, A., Winkler, H., Auer, C., Brutschin, E., Lepault, C., Müller-Casseres, E., Gidden, M., Huppmann, D., Kolp, P., Marangoni, G., Werning, M., Calvin, K., Guivarch, C., Hasegawa, T., Peters, G., Steinberger, J., Tavoni, M., van Vuuren, D., Al-Khourdajie, A., Forster, P., Lewis, J., Meinshausen, M., Rogelj, J., Samset, B., & Skeie, R. (2023). *AR6 scenarios database*. Zenodo. <https://doi.org/10.5281/zenodo.5886912>
- Cairns, R. D. (2014). The green paradox of the economics of exhaustible resources. *Energy Policy*, 65, 78–85.
- Callahan, C. (2020). *Illinois coal 2020* [Annual Statistical Report]. Office of Mines and Minerals, Department of Natural Resources. <https://www.ilga.gov/reports/ReportsSubmitted/2807RSGAEmail5263RSGAAttach2020%20Office%20of%20Mines%20and%20Minerals%20Annual%20Statistical%20Report.pdf>
- Calverley, D., & Anderson, K. (2022). *Phaseout pathways for fossil fuel production within Paris-compliant carbon budgets*. University of Manchester. <https://research.manchester.ac.uk/en/publications/phaseout-pathways-for-fossil-fuel-production-within-paris-complia>
- The Constitution Act, 1867, 30 & 31 Vict, c 3, <https://canlii.ca/t/ldsw>
- Canada Energy Regulator. (2017). *Market snapshot: Natural gas plays an important role in Alberta's oil sands*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2017/market-snapshot-natural-gas-plays-important-role-in-albertas-oil-sands.html>
- Canada Energy Regulator. (2019). *Canada's energy future 2019*. <https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/archive/2019/>
- Canada Energy Regulator. (2020). *Market snapshot: Oil sands use of natural gas for production decreases considerably in early 2020*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2020/market-snapshot-oil-sands-use-of-natural-gas.html>
- Canada Energy Regulator. (2021). *Canada's energy future 2021*. <https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/canada-energy-futures-2021.pdf>
- Canada Energy Regulator. (2022a). *Commodity statistics*. <https://apps.cer-rec.gc.ca/CommodityStatistics/Statistics.aspx?language=englishhttps://apps.neb-one.gc.ca/CommodityStatistics/Statistics.aspx?language=english>
- Canada Energy Regulator. (2022b). *Estimated production of Canadian crude oil and equivalent*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/crude-oil-petroleum-products/statistics/estimated-production-canadian-crude-oil-equivalent.html>
- Canada Energy Regulator. (2022c). *Market snapshot: Canada exports around half of the natural gas it produces*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2022/market-snapshot-canada-exports-around-half-natural-gas-it-produces.html>



- Canada Energy Regulator. (2023a). *Marketable natural gas production in Canada*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/natural-gas/statistics/marketable-natural-gas-production-in-canada.html>
- Canada Energy Regulator. (2023b). *Market snapshot: Western Canadian natural gas production reaches a record high in 2022*. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-western-canadian-natural-gas-production-reaches-a-record-high-in-2022.html>
- Cetinkaya, E., Liu, N., Simons, T. J., & Wallach, J. (2018). *Petrochemicals 2030: Reinventing the way to win in a changing industry*. McKinsey Global Institute. <https://www.mckinsey.com/industries/chemicals/our-insights/chemicals-2030-reinventing-the-way-to-win-in-a-changing-industry#>
- Cha, J. M., Price, V., Stevis, D., Vachon, T. E., & Brescia-Weiler, M. (2021). *Workers and communities in transition: Report of the Just Transition Listening Project*. Labor Network for Sustainability. <https://www.labor4sustainability.org/jtlt-2021/jtlt-report/appendices/#Case1>
- Chalifour, N. J. (2016). *Canadian climate federalism: Parliament's ample constitutional authority to legislate GHG emissions through regulations, a national cap and trade program, or a national carbon tax* (SSRN Scholarly Paper No. 2775370). <https://doi.org/10.2139/ssrn.2775370>
- Chianese, L. (2022, July 15). *Africa, a promising market for LNG?* Energynews.Pro. <https://energynews.pro/en/africa-a-promising-market-for-lng/>
- Clean Jobs Midwest. (2022). *A return to rapid clean energy job growth in Illinois*. Clean Jobs Midwest. <https://www.cleanjobsmidwest.com/state/illinois>
- Clean Shipping Act of 2022. (2022). H.R. 8336. <https://www.congress.gov/bill/117th-congress/house-bill/8336>
- Cleary, S., & Willcott, N. (2022). *The physical costs of climate change: A Canadian perspective*. Institute for Sustainable Finance. <https://smith.queensu.ca/centres/isf/pdfs/ISF-Report-PhysicalCostsOfClimateChange.pdf>
- Climate Act, Act. No 965. (2020). Denmark. <https://en.kefm.dk/Media/1/B/Climate%20Act-Denmark%20-%20WEBTILG%C3%86NGELIG-A.pdf>
- Climate Action Network Canada. (2019). *Canada's fair share towards limiting global warming to 1.5°C*. <https://climateactionnetwork.ca/2019/12/02/canadas-fair-share-towards-limiting-global-warming-to-1-5c/>
- Climate Action Tracker. (2023). *Country summary—Canada*. <https://climateactiontracker.org/countries/canada/>
- Climate and Equitable Jobs Act, Illinois Pub. L. No. 102–0662, SB 2408. (2021). <https://ilga.gov/legislation/publicacts/fulltext.asp?Name=102-0662>



- Colorado Department of Labor and Employment. (2022). *About the Office of Just Transition*. Colorado Department of Labor and Employment. <https://cdle.colorado.gov/offices/the-office-of-just-transition/about-the-office-of-just-transition>
- Corkal, V. (2020, March 26). *Who will pay for Alberta's orphan wells?* International Institute for Sustainable Development. <https://www.iisd.org/articles/insight/who-will-pay-albertas-orphan-wells>
- Corkal, V. (2021). *Federal fossil fuel subsidies in Canada: COVID-19 edition*. International Institute for Sustainable Development. <https://www.iisd.org/system/files/2021-02/fossil-fuel-subsidies-canada-covid-19.pdf>
- Corkal, V., & Beedell, E. (2022). *Making good green jobs the law: How Canada can build on international best practice to advance just transition for all* [Report]. International Institute for Sustainable Development. <https://www.iisd.org/system/files/2022-01/green-jobs-advance-canada-just-transition.pdf>
- Cosbey, A. (2022a). *Why Canada is unlikely to sell the last barrel of oil*. International Institute for Sustainable Development. <https://www.iisd.org/articles/deep-dive/why-canada-unlikely-sell-last-barrel-oil>
- Cosbey, A. (2022b). *Why Canada needs to plan for a steep decline in global oil demand*. International Institute for Sustainable Development. <https://www.iisd.org/articles/deep-dive/canada-can-expect-declining-oil-demand>
- Cosbey, A., Sawyer, D., & Stiebert, S. (2021). *In search of prosperity: The role of oil in the future of Alberta and Canada*. International Institute for Sustainable Development. <https://www.iisd.org/publications/search-prosperity-oil-alberta-canada>
- Crowe, J. A., & Li, R. (2020). Is the just transition socially accepted? Energy history, place, and support for coal and solar in Illinois, Texas, and Vermont. *Energy Research & Social Science*, 59, 101309. <https://doi.org/10.1016/j.erss.2019.101309>
- Dabbs, B. (2021, March). *Eminent-domain concerns loom over clean energy transition*. National Journal Daily. <https://www.wind-watch.org/news/2021/03/23/eminant-domain-concerns-loom-over-clean-energy-transition/>
- Danish Energy Agency. (2016, August 10). *Economy for oil and gas*. Energistyrelsen. <https://ens.dk/en/our-responsibilities/oil-gas/economy-oil-and-gas>
- Danish Energy Agency. (2018). *Resource assessment and production forecasts*. https://ens.dk/sites/ens.dk/files/OlieGas/ressourcer_og_prognoser_20180829_rev_en.pdf
- Danish Ministry of Climate, Energy and Utilities. (2020, December 4). Denmark introduces cutoff date of 2050 for oil and gas extraction in the North Sea, cancels all future licensing rounds [Press release]. <http://en.kefm.dk/news/news-archive/2020/dec/denmark-introduces-cutoff-date-of-2050-for-oil-and-gas-extraction-in-the-north-sea-cancels-all-future-licensing-rounds>



- De Souza, M., Jarvis, C., McIntosh, E., & Bruser, D. (2018, November 1). *Alberta regulator privately estimates oilpatch's financial liabilities are hundreds of billions more than what it told the public*. National Observer. <https://www.nationalobserver.com/2018/11/01/news/alberta-regulator-privately-estimates-oilpatches-financial-liabilities-are-hundreds>
- DNV. (2022). *Energy transition outlook 2022: A global and regional forecast to 2050*. <https://www.dnv.com/energy-transition-outlook/index.html>
- Dusyk, N., Turcotte, I., Gunton, T., MacNab, J., McBain, S., Penney, N., Pickrell-Barr, J., & Pope, M. (2021). *All hands on deck: An assessment of provincial, territorial and federal readiness to deliver a safe climate*. Pembina Institute. <https://www.pembina.org/reports/all-hands-on-deck.pdf>
- E2. (2021). *Clean jobs Colorado: The promise of a bright future and strong economy* (No. 4). E2.
- Earth Negotiations Bulletin. (2022, June). *Summary report 29 May – 1 June 2022 Ad hoc open-ended working group to prepare for the Intergovernmental Negotiating Committee to End Plastic Pollution*. International Institute for Sustainable Development Earth Negotiations Bulletin. <https://enb.iisd.org/working-group-intergovernmental-negotiating-committee-end-plastic-pollution-oweg-inc-summary>
- Eaton, C. (2019, June 18). *Canadian crude Gulf Coast exports rise as Venezuelan gap is filled: Trade sources*. Reuters. <https://www.reuters.com/article/us-usa-crude-exports-idUSKCN1TJ2AC>
- The Economist. (2022a, September 24). *The war in Ukraine has reshaped the world's fuel markets*. The Economist. <https://www.economist.com/interactive/briefing/2022/09/24/war-in-ukraine-has-reshaped-worlds-fuel-markets>
- The Economist. (2022b, August 17). *Ways to make aviation fuel green*. The Economist. https://www.economist.com/science-and-technology/2022/08/17/ways-to-make-aviation-fuel-green?etear=nl_today_3
- The Economist. (2023, February 13). *War and subsidies have turbocharged the green transition*. The Economist. <https://www.economist.com/finance-and-economics/2023/02/13/war-and-subsidies-have-turbocharged-the-green-transition>
- Egli, F., Schmid, N., & Schmidt, T. S. (2022). *Backlash to fossil fuel phase-outs: The case of coal mining in US presidential elections*. *Environmental Research Letters*, 17(9), 094002. <https://doi.org/10.1088/1748-9326/ac82fe>
- Eicke, L., & Blasio, N. D. (2022). *The future of green hydrogen value chains*. Harvard Kennedy School Belfer Centre.
- Environment and Climate Change Canada. (2022a). *2030 Emissions reduction plan: Canada's next steps to clean air and a strong economy*. https://publications.gc.ca/collections/collection_2022/eccc/En4-460-2022-eng.pdf



- Environment and Climate Change Canada. (2022b). *Global greenhouse gas emissions* [Research]. <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/global-greenhouse-gas-emissions.html>
- Environment and Climate Change Canada. (2023, April 14). *Greenhouse gas sources and sinks in Canada: Executive summary 2023* [Program results]. <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2023.html>
- European Climate Foundation. (2022). *Delivering EU energy security through climate action*. <https://europeanclimate.org/wp-content/uploads/2022/07/ecf-external-white-paper.pdf>
- European Commission. (n.d.a). *European climate law*. https://climate.ec.europa.eu/eu-action/european-green-deal/european-climate-law_en
- European Commission. (n.d.b). *Initiative for coal regions in transition*. https://energy.ec.europa.eu/topics/oil-gas-and-coal/eu-coal-regions/initiative-coal-regions-transition_en
- European Commission. (2021a, July 14). *A European green deal*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
- European Commission. (2021b). *Proposal for a regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport*. https://eur-lex.europa.eu/resource.html?uri=cellar:00c59688-e577-11eb-a1a5-01aa75ed71a1.0001.02/DOC_1&format=PDF
- European Commission. (2022a, October). *EU Cohesion Policy: €2.5 billion for Germany* [Text]. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_6275
- European Commission. (2022b, May 18). *REPowerEU: Affordable, secure and sustainable energy for Europe*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en
- European Heat Pump Association. (2023, February). *Heat pump record: 3 million units sold in 2022, contributing to REPowerEU targets*. https://www.ehpa.org/press_releases/heat-pump-record-3-million-units-sold-in-2022-contributing-to-repowereu-targets/
- European Parliament. (n.d.). *Just Transition Fund*. Fact Sheets on the European Union. <https://www.europarl.europa.eu/factsheets/en/sheet/214/just-transition-fund>
- Fawcett, M. (2021, June 25). *The coming oil boom will be Alberta's last—but could still help Jason Kenney*. Canada's National Observer. <https://www.nationalobserver.com/2021/06/25/opinion/oil-boom-will-be-albertas-last-could-still-help-jason-kenney>
- Federal Cabinet of Germany. (2021, June 25). *Climate Change Act: Climate neutrality by 2045*. Die Bundesregierung Informiert. <https://www.bundesregierung.de/breg-de/themen/klimaschutz/climate-change-act-2021-1936846>



- Federal Government of Germany. (2023a). *Cabinet adopts Structural Development Act (Strukturstärkungsgesetz)*. Bundesregierung. <https://www.bundesregierung.de/breg-en/service/archive/kohleregionen-foerderung-1665150>
- Federal Government of Germany. (2023b). *Ending coal-generated power*. Bundesregierung. <https://www.bundesregierung.de/breg-en/service/archive/kohleausstiegsgesetz-1717014>
- Fellows, G. K. (2002). Pipes, trains and automobiles: Explaining British Columbia's high wholesale gasoline prices. *The Energy Journal*, 43(5), 139–160. <https://doi.org/10.5547/01956574.43.5.gfel>
- Fellows, K. (2022). *Last barrel standing? Confronting the myth of “high-cost” Canadian oil sands production*. C.D. Howe Institute. <https://www.cdhowe.org/public-policy-research/last-barrel-standing-confronting-myth-high-cost-canadian-oil-sands>
- Filimonova, I. V., Komarova, A. V., Sharma, R., & Novikov, A. Y. (2022). Transformation of international liquefied natural gas markets: New trade routes. *Energy Reports*, 8, 675–682. <https://doi.org/10.1016/j.egyr.2022.07.069>
- Flavelle, C. (2020, February 12). Global financial giants swear off funding an especially dirty fuel. *The New York Times*. <https://www.nytimes.com/2020/02/12/climate/blackrock-oil-sands-alberta-financing.html>
- Foster, R. (1986). *The S-curve*. Simon & Schuster.
- Frost, R. (2022, June 4). *Are domestic flights the first big step to electrifying aviation?* Euronews. <https://www.euronews.com/travel/2022/06/04/electrifying-domestic-flights-could-be-the-first-big-step-to-cutting-aviation-s-carbon-emi>
- Furnaro, A., Herpich, P., Brauers, H., Oei, P.-Y., & Kemfert, C. (2021). *German Just Transition: A review of public policies to assist German coal communities in transition*. Resources for the Future. <https://www.rff.org/publications/reports/german-just-transition-a-review-of-public-policies-to-assist-german-coal-communities-in-transition/>
- Future Energy Jobs Act, Pub. L. No. 99–0906, SB 2814. (2016). <https://www.ilga.gov/legislation/99/SB/09900SB2814ham003.htm>
- Galgóczi, B. (2014). The long and winding road from black to green: Decades of structural change in the Ruhr region. *International Journal of Labour Research*, 6(2), 217–240.
- Garside, M. (2022, November). *Coal-mining employment Illinois 2021*. Statista. <https://www.statista.com/statistics/215758/coal-mining-employment-in-illinois/>
- Gärtner, S. (2019). Chapter 5: An attempt at preventive action in the transformation of coal-mining regions in Germany. In B. Galgóczi (Ed.), *Towards a just transition: Coal, cars and the world of work* (pp. 135–154). European Trade Union Institute. https://www.iat.eu/aktuell/veroeff/2020/gaertner_01.pdf



- Gass, P., & Corkal, V. (2019). *Locked in and losing out: British Columbia's fossil fuel subsidies*. International Institute for Sustainable Development. <https://www.iisd.org/system/files/publications/locked-in-losing-out.pdf>
- Gibson, R., Peloffy, K., Greenford, D. H., Doelle, M., Matthews, D., Holz, C., Staples, K., Wiseman, B., & Grenier, F. (2019). *From Paris to projects: Clarifying the implications of Canada's climate change mitigation commitments for the planning and assessment of projects and strategic undertakings*. https://uwaterloo.ca/applied-sustainability-projects/sites/default/files/uploads/documents/p2p_full_report_23jan19.pdf
- Gillus, D., & McKibbin, A. (2022). Equity provisions in Illinois' Climate and Equitable Jobs Act. *Elevate*, 15.
- Goel, S., Muzondo, C., Devagudi, S. H., Beaton, C., & Gass, P. (2023). *Evidence review for just transition* [Manuscript in preparation]. International Institute for Sustainable Development.
- Gorski, J., & El-Aini, E. (2022). *Waiting to launch: The gap between Canadian oilsands companies' climate pledges and actions*. Pembina Institute. <https://www.pembina.org/reports/waiting-to-launch-2022-09-23.pdf>
- Government of Alberta. (2018). *Climate Leadership Plan: Implementation Plan 2018–19*. https://open.alberta.ca/dataset/da6433da-69b7-4d15-9123-01f76004f574/resource/b42b1f43-7b9d-483d-aa2a-6f9b4290d81e/download/clp_implementation_plan-jun07.pdf
- Government of Alberta. (2021). *Fiscal plan: Protecting lives and livelihoods 2021–2024*. Government of Alberta. <https://open.alberta.ca/dataset/6f47f49d-d79e-4298-9450-08a61a6c57b2/resource/ec1d42ee-ecca-48a9-b450-6b18352b58d3/download/budget-2021-fiscal-plan-2021-24.pdf>
- Government of Alberta. (2022a). *Annual report: Energy 2021–2022*. <https://open.alberta.ca/dataset/cbd7147b-d304-4e3e-af28-78970c71232c/resource/fd81b900-5a31-4124-937f-0c7bcb23cebb/download/energy-annual-report-2021-2022.pdf>
- Government of Alberta. (2022b). *Fiscal plan: Moving forward 2022–2025*. <https://open.alberta.ca/dataset/6d0f1358-beb5-4bb7-8da1-a350a138039c/resource/36771cab-bee0-44b5-99ad-a03d88da653c/download/budget-2022-fiscal-plan-2022-25.pdf>
- Government of Canada. (2022). *National inventory report 1990–2020*. <https://unfccc.int/documents/461919>
- Government of Canada. (2023a). *Reduction of carbon dioxide emissions from coal-fired generation of electricity regulations (SOR/2012-167)*. Pollution and Waste Management. <https://pollution-waste.canada.ca/environmental-protection-registry/regulations/view?Id=116>
- Government of Canada. (2023b, April 20). *Social cost of greenhouse gas emissions*. <https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/social-cost-ghg.html>



- Government of Newfoundland and Labrador. (2020). *Estimates of the program expenditure and revenue of the consolidated revenue fund 2020–21*. <https://www.gov.nl.ca/budget/2020/wp-content/uploads/sites/3/2020/09/Estimates-2020.pdf>
- Government of Newfoundland and Labrador. (2021). *Estimates of the program expenditure and revenue of the consolidated revenue fund 2021–22*. <https://www.gov.nl.ca/budget/2021/wp-content/uploads/sites/5/Estimates.pdf>
- Government of Newfoundland and Labrador. (2022). *Estimates of the program expenditure and revenue of the consolidated revenue fund 2022–23*. <https://www.assembly.nl.ca/business/electronicdocuments/Budget2022Estimates.pdf>
- Government of Saskatchewan. (2020). *Saskatchewan provincial budget 2020–21*. <https://pubsaskdev.blob.core.windows.net/pubsask-prod/118855/2020-21%252BBudget%252BJune.pdf>
- Government of Saskatchewan. (2021). *Saskatchewan provincial budget 2021–22*. <https://pubsaskdev.blob.core.windows.net/pubsask-prod/126474/2021-22%252BBudget.pdf>
- Government of Saskatchewan. (2022). *Saskatchewan provincial budget 2022–23*. <https://publications.saskatchewan.ca/#/products/117339>
- Graney, E. (2021, March 1). *ESG focus will help attract investors to oil sands, Kenney says*. The Globe and Mail. <https://www.theglobeandmail.com/business/article-how-alberta-will-implement-esg-measures/>
- Graver, B., Zheng, S., Rutherford, D., Mukhopadhyaya, J., & Pronk, E. (2022). *Vision 2050: Aligning aviation with the Paris Agreement*. International Council for Clean Transportation. <https://theicct.org/publication/global-aviation-vision-2050-align-aviation-paris-jun22/>
- Greenhouse Gas Pollution Pricing Act. (2021) (testimony of SCC 11).
- Grubert, E., & Hastings-Simon, S. (2022). Designing the mid-transition: A review of medium-term challenges for coordinated decarbonization in the United States. *WIREs Climate Change*, 13(3), e768. <https://doi.org/10.1002/wcc.768>
- Guo, J., Kubli, D., & Saner, P. (2021). *The economics of climate change: No action not an option*. Swiss Re Institute. <https://www.swissre.com/dam/jcr:e73ee7c3-7f83-4c17-a2b8-8ef23a8d3312/swiss-re-institute-expertise-publication-economics-of-climate-change.pdf>
- Harris, W. M., Beck, M., & Gerasimchuk, I. (2015). *The end of coal: Ontario's coal phase-out*. International Institute for Sustainable Development. <https://www.iisd.org/system/files/publications/end-of-coal-ontario-coal-phase-out.pdf>
- Hersh, A. S. (2021). *'Build Back Better' agenda will ensure strong, stable recovery in coming years*. Economic Policy Institute. <https://files.epi.org/uploads/235941.pdf>
- Hoberg, G. (1997). *Governing the environment: Comparing Canada and the United States*. McGill-Queen's University Press.



- Holz, C., Kartha, S., & Athanasiou, T. (2018). *Fairly sharing 1.5: National fair shares of a 1.5°C-compliant global mitigation effort* (SSRN Scholarly Paper No. 3072045). <https://papers.ssrn.com/abstract=3072045>
- Hossain, S., Rahman, M. A., Chowdhury, M. A., & Mohonta, S. K. (2021). Plastic pollution in Bangladesh: A review on current status emphasizing the impacts on environment and public health. *Environmental Engineering Research*, 26(6). <https://www.eeer.org/upload/eeer-2020-535.pdf>
- Hussey, I. (2020). *The future of Alberta's oil sands industry: More production, less capital, fewer jobs*. Parkland Institute.
- Hussey, I. (2023). *No worker left behind: A job creation strategy for energy transition in Alberta*. Parkland Institute.
- Hydrocarbons Technology. (n.d.). *BP Whiting refinery modernisation, Indiana*. Retrieved April 1, 2023, from https://www.hydrocarbons-technology.com/projects/bt_whiting/
- Inflation Reduction Act, Pub. L. No. 117–169, HR 5376. (2022). <https://www.congress.gov/bill/117th-congress/house-bill/5376>
- Infrastructure Investment and Jobs Act, Pub. L. No. 117–58, HR 3684. (2021). <https://www.congress.gov/bill/117th-congress/house-bill/3684/text>
- Institute for Energy Economics and Financial Analysis. (2023). *Global LNG outlook 2023–27: High prices create new risks to demand growth*. <https://ieefa.org/media/3619/download?attachment>
- Integrated National Energy and Climate Plan. (2019). European Union. https://energy.ec.europa.eu/system/files/2022-08/de_final_necp_main_en.pdf
- Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. <https://www.ipcc.ch/sr15/>
- Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf
- Intergovernmental Panel on Climate Change. (2023). *AR6 synthesis report: Climate change 2023*. <https://www.ipcc.ch/report/ar6/syr/>
- International Energy Agency. (2018). *World energy outlook 2018*.
- International Energy Agency. (2020). *Danish energy agreement for 2012–2020: Policies*. <https://www.iea.org/policies/606-danish-energy-agreement-for-2012-2020>



- International Energy Agency. (2021a). *Denmark—Countries & regions*. <https://www.iea.org/countries/denmark>
- International Energy Agency. (2021b). *Net zero by 2050*. https://iea.blob.core.windows.net/assets/7ebafc81-74ed-412b-9c60-5cc32c8396e4/NetZeroBy2050-ARoadmapfortheGlobalEnergySector-SummaryforPolicyMakers_CORR.pdf
- International Energy Agency. (2021c). *World energy outlook 2021*. <https://www.iea.org/reports/world-energy-outlook-2021>
- International Energy Agency. (2022a). *Gas market report, Q3-2022: Analysis*. <https://www.iea.org/reports/gas-market-report-q3-2022>
- International Energy Agency. (2022b). *Global EV outlook 2022*. <https://www.iea.org/reports/global-ev-outlook-2022>
- International Energy Agency. (2022c). *Global natural gas demand per region, 2005-2025 – Charts – Data & Statistics*. <https://www.iea.org/data-and-statistics/charts/global-natural-gas-demand-per-region-2005-2025>
- International Energy Agency. (2022d). *Heating: Analysis*. <https://www.iea.org/reports/heating>
- International Energy Agency. (2022e). *Renewables 2022*. <https://www.iea.org/news/renewable-power-s-growth-is-being-turbocharged-as-countries-seek-to-strengthen-energy-security>
- International Energy Agency. (2022f). *World energy outlook 2022*. <https://www.iea.org/reports/world-energy-outlook-2022>
- International Energy Agency. (2023a). *Gas market report, Q2-2023*. <https://iea.blob.core.windows.net/assets/6f2f0dcc-72af-4c01-bcc7-fbfe690ab521/GasMarketReportQ22023.pdf>
- International Energy Agency. (2023b). *Oil market report—April 2023: Analysis*. <https://www.iea.org/reports/oil-market-report-april-2023>
- International Energy Agency. (2023c). *Outlooks for gas markets and investment: A report for the G7*. <https://iea.blob.core.windows.net/assets/3e076ae9-9055-4af4-bba9-15ddaedcb703/OutlooksforGasMarketsandInvestment.pdf>
- International Renewable Energy Agency. (2021). *Renewable power generation costs in 2020*. <https://www.irena.org/publications/2021/Jun/Renewable-Power-Costs-in-2020>
- International Renewable Energy Agency. (2022a). *Renewable power generation costs in 2021*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jul/IRENA_Power_Generation_Costs_2021.pdf?rev=34c22a4b244d434da0accde7de7c73d8
- International Renewable Energy Agency. (2022b). *World energy transitions outlook: 1.5°C pathway*. <https://irena.org/publications/2022/mar/world-energy-transitions-outlook-2022#:~:text=The%20World%20Energy%20Transitions%20Outlook,hydrogen%20and%20sustainable%20modern%20bioenergy.>



- Jakob, M., & Steckel, J. C. (2022). *The political economy of coal: Obstacles to clean energy transitions*. Routledge.
- Jameson, P., Egloff, C., Sanders, U., Krogsgaard, M., Burke, D., Tan, M., Hegnholt, E., & Nyheim, E. (2021). *Global shipping's net-zero transformation challenge*. BCG Global. <https://www.bcg.com/publications/2021/global-zero-carbon-shipping-transformation-challenge>
- Jang, B., & Graney, E. (2022, May 27). *Ottawa open to East Coast LNG plans, subject to meeting climate goals*. The Globe and Mail. <https://www.theglobeandmail.com/business/article-ottawa-open-to-east-coast-lng-plans-subject-to-meeting-climate-goals/>
- Jenkins, J. D., Mayfield, E. N., Farbes, J., Jones, R., Patankar, N., Xu, Q., & Schivley, G. (2022). *Preliminary report: The climate and energy impacts of the Inflation Reduction Act of 2022*. Zero-carbon Energy Systems Research and Optimization Laboratory. [https://repeatproject.org/docs/REPEAT_IRA_Preliminary_Report_2022-09-21%20\(1\).pdf](https://repeatproject.org/docs/REPEAT_IRA_Preliminary_Report_2022-09-21%20(1).pdf)
- Just Transition Advisory Committee. (2020). *Draft Colorado Just Transition Plan*. Colorado Department of Labor and Employment. https://cdle.colorado.gov/sites/cdle/files/2020-09/draft_colorado_just_transition_plan_08.03.2020.pdf
- Kelly, J. A., Fu, M., & Clinch, J. P. (2016). Residential home heating: The potential for air source heat pump technologies as an alternative to solid and liquid fuels. *Energy Policy*, 98, 431–442. <https://doi.org/10.1016/j.enpol.2016.09.016>
- Kelly, S., & Williams, N. (2022, February 11). *Canadian oil barrels head out of the U.S. Gulf in record numbers*. Reuters. <https://www.reuters.com/business/energy/canadian-oil-barrels-head-out-us-gulf-record-numbers-2022-02-11/>
- Kemfert, C., Präger, F., Braunger, I., Hoffart, F. M., & Brauers, H. (2022). The expansion of natural gas infrastructure puts energy transitions at risk. *Nature Energy*, 7(7), Article 7. <https://doi.org/10.1038/s41560-022-01060-3>
- Krawchenko, T., & Foster, J. (2021). *From concept to action—Implementing a just transition in Alberta*. Parkland Institute. https://www.parklandinstitute.ca/just_transition_blog_tk
- Krawchenko, T. A., & Gordon, M. (2022). Just transitions for oil and gas regions and the role of regional development policies. *MDPI, Energies* 15(13), 4834 (Special Issue Challenges and Research Trends of Energy Transition in Fuel-Dependent Regions). <https://www.mdpi.com/1996-1073/15/13/4834>
- Kwasniak, A. J. (2017). *Climate change and water: Law and policy options for Alberta*. Canadian Institute of Resources Law. <https://www.canlii.org/en/commentary/doc/2017CanLIIDocs4052#!fragment/BQCwhgziBcwMYgK4DsDWszIQewE4BUBTADwBdoByCgSgBplrTCIBFRQ3AT0otokLC4EbDtyp8BQkAGU8pAELcASgFEAMioBqAQQByAYRW1SYAEbRS2ONWpA>



- Labor Energy Partnership. (2022). *Inflation Reduction Act analysis: Key findings on jobs, inflation, and GDP*. Labor Energy Partnership. <https://laborenergy.org/wp-content/uploads/2022/08/8-6-22-IRA-Impact-Analysis-V14.pdf>
- Larsen, J., King, B., Kolus, H., Dasari, N., Hiltbrand, G., & Herndon, W. (2022, August 12). *A turning point for US climate progress: Assessing the climate and clean energy provisions in the Inflation Reduction Act*. Rhodium Group. <https://rhg.com/research/climate-clean-energy-inflation-reduction-act/>
- Lee, J. (2020, September 12). *There's no easy fix to OPEC's whack-a-mole problem*. Bloomberg. <https://www.bloomberg.com/opinion/articles/2020-09-13/opec-s-60th-birthday-the-oil-cartels-got-a-whack-a-mole-problem>
- Lee, M. (2019). *A critical look at BC's new tax breaks and subsidies for LNG*. Canadian Centre for Policy Alternatives. https://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2019/05/CCPA_BC%20Critiquing%20the%20LNG%20Canada%20agreement_FINAL_190506.pdf
- Lewis, J., Jones, J., D'Aliesio, R., & Wang, C. (2018, November 23). *Hustle in the oil patch: Inside a looming financial and environmental crisis*. The Globe and Mail. <https://www.theglobeandmail.com/canada/article-hustle-in-the-oil-patch-inside-a-looming-financial-and-environmental/>
- Liebreich, M. (2023, April 26). *The next half-trillion-dollar market—Electrification of heat*. BloombergNEF. <https://about.bnef.com/blog/liebreich-the-next-half-trillion-dollar-market-electrification-of-heat/>
- Losman, D. L. (2010). The rentier state and national oil companies: An economic and political perspective. *Middle East Journal*, 64(3), 427–445.
- Lydersen, K. (2021, September 28). *In Illinois, energy law's coal-to-solar commitments spark hope, skepticism*. Energy News Network. <http://energynews.us/2021/09/28/in-illinois-energy-laws-coal-to-solar-commitments-spark-hope-skepticism/>
- Marsh, K., McKee, N., & Welch, M. (2021). *Opposition to renewable energy facilities in the United States*. Sabin Center for Climate Change Law, Columbia Law School. https://legacy-assets.eenews.net/open_files/assets/2021/03/01/document_ew_01.pdf
- Mawji, O. (2022). *Review of LNG Canada project: Delays, policy changes, and rising costs*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/review-lng-canada-project-delays-policy-changes-and-rising-costs>
- Mayer, A. (2018). A just transition for coal miners? Community identity and support from local policy actors. *Environmental Innovation and Societal Transitions*, 28, 1–13. <https://doi.org/10.1016/j.eist.2018.03.006>
- Mayer, A. (2022). Support for displaced coal workers is popular and bipartisan in the United States: Evidence from Western Colorado. *Energy Research & Social Science*, 90, 102593. <https://doi.org/10.1016/j.erss.2022.102593>



- McKinsey. (2022). *Global energy perspective 2022*. <https://www.mckinsey.com/~media/McKinsey/Industries/Oil%20and%20Gas/Our%20Insights/Global%20Energy%20Perspective%202022/Global-Energy-Perspective-2022-Executive-Summary.pdf>
- Melnitzer, J. (2022, January 9). *Energy workers switch to other professions in droves as work dries up in once booming sector*. Financial Post. <https://financialpost.com/commodities/energy/oil-gas/energy-workers-switch-to-other-professions-in-droves-as-work-dries-up-in-once-booming-sector>
- Mercure, J.-F., Pollitt, H., Viñuales, J. E., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., Sognnaes, I., Lam, A., & Knobloch, F. (2018). Macroeconomic impact of stranded fossil fuel assets. *Nature Climate Change*, 8(7), Article 7. <https://doi.org/10.1038/s41558-018-0182-1>
- Meyer, C. (2022). *How oil lobbyists persuaded Alberta to weaken rules for dirty facilities*. The Narwhal. <https://thenarwhal.ca/alberta-climate-methane-cnrl/>
- Mukheed, M., & Khan, A. (2020). Plastic Pollution in Pakistan: Environmental and Health Implications. *Journal of Pollution Effects & Control*, 8(4). https://www.researchgate.net/profile/Alisha-Khan-15/publication/351599379_Journal_of_Pollution_Effects_Control_Plastic_Pollution_in_Pakistan_Environmental_and_Health_Implications/links/609f685192851cfd332f1d6/Journal-of-Pollution-Effects-Control-Plastic-Pollution-in-Pakistan-Environmental-and-Health-Implications.pdf
- Muttitt, G., Price, J., Pye, S., & Welsby, D. (2023). Socio-political feasibility of coal power phase-out and its role in mitigation pathways. *Nature Climate Change*, 13(2), Article 2. <https://doi.org/10.1038/s41558-022-01576-2>
- Muttitt, G., Sharma, S., Mostafa, M., Kühne, K., Doukas, A., Gerasimchuk, I., & Roth, J. (2021). *Step off the gas: International public finance, natural gas and clean alternatives in the Global South*. International Institute for Sustainable Development. <https://www.iisd.org/publications/natural-gas-finance-clean-alternatives-global-south>
- National Assembly of Quebec. (2022). *Bill 21, An Act mainly to end petroleum exploration and production and the public financing of those activities*. <https://m.assnat.qc.ca/en/travaux-parlementaires/projets-loi/projet-loi-21-42-2.html>
- Natural Resource Governance Institute. (2019). *The national oil company database*. <https://resourcegovernance.org/analysis-tools/publications/national-oil-company-database>
- Natural Resources Canada. (2020). *Exploration and production of shale and tight resources*. <https://natural-resources.canada.ca/energy/energy-sources-distribution/natural-gas/shale-tight-resources-canada/exploration-and-production-shale-and-tight-resources/17677>
- Natural Resources Canada. (2021). *Energy fact book 2021–2022*. https://www.nrcan.gc.ca/sites/nrcan/files/energy/energy_fact/2021-2022/PDF/section6_Energy-factbook_december9_en_accessible.pdf



- Natural Resources Canada. (2022). *Energy fact book 2022–2023*. https://publications.gc.ca/collections/collection_2022/rncan-nrcan/M136-1-2022-eng.pdf
- Nduagu, E., Rahmanifard, H., Sow, A., & Mascarenhas, K. (2018). *Economic impacts and market challenges for the methane to derivatives petrochemical sub-sector* (No. 169). Canadian Energy Research Institute. https://www.dropbox.com/scl/fo/xg616p3g0n0glo3wuwc8m/h/CERI%20Studies/CERI%20Studies/Study%20169?dl=0&preview=Study_169_Full_Report.pdf&subfolder_nav_tracking=1
- Nordsøfonden. (n.d.). *Oil and gas in Denmark*. <https://admin.eng.nordsoefonden.dk/oil-and-gas/oil-and-gas-in-denmark>
- O'Connor, M. (2022). *Crude intentions: How oil and gas executives are still rewarded to chase fossil growth, despite the urgent need to transition* [Analyst Note]. Carbon Tracker. <https://carbontracker.org/reports/crude-intentions/>
- The Office of Just Transition. (2022). *Coal in Colorado*. Colorado Department of Labor and Employment. <https://cdle.colorado.gov/offices/the-office-of-just-transition/coal-in-colorado>
- OFX. (n.d.). *Yearly average rates & forex history data*. <https://www.ofx.com/en-us/forex-news/historical-exchange-rates/yearly-average-rates/>
- Oil Change International. (2019, May 30). *New report debunks gas “bridge fuel” myth*. <http://priceofoil.org/2019/05/30/new-report-debunks-gas-bridge-fuel-myth/>
- Organisation for Economic Co-operation and Development. (2020). *Fossil fuel support country note: Denmark*.
- Orphan Well Association. (n.d.). *Orphan inventory*. <https://www.orphanwell.ca/about/orphan-inventory/>
- Orphan Well Association. (2022). *Orphan Well Association Annual Report 2021/2022*. https://www.orphanwell.ca/wp-content/uploads/2022/07/OWA-Annual_2021_web.pdf
- Pannett, R. (2022, December 12). Renewables to overtake coal as world’s top energy source by 2025, IEA says. *The Washington Post*. <https://www.washingtonpost.com/world/2022/12/12/renewables-coal-energy-crisis-iea-2022/>
- Pollin, R., Chakraborty, S., Lala, C., & Semieniuk, G. (2022). *Job creation estimates through proposed Inflation Reduction Act: Modeling impacts of climate, energy, and environmental provisions of bill*. Political Economy Research Institute. <https://peri.umass.edu/publication/item/1633-job-creation-estimates-through-proposed-inflation-reduction-act>
- Port Esbjerg. (2019, June 24). *Port Esbjerg gets up to speed on sustainability*. <https://portesbjerg.dk/en/news/port-esbjerg-gets-up-to-speed-on-sustainability>
- Port Esbjerg. (2020, December 18). *New offshore training programme to ensure the right skill sets for offshore wind adventure*. <https://portesbjerg.dk/en/news/new-offshore-training-programme-to-ensure-the-right-skill-sets-for-offshore-wind-adventure>



- Raimi, D., Campbell, E., Newell, R., Prest, B., Villanueva, S., & Wingenroth, J. (2022). *Global energy outlook 2022: Turning points and tension in the energy transition*. Resources for the Future. https://media.rff.org/documents/Report_22-04_v1.pdf
- Renewable Electricity Act, Chapter R-16.5. (2016). https://kings-printer.alberta.ca/1266.cfm?page=r16p5.cfm&leg_type=Acts&isbncln=9780779814060
- Reynolds, S. (2022, August 15). *The economic case for LNG in Asia is crumbling*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/economic-case-lng-asia-crumbling>
- Reynolds, S. (2023, January 11). *Asia's lower LNG demand in 2022 highlights challenges for industry growth*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/asias-lower-lng-demand-2022-highlights-challenges-industry-growth>
- Reynolds, S., & Hauber, G. (2021, December 16). *Examining cracks in emerging Asia's LNG-to-power value chain*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/examining-cracks-emerging-asias-lng-power-value-chain>
- RI. (n.d.). *USA historical consumer price index (CPI)—1913 to 2023*. Retrieved May 1, 2023, from <https://www.rateinflation.com/consumer-price-index/usa-historical-cpi/>
- Ritchie, H., & Roser, M. (2022, October 27). *Energy mix*. Our World in Data. <https://ourworldindata.org/energy-mix>
- Ruppert Bulmer, E., Pela, K., Eberhard-Ruiz, A., & Montoya, J. (2021). *Global perspective on coal jobs and managing labor transition out of coal: Key issues and policy responses*. World Bank. <https://doi.org/10.1596/37118>
- Rystad Energy. (2020). *Bit by bitumen: Canada oil sands players target smaller, cheaper expansions—Upstream Analytics*. <https://clients.rystadenergy.com/ReportPage/Download/3694>
- Rystad Energy. (2022). *Upstream Trends Report June 2022*.
- Rystad Energy. (2023). *UCube Browser v. 2.3.3*. <https://www.rystadenergy.com/services/>
- Sattler, S., Gignac, J., Collingsworth, J., Clemmer, S., & Garcia, P. (2018). Achieving a clean energy transition in Illinois: Economic and public health benefits of replacing coal plants in Illinois with local clean energy alternatives. *The Electricity Journal*, 31(10), 52–59. <https://doi.org/10.1016/j.tej.2018.11.001>
- Sawyer, D. (2022). *Damage control: Reducing the costs of climate impacts in Canada*. Canadian Climate Institute. https://climateinstitute.ca/wp-content/uploads/2022/09/Damage-Control-EN_0927.pdf
- Semieniuk, G., Holden, P. B., Mercure, J.-F., Salas, P., Pollitt, H., Jobson, K., Vercoulen, P., Chewpreecha, U., Edwards, N. R., & Viñuales, J. E. (2022). Stranded fossil-fuel assets translate to major losses for investors in advanced economies. *Nature Climate Change*, 12(6), Article 6. <https://doi.org/10.1038/s41558-022-01356-y>



- Shell. (2022). *Shell LNG outlook 2022*. https://www.shell.com/energy-and-innovation/natural-gas/liquefied-natural-gas-lng/lng-outlook-2022/jcr_content/root/main/section_599628081/promo_copy/links/item0.stream/1665743269121/3399fc5b65329ddf5fda80ad6cf2f6eab2abd9e5/shell-lng-outlook-2022.pdf
- Shen, M., Huang, W., Chen, M., Song, B., Zeng, G., & Zhang, Y. (2020). (Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change. *Journal of Cleaner Production*, 254, 120138. <https://doi.org/10.1016/j.jclepro.2020.120138>
- Sinn, H.-W. (2012). *The green paradox*. MIT Press.
- Smith, G., Blas, J., & El Wardany, S. (2020, December 1). *OPEC+ works silently to repair crack at oil coalition's core*. Bloomberg. <https://www.bloomberg.com/news/articles/2020-12-01/opec-splits-at-its-core-risking-deal-that-underpins-oil-price>
- Sperling, K., Madsen, P. T., Gorroño-Albizu, L., & Mathiesen, B. V. (2021). *Denmark without oil and gas production: Opportunities and challenges* (Oil and Gas Transitions). Aalborg University. <https://oilandgastransitions.org/wp-content/uploads/2021/11/Denmark-Oil-and-Gas-Report.pdf>
- Stanford, J. (2021). *Employment transitions and the phase-out of fossil fuels*. Centre for Future Work. <https://www.centreforfuturework.ca/wp-content/uploads/2021/01/Employment-Transitions-Report-Final.pdf>
- Stapczynski, S. (2023). *Clock is ticking for Qatar to sell its LNG*. Bloomberg. <https://www.bloomberg.com/news/newsletters/2023-05-23/clock-is-ticking-for-qatar-to-sell-its-lng?sref=CZ0inxEB>
- State of Colorado. (2019). *Climate Action Plan to Reduce Pollution, HB19-1261*. Colorado General Assembly, 2019 Regular Session. https://leg.colorado.gov/sites/default/files/2019a_1261_signed.pdf
- State of Green. (2021). *The economic benefits of wind energy*. <https://stateofgreen.com/en/news/the-economic-benefits-of-wind-energy/>
- State of Illinois. (2021). *Gov. Pritzker signs transformative legislation establishing Illinois as a national leader on climate action* [Press release]. <https://www.illinois.gov/news/press-release.23893.html>
- Statista. (2021). *Industry revenue of “coal mining” in Illinois from 2012–2024*. <https://www.statista.com/forecasts/1208703/coal-mining-revenue-in-illinois>
- Statista. (2022, February). *Total number of employees in the crude petroleum and natural gas extraction sector in Denmark from 2008 to 2019*. <https://www.statista.com/statistics/422208/number-of-employees-extraction-of-crude-petroleum-and-natural-gas-denmark/>
- Statistics Canada. (2018, June 27). *Coal, monthly production and exports*. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510004601>
- Statistics Canada. (2022a, March 29). *Employment by industry, annual—Table 14-10-0202-01*. <https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1410020201>



- Statistics Canada. (2022b, December). *Gross domestic product (GDP) at basic prices, by industry, provinces and territories—Table 36-10-0402-01*. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610040201>
- Stocker, M., Baffes, J., & Vorisek, D. (2018, January 18). *What triggered the oil price plunge of 2014–2016 and why it failed to deliver an economic impetus in eight charts*. World Bank Blogs. <https://blogs.worldbank.org/developmenttalk/what-triggered-oil-price-plunge-2014-2016-and-why-it-failed-deliver-economic-impetus-eight-charts>
- Stockholm Environment Institute, International Institute for Sustainable Development, ODI, E3G, and United Nations Environment Programme. (2021). *The production gap report 2021*. <http://productiongap.org/2021report>
- Structural Development Act [Strukturstärkungsgesetz Kohleregionen], 1795 (2020). Germany. <http://www.bgbl.de/xaver/bgbl/start.xav?startbk=BundesanzeigerBGBI&jumpTo=bgbl120s1795.pdf>
- Thibault, B., Jeyakumar, B., Brown, G., & Olmsted, K. (2021). *From coal to clean: Canada's progress toward phasing out coal power*. Pembina Institute. https://doi.org/10.1163/9789004322714_cclc_2021-0028-170
- Thurton, David. (2022). *Finance Canada defends \$10 billion loan guarantee for Trans Mountain*. CBC News. <https://www.cbc.ca/amp/1.6449824>.
- Thurton, David. (2023). *The overbudget Trans Mountain pipeline project is carrying \$23B in debt — and needs to borrow more*. CBC News. <https://www.cbc.ca/amp/1.6841502>.
- Tippee, B. (2021). Wood River refinery expansion nearly complete. *Oil & Gas Journal*. <https://www.ogj.com/refining-processing/refining/capacities/article/17266109/wood-river-refinery-expansion-nearly-complete>
- Toft, L., & Dusyk, N. (2022, August). *Why Canadian liquefied natural gas is not the answer for the European Union's short-term energy needs*. International Institute for Sustainable Development. <https://www.iisd.org/articles/deep-dive/canadian-lng-not-eu-energy-crisis-solution>
- Trout, K., Muttitt, G., Lafleur, D., Graaf, T. V. de, Mendelevitch, R., Mei, L., & Meinshausen, M. (2022). Existing fossil fuel extraction would warm the world beyond 1.5 °C. *Environmental Research Letters*, 17(6), 064010. <https://doi.org/10.1088/1748-9326/ac6228>
- United Kingdom. (2021). *COP 26 declaration: International Aviation Climate Ambition Coalition*. <https://www.gov.uk/government/publications/cop-26-declaration-international-aviation-climate-ambition-coalition/cop-26-declaration-international-aviation-climate-ambition-coalition>
- United Kingdom. (2022). *Jet zero: Our strategy for net zero aviation*. <https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050>



- United Nations. (2023, March 20). *Secretary-General calls on states to tackle climate change 'time bomb' through new solidarity pact, acceleration agenda, at launch of Intergovernmental Panel Report* [Press release]. <https://press.un.org/en/2023/sgsm21730.doc.htm>
- United Nations Comtrade. (2021). *United Nations Comtrade Database*. <https://comtrade.un.org/>
- United Nations Environment Programme. (2022). *Emissions gap report 2022*. <http://www.unep.org/resources/emissions-gap-report-2022>
- United Nations Framework Convention on Climate Change. (2015). *Paris Agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf
- United States Energy & Employment. (2021). *Energy employment by state: 2021* (United States Energy & Employment Report). <https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20State%20Reports.pdf>
- U.S. Department of Energy. (2022). *2022 U.S. Energy and Employment Report Fact Sheet*. U.S. Department of Energy, Office of Policy, Office of Energy Jobs. https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20Fact%20Sheet_0.pdf
- U.S. Energy Information Administration. (2020, July). *Colorado ranks seventh among states with the most energy production*. <https://www.eia.gov/todayinenergy/detail.php?id=44476>
- U.S. Energy Information Administration. (2022a, December). *Cushing, OK WTI spot price FOB (dollars per barrel)*. Petroleum and other liquids - Data. <https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M>
- U.S. Energy Information Administration. (2022b). *Illinois state energy profile*. <https://www.eia.gov/state/print.php?sid=il>
- U.S. Energy Information Administration. (2022c). *Henry Hub natural gas spot price (dollars per million Btu)*. Natural gas - Data. <https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm>
- U.S. Senate. (n.d.). *Summary of the Energy Security and Climate Change Investments in the Inflation Reduction Act of 2022*. https://www.democrats.senate.gov/imo/media/doc/summary_of_the_energy_security_and_climate_change_investments_in_the_inflation_reduction_act_of_2022.pdf
- van der Ploeg, F., & Rezai, A. (2020). Stranded assets in the transition to a carbon-free economy. *Annual Review of Resource Economics*, 12(1), 281–298. <https://doi.org/10.1146/annurev-resource-110519-040938>
- van Est, R. (2022). The success of Danish wind energy innovation policy: Combining visionary politics and pragmatic policymaking. In C. de la Porte, G. B. Eydal, J. Kauko, D. Nohrstedt, P. 't Hart, & B. S. Tranøy (Eds.), *Successful public policy in the Nordic countries* (1st ed., pp. 45–65). Oxford University Press. <https://doi.org/10.1093/oso/9780192856296.003.0003>
- Webster, J., Fitz, R., Berns, M., Follette, C., & Gordon, A. (2021). *The last oil price boom may be in sight*. BCG. <https://www.bcg.com/publications/2021/preparation-for-last-oil-price-boom>



- The White House. (2022). *Inflation Reduction Act guidebook: Clean energy*. <https://www.whitehouse.gov/cleanenergy/inflation-reduction-act-guidebook/>
- Wilke, S. (2020, January 21). *Indicator: Employment in the renewable energy sector*. Umweltbundesamt; Umweltbundesamt. <https://www.umweltbundesamt.de/en/data/environmental-indicators/indicator-employment-in-the-renewable-energy-sector>
- Williams-Derry, C. (2023a, February 1). *British Columbia LNG project costs rising again*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/british-columbia-lng-project-costs-rising-again>
- Williams-Derry, C. (2023b, April 24). *LNG exports may spell trouble on horizon for U.S. consumers*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/lng-exports-may-spell-trouble-horizon-us-consumers>
- Willige, A. (2022, August 19). *Hydrogen production: Is it better to go green or blue ... or green and blue?* *Spectra*. <https://spectra.mhi.com/hydrogen-production-is-it-better-to-go-green-or-blue-or-green-and-blue>
- World Meteorological Organization. (2022). *WMO global annual to decadal climate update*.
- World Resources Institute. (2021a). *European Union's Just Transition Mechanism: Transnational funding and support for a just transition*. <https://www.wri.org/update/european-unions-just-transition-mechanism-transnational-funding-and-support-just-transition>
- World Resources Institute. (2021b). *Germany: The Ruhr region's pivot from coal mining to a hub of green industry and expertise*. <https://www.wri.org/update/germany-ruhr-regions-pivot-coal-mining-hub-green-industry-and-expertise>
- Yedlin, Deborah. (2022, March 11). *The world needs Canadian oil and gas – it just doesn't know it yet*. CBC News. <https://www.cbc.ca/news/canada/calgary/opinion-canadian-energy-ceraweek-yedlin-1.6379930>

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